Roman Corobov

Climate Change Adaptation Policies in the Framework of Sustainable Environmental Management

An Emphasis on Countries in Transition

Eco-Tiras

Roman Corobov

Climate Change Adaptation Policies
in the Framework of Sustainable Environmental Management

An Emphasis on Countries in Transition

Eco-TIRAS
Chisinau 2011

Dr. Roman M. Corobov
Independent Researcher
Eco-TIRAS Association

Str. Teatrala 11A, Chisinau MD-2012, Republic of Moldova
Tel./Fax: (+373 22) 225615
E-mail: ecotiras@mtc.md
www.eco-tiras.org

Climate change adaptation policies in the framework of sustainable environmental management: An emphasis on countries in transition.

The threat of global warming is a typical example of systemic environmental problems, which become more urgent and, being connected in unforeseen ways, create unexpected impacts. It is also increasingly recognized interaction between climate change and development. The environment and sustainable development dimensions are major 'lenses' through which climate change adaptation is discussed in this book, intertwining the three issues as single challenge. The framing of climate change as an environmental and human-influenced development problem necessary shifts research strategies from a mono-disciplinary approach with an emphasis on natural sciences towards an interdisciplinary research with stronger focus on co-production of scientific knowledge between natural and social scientists, policy-makers, and society. The book presents a thorough review of the recent literature on the discussed themes. Some original findings of the author and his colleagues are used mainly to illustrate different scientific and political recommendations expressed in the cited sources. The structure of the book follows its principal idea and targeted audience, first of all those who work in the climate change field in countries with economy in transition, and is aimed at specialists who are sufficiently acquainted with the problem.

Reviewers:
Prof. Alexios Antypas & Prof. Ruben Mnatsakanian,
Department of Environmental Sciences and Policy, Central European University, Budapest

Copy editing and design:
Aureliu Overcenco,
Institute of Ecology and Geography, Academy of Sciences of Moldova

Descrierea CIP a Camerei Naționale a Cărții

Corobov, Roman
Climate change adaptation policies in the framework of sustainable environmental management: An emphasis on countries in transition / Roman Corobov. – Ch.: Eco-TIRAS, 2011 (Tipogr. "Elan Poligraf" SRL). – 664 p.
500 ex.
ISBN 978-9975-66-233-8

CZU 502/504(094)
C 71

Contents

Preface

Global climate change has evolved from being an abstract scientific problem to one of the most politically, economically and environmentally challenging issues that the world will face in this century. It also represents a profound, long-term challenge for governments, business, and society at large.

Much has been said about the complexities of climate change, which along with fruitful international cooperation in this field has led to important advances in scientific understanding of its causes and consequences. With the publication of the IPCC's 4th Assessment Report (IPCC, 2007) and the Stern Review on the economics of climate change (Stern, 2007), the scientific background and social and environmental implications of the problem have become clearer. It is the current consensus of numerous international experts that most of the global warming in recent decades can be attributed to human activities, and the rate and severity of changes in climate will increase in the absence of significant steps to reduce greenhouse gas emissions into the atmosphere. Given the evident human impact on climate, decisions made in the coming decades will significantly shape the world's weather, geography, distribution of plant and animal life, and even population health and well-being.

Since some climate change impacts will be irreversible, and some may be catastrophic, the need for actions is clear, both to avert the potential adverse consequences and to prepare for those which cannot be avoided. Moreover, mounting scientific evidence provide clear justification for stronger action now and in the decades to come. While further scientific work is needed to better characterize future climate risks, any delaying action could substantially increase the long-term costs of addressing these risks and will result in harsher climate impacts and undermine economic growth, particularly in poor countries. The critical question is how best to engage nations and their peoples in the efforts to fairly and effectively mobilize technology and resources needed to protect the earth's climate and sustain economic growth. Global warming is inherently a global challenge that calls for a policy response. As a result, the focus of the debate has finally shifted from whether the climate is indeed changing to what we can do about it, although the gap between scientific evidence and political response remains large (UNDP, 2007a).

Anthropogenic climate change was brought to public attention in the 1980s and initially was viewed as an atmospheric physic and environmental problem for scientific analysis, while its human dimensions were ignored. As the recognition of the human-induced drivers of global warming has become nearly universal, along with an understanding that changes in climate are already inevitable, the parameters of the related debate have also shifted. Now, the emphasis is spreading rapidly from the scientific to policy realm and in the latter – from the societies' intervention to reduce an anthropogenic forcing of the climate system *(mitigation)* toward a focus on adjustment in natural or human systems in response to observed or expected impacts that are unavoidable *(adaptation).* The task challenge for policymakers is to understand these tendencies and to develop and implement policies that ensure the optimal level of adaptation.

Undoubtedly, a political interest in addressing the threats associated with climate change is increasing at all levels of environmental governance. Adaptation is already taking place but, as the European Commission (2009) stated, in a 'piecemeal manner', and a more strategic approach is needed to ensure that adaptation measures are taken timely and effectively. The need to integrate a climate change dimension into all areas of policy-making has become more acute, but there are still no accepted methods for achieving this goal. Similarly, it is becoming obvious that new policies in climatic and non-climatic sectors are needed to be designed in ways, which facilitate rather than hinder adaptive decisions.

In large part, the present political response to the situation is inadequate. Many governments continue to put the climate change issue behind their fundamental commitments to strong economic growth and political stability, especially in developing and transition countries. A serious barrier to effective addressing climate change concerns is the lack of integrated policy-making at different levels of action and among different government agencies. In order to 'normalize' climate adaptation, it is necessary to examine all dimensions of the global warming problem and to consider why, what and where actions are needed. Development of the prospects for connecting climate adaptation more closely to existing policies and management capacities creates a strong basis on which to build adaptation strategies. Action should be focused on increasing the ability of the public sector to assess, design and implement policies that appropriately satisfy environment and sustainable development objectives.

The environment and sustainable development dimensions are major 'lenses' through which climate change adaptation is discussed in this book. However, these 'lenses' cannot be addressed (and understood by a potential reader) without answering some basic questions: How serious is the climate change problem, and are there serious climate impacts that justify precautionary actions? What dilemmas do countries face? Are there other factors that could facilitate or hinder an adaptation process?

The threat of global warming is a typical example of systemic environmental problems, which become more urgent and, being connected in unforeseen ways, create unexpected impacts. Although in the contemporary world the humanity faces many urgent problems, the environmental issues are high on the list of topics that science, technology, economy and other spheres of human activity must contribute to deepen their understanding, to develop policy options and take actions to address if not resolve. State-of-the-art management of the environment and its resources requires multidisciplinary and integrated research in order to advance available understanding of the interactions between climate, biosphere, ecosystems and human activities. The widespread recognition that many environmental problems are both systemic and global in scope has introduced a variety of challenges for science and decision-makers. At the same time, mainly according to the latest IPCC assessments, global warming is considered to be vastly different from other environmental and public policy issues. It is of interest to summarize these differences. This will help to explain why this is so and to militate against easy solutions.

On the other hand, the magnitude of observed impacts and anticipated future consequences of climate change, as of a systemic environmental problem, has focused the attention of public and policy-makers not only on confronting climate change *per se*, but also on current notions of sustainable development that remains a guiding theme in international relations. Interaction between climate change and development is being increasingly recognized: climate change vulnerability and impacts influence prospects for development; in turn, the development path not only determines greenhouse gas emissions and mitigation efforts, but also influences capacities to adapt to new climatic conditions. Understanding of these links has accelerated a shift from the one-sided political and scientific focus on confronting climate change as a stand-alone problem towards a broader interdisciplinary perspective on adaptation. The sustainable development framework strengthens efforts to harmonize sometimes disparate categories of climate change responses. The aim of this book is not to address comprehensively the different aspects of sustainable development, but rather to review available methodological frameworks and practical approaches to put strategies of climate change adaptation in the context of sustainable development and, thus, to widen the discussion. In most studies it is mainly limited to mitigation issues; significantly less research is concentrated on the sustainability effects of adaptation options.

The increasing concerns of society and policy about climate change have reshaped the production of relevant knowledge. To decide and prioritize a political action, we need to know how environmental and social systems are affected by climate change and much more about how they interact during this process. Under the likely significant incremental losses for national or local economies, it is crucial to understand what value, which people, assets and sectors are at risk, both from historic climate patterns and from new threats. Just as importantly, policy and decision-makers need a robust and rapid way to identify the adaptation measures required to avert possible losses at the lowest possible cost to society. To be able to implement any new adaptation regime, more knowledge is needed about how such regimes are brought to life. The framing of climate change as an environmental and human-influenced development issue shifted research strategies from a mono-disciplinary approach with an emphasis on the natural sciences towards an interdisciplinary research strategy with stronger focus on co-production of scientific knowledge between natural and social scientists, policy-makers, and society. If knowledge about future climate, especially regional, and response strategies is incomplete, decision-makers have no option but to make policy choices under uncertainty.

The focus of the discussion is primarily on countries with economies in transition and, first of all, on the countries of the Former Soviet Union where these problems have not been previously discussed or summarized as an independent issue. In the context of transition countries, the need for adaptation is urgent because here it must be coupled with efforts to improve rural and urban livelihoods, especially for the poorest and most vulnerable. There is a deficit of research on how stakeholders and the public in these countries will respond to climate impacts, while understanding that evolution and shaping of a nation policy is the function of its position in the world system, of its economic status resulting from this position, and consequently – the nation's contribution to addressing global warning concerns. This function is disturbed by other complicating factors: geography, energy resource endowments, population size, level of industrial maturity, and others.

Undoubtedly, this book addresses only a small part of the broad topic of climate change adaptation. Tackling this problem requires specific policies addressing a wide range of activities and sectors, the development of integrated national response strategies combining technology development, new scientific research, identification of critical steps in key sectors and dimensions that contribute to the problem on the whole. We must agree with the opinion of the now deceased Dr. Stephen Schneider – a well-known American climatologist – expressed in one of his last interviews[1]: *"Will those of us arguing for such policies and measures succeed? I think partly. We will have weaker targets than any of us would like to see. We will have weaker policies than we'd like to see, but much stronger than we've ever seen before"*.

---

[1] Snell M.B., 2009: TNR Q&A: Dr. Stephen Schneider. *The New Republic,* November 9, 2009. See: *http://www.tnr.com*

Additionally, the UNDP, in its Human Development Report 2007/2008, calling for human solidarity in fighting climate change, considers this battle as a part of the fight for humanity. Winning this battle will require far-reaching changes at many levels in consumption, in how we produce and price energy, in international cooperation and, above all, in how we think about our ecological interdependence, social justice and entitlements of future generations to a worthy life.

What is the 'genre' of this book? I think that it is a thorough review of the recent literature on the discussed themes. Some original findings of the author and his colleagues are used mainly to illustrate different scientific and political recommendations expressed in the cited sources. The structure of the book follows its principal idea and targeted audience – those who work in the climate change field in the countries of the FSU. Undoubtedly, the weakest place of environmental and climate change research in this region is insufficient knowledge of international studies that can be explained by limited access to the world's leading scientific journals and thematic collections. I would like to believe that this book will help, even partially, to bridge this knowledge gap; however, it cannot serve as a 'textbook', since it is aimed at specialists who are sufficiently acquainted with the problem of confronting climate change.

This publication was made feasible thanks to two great opportunities that were provided for the author in the form of a Fulbright Award in 2003 (Pennsylvania State University, U.S.) and a Research Fellowship at the Central European University (Budapest, Hungary) in 2007. Moreover, the fellowship at the Department of Environmental Sciences and Policy of this University, which is a center of excellence for environment-related scholarship and teaching in Europe, helped the forming of an idea to intertwine and examine climate change and environmental problems as single challenge. The research trip to Kent State University in 2009, awarded by the U.S. Civilian Research & Development Foundation for the Independent States of the Former Soviet Union (CRDF), allowed for updating of the initial literature search. The rich scientific libraries (including electronic ones) of all these universities have demonstrated the enormous potential for research provided by advanced information technologies. Final editing of the book was supported by the Black Sea Trust for Regional Cooperation; prepress and publishing was financed by the Rosa Luxemburg Foundation (Germany).

I wish to express my deep appreciation to all these organizations for their assistance.

I would like to mention Prof. Alexios Antypas and Prof. Ruben Mnatsakanian with whom I shared and developed the principal concept of this work during my stay in CEU. Unfortunately, due to other commitments, these people were unable to be co-authors. Ms Christine Sylvester is sincerely acknowledged for her useful comments and editing. Dr. Ilya Trombitsky and Dr. Aureliu Overcenco, who are always open to help any author, rendered an invaluable service by promoting the publication.

I would also like to thank my colleagues, friends and my family for their continuous support and motivation to finish this book, even though sometimes I felt that I could not do so.

Author

Abbreviations

AMSD	Adaptation & Mitigation in the context of SD
ANSEA	Analytical Strategic Environmental Assessment
APF	Adaptation Policy Framework
AR4	IPCC Fourth Assessment Report
CCA	Causal Chain Analysis
CCE	Central and Eastern Europe
CCFM	Climate Change Funding Mechanism
CCIAV	Climate Change, Impacts, Adaptation and Vulnerability assessment
CDM	Clean Development Mechanism
CEE	Central and Eastern Europe
CEM	Corporate Environmental Management
CERF	Central Emergency Response Fund
COP	Conference of Parties to UNFCCC
CRA	Community Risk Assessment
CIS	Commonwealth of Independent States
DAI	Dangerous Anthropogenic Interference with the climate system
DEV	Decisional Environmental Value
DCP	Development Cooperation Policy
DDC	IPCC Data Distribution Centre
DRA	Disaster Risk Assessments
EA	Environmental Assessment
EEA	European Environmental Agency
EECCA	Eastern Europe, Caucasus and Central Asia Region
EIA	Environmental Impact Assessment
EIT	Economy in Transition
EMS	Environmental Management System
EMT	Environmental Modernization Theory
EPI	Environmental Policy Integration
EST	Environmentally Sound Technologies
FSU	Former Soviet Union
HDI	Human Development Index
HWB	Human Well-Being
GCM	General Circulation Model
GDP	Gross Domestic Product
GEA	Global Environmental Assessment
GHG	Greenhouse Gas
GIS	Geographical Information System
GWP	Gross World Product
IA	Integrated Assessment
IA/SIA	Integrated/Sustainability Impact Assessment
IAIA	International Association for Impact Assessment

IEA	Integrated Environmental Assessment
IHDP	International Human Dimensions Program
IPCC	Intergovernmental Panel on Climate Change
ISA	Integrated Sustainability Assessment
JI	Joint Implementation
LVI	Livelihood Vulnerability Index
MEA	Multilateral Environmental Agreement
MDG	Millennium Development Goal
NSDS	National Sustainable Development Strategy
NCSP	UNDP National Communication Support Programme
NEPA	US National Environmental Policy Act
NEPI	New Environmental Policy Instruments
NGO	Nongovernmental Organization
NIS	Newly Independent States
OECD	Organization for Economic Cooperation and Development
ODA	Official Development Assistants
OVOS	Assessment of Environmental Impacts (abbreviation in Russian)
PCM	Project Cycle Management
PIA	Participatory Integrated Assessment
PPP	Policies, Plans and Programmes
PRA	Participatory Rapid Appraisal
R&D	Research and Development
SA	Social Assessment
SAC	Synergistic Adaptive Capacity
SD	Sustainable Development
SCCF	Special Climate Change Fund
SEA	Strategic Environmental Assessment
SER	State Environmental Review
SES	Socio(al)–Ecological System
SDA	Sustainable Development Assessment
SDS	Sustainable Development Strategies
SIA	Sustainability Impact Assessments
SME	Small & Medium Size Enterprises
SOT	Synergies, Opportunities and Threats analysis
SRES	Special Report on Emissions Scenarios
S&T	Science and Technology
TAR	IPCC Third Assessment Report
TWA	Tolerable Windows Approach
UNCSD	UN Commission on Sustainable Development
UNDP	United Nations Development Program
UNEP	United Nations Environmental Program
UNFCCC	United Nations Framework Convention on Climate Change
V&A	Vulnerability and Adaptation
WCED	World Commission on Environment and Development
WEHAB	Water, Energy, Health, Agriculture and Biodiversity framework
WG	IPCC Working Group
WMO	World Meteorological Organization
WSSD	World Summit on Sustainable Development in Johannesburg

Chapter 1
Climate Change as a Global Problem

1.1. Today's vision of climate change: principal conclusions from the IPCC Assessment Reports

1.1.1 Understanding of human-induced climate change

Many definitions for climate change have been developed; however, the recognized authority on climate change research, the Intergovernmental Panel on Climate Change (IPCC), believes that to understand a complex subject such as climate change, one must first understand the meaning of *climate*. According to the IPCC definition (IPCC, 2007d, p. 871), "Climate in a narrow sense is usually defined as the 'average weather', or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands or millions of years". The 'relevant quantities' are most often surface variables such as air temperature, precipitation and wind; the classical period for averaging is 30 years as defined by the World Meteorological Organization (WMO). In a wider sense, climate *"*is the state, including a statistical description, of the climate system*"*. The latter is the highly complex system consisting of five major components – *atmosphere, hydrosphere, cryosphere, land surface and biosphere* – as well as of the interactions between them. The following figure from the IPCC Third Assessment Report (IPCC, 2001b) aids the understanding of how these five components interact (Fig. 1.1).

The scientific understanding of the global *climate system* has greatly improved since 1900. However, until the 1960s the study of climate 'history' was mainly viewed as a specialized part of Atmospheric Sciences and Geography disciplines. In the early 1970s climate came into focus as a global issue. Ironically, several articles and books which appeared around this time suggested the beginning of global climate cooling, sparking scientific and public concern that the Earth was moving to a new Ice Age. Glantz and Adeel (2000) explained this phenomenon by stating that the period from the 1940s to the early 1970s was cooler than the long-term average for the previous decades. Several additional examples supported this theory of global cooling. A list of subtle environmental changes reinforced the global cooling hypothesis, in particular an unusual inter-annual variability, coupled with famines in Africa in the early 1970s. The reanalysis of the climate system behavior began in the mid-1970s, opening a debate about the stability of the global climate. During the 1980s, scientific interest in the climate change issue grew significantly, resulting in the United Nation Framework Convention on Climate Change (UNFCCC) and the creation of the IPCC, although each had its own area of study (Box 1.1).

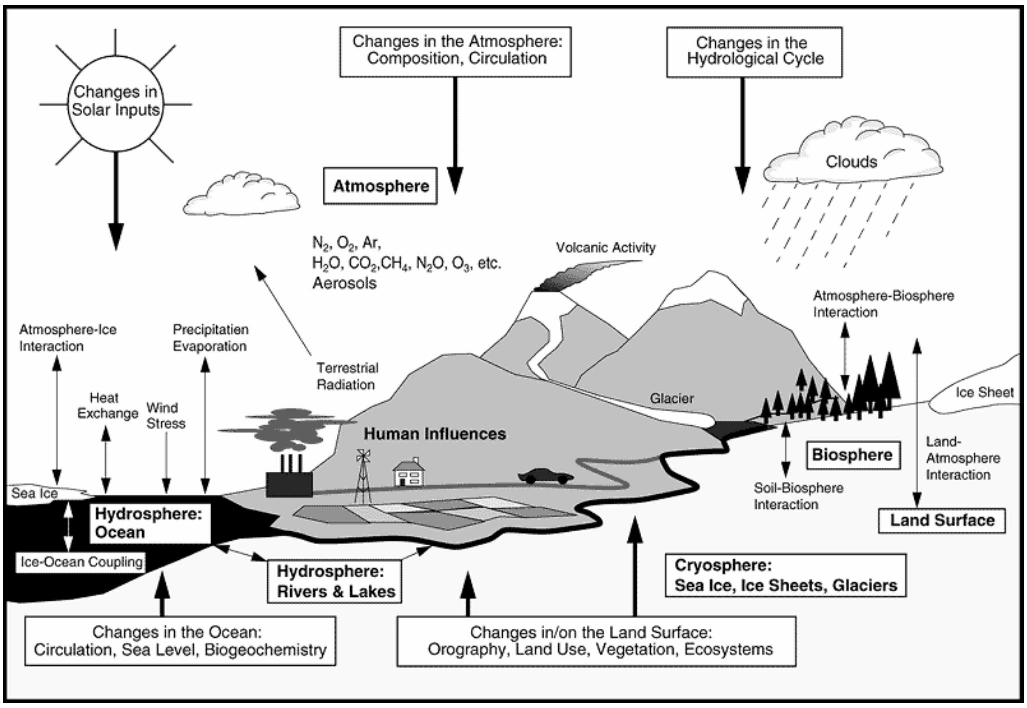


Fig. 1.1 Schematic view of the components of the global climate system *(bold),* their processes and interactions *(thin arrows)* and some aspects that may change *(bold arrows)*. *Source*: IPCC, 2001b

> **Box 1.1** Definitions of climate change
>
> The IPCC refers *climate change* to a change in the state of the *climate* that can be identified (e.g. by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. Climate change may be due to natural *internal processes* or *external forcing*, or to persistent *anthropogenic* changes in the composition of the *atmosphere* or in *land use*.
>
> The UNFCCC defines *climate change* as a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods. Thus, the UNFCCC makes a distinction between climate change attributable to human activities altering the atmospheric composition, and *climate variability* attributable to natural causes.
>
> *Source:* IPCC, 2007b

As is well known, the global mean climate is determined by incoming energy from the Sun, the properties of the Earth and its atmosphere, namely through reflection, absorption and emission of energy within the atmosphere (Fig. 1.1). Any change in the amount of solar energy inevitably affects the Earth's energy budget; however, Earth's atmosphere and the planet surface also are important and may be affected by climate feedbacks (Solomon *et al.,* 2007). The character of astrophysics and celestial mechanics (cyclic variations of solar radiation flux, variations in elements of the Earth's orbit, e.g., eccentricity, longitude of perihelion or obliquity of the ecliptic), in combination with the nonlinearity of the Earth's climate system, induce natural variations in climate and form a baseline for its change

(Semenov, 2004). In addition to its own internal dynamics, the climate system is evolving over time under the influence of *external forcing,* such as volcanic eruptions.

The global climate has always varied naturally, but compelling evidence from around the world indicates that a new kind of change in climate is now under way, foreshadowing the drastic impacts on people, ecosystems and economies (IPCC, 2007a).

The Fourth Assessment Report of IPCC (hereinafter AR4) confirmed previous IPCC assessments that *anthropogenic (or human)* forcing, caused by the changes in several aspects of the atmosphere and the Earth surface (e.g., in a land-use practice, which transforms landscapes and leads to changes in albedo), alter the global energy budget and therefore can cause the climate to change (Solomon *et al.,* 2007). Among these changes are increases in greenhouse gas (Box 1.2) concentrations that act primarily to increase the atmospheric absorption of outgoing radiation, and increases in aerosols (microscopic airborne particles or droplets) that act to reflect and absorb incoming solar radiation and change cloud radiative properties. Such changes cause a radiative forcing[1] of the climate system. Forcing agents can differ considerably in their magnitudes of forcing, as well as spatial and temporal features. Positive and negative radiative forcings contribute to increases and decreases, respectively, in global average surface temperature.

The dominant factor in the radiative forcing of climate is the increasing concentration of various GHGs in the atmosphere. It is well known that the Earth's ability to support life – human societies – is influenced by the level of GHGs that envelop our planet, warm its surface, and deteriorate the atmosphere that protects us from harmful radiation. The warming effect of GHGs, referred to as the *greenhouse effect,* maintains a habitable climate, accounts for human, animal and plant life on the Earth and explains its absence on other planets of our solar system. For example, the abundance of GHGs on the planet Venus makes it too hot for human habitation, but the low levels of GHGs on the planet Mars make it too cold for life. Earth's temperature, like

Box 1.2 Greenhouse gases

Greenhouse gases (GHG) are those gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of thermal infrared radiation emitted by the Earth's surface, the atmosphere itself, and by clouds. This property causes the *greenhouse effect*. Water vapor (H_2O), *carbon dioxide* (CO_2), *nitrous oxide* (N_2O), *methane* (CH_4) and *ozone* (O_3) are the primary GHG in the Earth's atmosphere. Moreover, there are a number of entirely human-made GHG in the atmosphere, such as the *halocarbons* and other chlorine and bromine containing substances, dealt with under the Montreal Protocol. Beside CO_2, N_2O and CH_4, the *Kyoto Protocol* deals with *sulfur hexafluoride* (SF_6), *hydrofluorocarbons* (HFCs) and *perfluorocarbons* (PFCs) greenhouse gases.

Source: IPCC, 2007b

[1] *Radiative forcing* is the change in the net vertical irradiance at the tropopause due to an internal or external change in the forcing of the climate system, such as a change in the concentration of CO_2 or the output of the Sun. *Radiative forcing* is also a measure of the influence a factor has in altering the balance of incoming and outgoing energy in the Earth-atmosphere system and is an index of the factor importance as a potential climate change mechanism. Positive forcing tends to warm the surface, while negative – to cool it. In AR4, radiative forcing values are for changes relative to a pre-industrial background at 1750, are expressed in Watts per square metre (W m^{-2}) and, unless otherwise noted, refer to a global and annual average value (IPCC, 2007a, b)

Goldilocks' porridge[2], is just right (Rosa, 2001). However, if the level of GHGs on Earth will become too high, the resulting overall rise in air temperatures – *global warming* – is liable to disrupt natural patterns of the Earth's climate.

Some GHGs occur naturally; however, increases in their atmospheric concentrations over the last 250 years are largely due to or entirely the result of human activities. Several industrial, economic and residential activities were thought to be contributors, including the heavy use of fossil fuels, tropical deforestation, formations from precursor species emitted to the atmosphere (as a refrigerant and foam-blowing agent), and so on. Levels of CO_2 and other GHGs in the atmosphere have risen steeply spurred by economic and population growth as well as by new tendencies in global socio-economic development (UNFCCC, 2005). Nijkamp and Verbruggen (2003) have found several megatrends that are likely to act as drivers in the occurrence of global warming. Because this list is almost endless, depending on the disciplinary angle taken, the authors selected eight driving forces which are directly linked with human behavior patterns. In Table 1.1 they are presented along with AR4's list.

Table 1.1 Two lists of assumed socio-economic drivers of anthropogenic climate change

AR4 Synthesis Report (IPCC, 2007a)	*Nijkamp and Verbruggen* (2003)
• governance	• institutional change
• technology	• internationalization and economic integration
• trade	• rapid technological progress
• production and consumption patterns	• the emergence of a knowledge economy
• socio-cultural preferences	• improvement of transport systems
• population	• demographic development and transformations
• literacy	• cultural shifts
• equity	• international business strategies
• health	

The identified megatrends portray a global economy where Western patterns of energy-intensive production, modes of consumption and transport spread rapidly across countries (Box 1.3). The risk of further danger climate change is even greater if the global economy locks itself into this energy-intensive trajectory with high energy demand.

However, some megatrends contain the seeds of change. A shift is occurring in economic structures away from manufacturing towards the service sector. This transition in the developed world will gradually emerge in developing and transitioning countries as further economic development proceeds. The service economy is transforming into a knowledge economy and information society. There are indications that the knowledge economy will spread worldwide at a much faster pace that any previous technological trajectory[3]. These major transformations are supported by the promise that rising global

[2] *The Goldilocks Principle* or '*Goldilocks effect'* states that something must fall within certain margins, as opposed to reaching certain extremes. It is used, for example, in the Rare Earth hypothesis to state that a planet must neither be too far away nor too close to the Sun to support life (See: *http://en.wikipedia.org/wiki/Goldilocks_Principle*)

[3] "The continuing adoption of advanced information, communications technologies and of more open, market-based economic policies has led to further integration of the world economy, accelerating

Box 1.3 The Dynamics of World Energy Production

Industrialization, more goods and better living standards were only possible because new sources of energy became available. In 1860 the consumption of coal as an energy source represented about 100 million tons per year; today we use more than 5 billion tons of coal per year. In recent years, the world has seen a movement to a new path of rapid global growth, largely driven by the developing countries which are energy intensive and heavily reliant on the use of coal. It was anticipated that global coal use would rise by nearly 60% from 2000 to 2010. In 1870 world oil production was less than 1 million tons per year, whereas today it exceeds 3 billion tons. In 1938, world gas production was less than 60 billion m^3 per year; now it is more than 2 trillion m^3, and still on the rise. For each of these three primary energy sources a roughly exponential increase in consumption has been observed since the years 1800 (coal), 1860 (oil) and 1940 (gas). This increase practically matches an exponential increase in the world's population: about 1 billion in 1750, 1.5 billion in 1860, 2.6 billion in 1950, 5.5 billion in 1990, and more than 6.8 billion in 2010. It is likely that, without changes to the policies in place, global CO_2 emissions from fuel combustion will nearly double their 2000 level by 2020 and would continue to rise.

Source: Bennewitz, 2009; Sheehan *et al.*, 2008

welfare will lead to a greater emphasis and concern for the environment in the interest of future generations. The potential to fully make a shift to a knowledge economy on a worldwide level is impressive, but this potential still has to be realized. Developing this idea further, the IPCC in AR4 (IPCC, 2007a) also pointed out that if at the time of its Third Assessment Report (IPCC, 2001), in the late 1990s, information was mainly available to describe the anthropogenic climate change driver–impact–response linkages clockwise, i.e. to derive climatic changes and impacts from socio-economic information and emissions, then with increased understanding of these linkages it became possible to assess them counterclockwise, or to evaluate possible development pathways and global emissions constraints that would reduce the risk of future adverse impacts.

The current concentration of GHGs is the net result of past emissions into the atmosphere, partially compensated by chemical and physical removal processes. With the important exception of CO_2, it is generally the case that these processes remove a fraction of the total amount of a given gas, depending on its mean lifetime. In some cases, the removal rate may vary with the gas concentration or other atmospheric properties (e.g., temperature or background chemical conditions).

The contribution of each GHG to radiative forcing over a particular time period is determined by the change in its atmospheric concentration and its effectiveness in disturbing the radiative balance. Long-living GHGs, for example, CO_2, CH_4 and N_2O, are chemically stable and stay in the atmosphere over time scale ranging from a decade to centuries and longer. Because these gases are long-living, they are well and much faster mixing throughout the atmosphere. Given this ability, their global concentrations can be accurately estimated from data at a few locations. CO_2 does not have a specific lifespan because it is continuously cycled between the atmosphere, oceans and land biosphere, and its net removal from the atmosphere involves a range of processes with different time scales. Short-lived gases (e.g., sulfur dioxide and carbon monoxide) are chemically

technological change and sustained rapid growth in countries such as China and India. This is a well-documented process, often referred to as the rise of the new economy or of the global knowledge economy. Sustained, higher than expected global economic growth has produced much greater energy demand than markets, providers and analysts have anticipated" (Sheehan *et al.*, 2008)

Box 1.4 Treatment of uncertainty in IPCC AR4

Different approaches are used to describe uncertainties in the IPCC assessment outputs, each with a distinct form of language. Choices among and within these approaches depend on both the nature of the information available and the authors' expert judgment of the correctness and completeness of current scientific understanding.

Where uncertainty is assessed qualitatively, it is characterized by providing a relative sense of the amount and quality of evidence and the degree of agreement through a series of self-explanatory terms such as: *high agreement, much evidence; high agreement, medium evidence; medium agreement, medium evidence*; etc.

Where uncertainty is assessed more quantitatively, using expert judgment of the correctness of underlying data, models or analyses, then the following scale of ***confidence levels*** is used to express the assessed chance of a finding being correct: *very high confidence* – at least 9 out of 10 chance*; high confidence* – about 8 out of 10; *medium confidence* – about 5 out of 10; *low confidence* – about 2 out of 10; and *very low confidence* – less than 1 out of 10.

Where uncertainty in specific outcomes is assessed using expert judgment and statistical analysis of a body of evidence (e.g. observations or model results), then the following ***likelihood*** ranges are used to express the assessed probability of occurrence/outcome: *virtually certain* – >99% probability of occurrence; *extremely likely* – >95%; *very likely* – >90%; *likely* – >66%; *more likely than not* – > 50%; *about as likely as not* – 33% to 66%; *unlikely* – <33%; *very unlikely* – <10%; *extremely unlikely* – <5%; *exceptionally unlikely* – <1% probability.

Working Group II has used a combination of *confidence* and *likelihood* assessments, while Working Group I has predominantly used *likelihood* assessments.

Unless otherwise stated, the numerical ranges, usually given in square brackets, indicate 90% uncertainty intervals (i.e. there is an estimated 5% likelihood that the value could be above the range given in square brackets and 5% likelihood that the value could be below that range). Uncertainty intervals are not necessarily symmetric around the best estimate.

Source: IPCC, 2007a

reactive and generally are removed by natural oxidation processes in the atmosphere, their removal at the earth's surface or by washout during precipitation; as a result, their concentrations vary significantly.

New observations and related modeling of GHG emissions, solar activity, land surface properties and some aspects of aerosols have led to improvements in the quantitative estimates of radiative forcing (IPCC, 2007b). Given the colossal amount of work completed by international researchers on this subject, it is not necessary to 'retell' their work. The following is a brief summary of the IPCC's principal conclusions, as well as their uncertainties (Box 1.4) based on the *Summary for Policymakers of the Contribution of Working Group I* to AR4 (IPCC, 2007c).

On the whole, it has shown that as a result of human activities, global atmospheric concentrations of long-living GHGs have increased markedly relative to pre-industrial conditions, defined as of 1750, and now far exceed values determined from ice core samples spanning many thousands of years. In particular:

- The atmospheric concentration of CO_2 has increased from a pre-industrial level of about 280 ppm[4] to 379 ppm in 2005. The latter exceeds by far the natural range over

[4] *ppm* (parts per million) or *ppb* (parts per billion) is the ratio of the number of GHG molecules to the total number of molecules of dry air

the last 650,000 years (180 to 300 ppm). The annual CO_2 concentration growth rate was larger during the last 10 years (1995–2005 average: 1.9 ppm per year) than it has been since the beginning of continuous direct atmospheric measurements (1960–2005 average: 1.4 ppm per year), although there is year-to-year variability in the rates of growth. The primary source of this increased concentration results from fossil fuel use; land-use change provides another significant but smaller contribution.

- The global atmospheric concentration of CH_4 has increased from a pre-industrial value of about 715 ppb to 1774 ppb in 2005, also exceeding by far the natural range of the last 650,000 years (320 to 790 ppb). It is *very likely* that the observed increase is due to anthropogenic activities, predominantly agriculture and fossil fuel use, but relative contributions from different source types have not been well determined.
- The global atmospheric N_2O concentration increased from a pre-industrial value of about 270 ppb to 319 ppb in 2005. The growth rate has been approximately constant since 1980; more than a third of all nitrous oxide emissions are anthropogenic and primarily due to agriculture.
- The combined radiative forcing due to increases in these three gases is +2.30[+2.07 to +2.53]W m^{-2}, and the rate of increase during the industrial era is *very likely* to have been unprecedented in more than 10,000 years. CO_2 radiative forcing increased by 20% from 1995 to 2005, the largest change for any decade in at least the last 200 years.
- Significant anthropogenic contributions to radiative forcing come from several other sources. Tropospheric ozone changes due to emissions of ozone-forming chemicals contribute +0.35[+0.25 to +0.65]W m^{-2}. Changes in surface albedo, due to land cover changes and deposition of black carbon aerosols on snow, exert average respective forcings of –0.2 and +0.1 W m^{-2}.

1.1.2 Evidences of the recent climate change

1.1.2.1 The Global Picture

The most principal AR4 conclusion is: *"Warming of the climate system is unequivocal, as is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level"* (IPCC, 2007b, p.5). Progress in understanding how climate is changing has been gained through improvements and expansion of numerous datasets and data analyses, broader geographical coverage, better understanding of uncertainties and a wider variety of measurements.

In particular, it was stated by IPCC (2007a) and in recent publications that:

1. In addition to observed changes in global average surface temperature shown in Fig. 1.2, twelve of the last thirteen years (1995–2007) rank among the thirteen warmest years in the instrumental record of global surface temperature since 1850. A century (1906–2005) linear trend of 0.74[0.56 to 0.92]°C is larger than the corresponding trend of 0.6[0.4 to 0.8]°C in 1901–2000. The trend over the second part of 1906 to 2005 period (0.13°C per decade) is nearly twice that for the first 50 years. Average Northern Hemisphere temperatures during the second half of the 20th century were *very likely* higher than during any other 50-year period in the last 500 years and *likely* the highest in at least

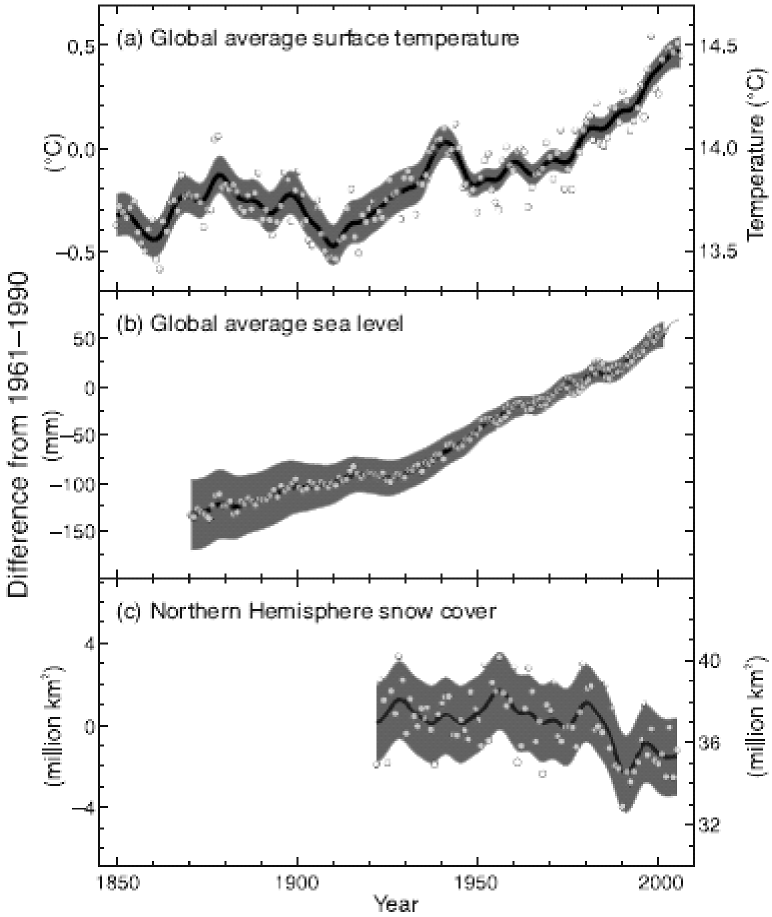


Fig. 1.2 Observed changes in global average surface temperature, global average sea level and Northern Hemisphere snow cover for March-April relative to corresponding averages in 1961–1990. Smoothed curves represent decadal averaged values while circles show yearly values. The shaded areas are the uncertainty intervals. *Source:* Solomon *et al.*, 2007

the past 1,300 years. As notable one can consider record, or near record, warmth of 2005 when global temperatures did not receive a boost from an El Niño, in contrast to the temperatures in 1998 that were raised by 0.2°C above the trend line due a "super El Niño" – the strongest one of the past century (Hansen *et al.,* 2006).

2. The geographic distribution of warming provides further proof of the existence of climate change. The temperature increase is widespread over the globe, but the largest warming is in remote regions, including areas at northern latitudes, specifically the Arctic. In the past 100 years, average Arctic temperatures have increased at almost twice the global average rate. Warming occurs over ocean areas, far from direct human effects, and at a higher rate than warming over land – an expected result for a forced climate change because of the ocean's great thermal inertia. The assertion that global warming is real – not an artifact due to measurements in urban areas – has been confirmed by surface

temperature changes inferred from borehole temperature profiles at remote locations (Hansen *et al.,* 2006).

3. Since 1961 the average temperature of the global ocean has increased to depths of at least 3000 m and the ocean has been absorbing over 80% of the heat being added to the climate system. Comparison of measured sea surface temperatures in the Western Pacific with paleoclimate data suggests that this critical ocean region, and probably of the planet as a whole, is approximately as warm now as at the Holocene Thermal Maximum[5] and within ~1°C of the maximum temperature of the past million years (Hansen *et al.,* 2006).

4. Increases in the global sea level are consistent with warming (Fig. 1.2). The average rate of water rising was about 1.8[1.3 to 2.3] mm per year over 1961 to 2003 and about 3.1[2.4 to 3.8] mm – from 1993 to 2003. Since 1993, the thermal expansion of the oceans has contributed about 57% of the total rise of sea levels, the reduced area of glaciers and ice caps accounts for about 28%, and losses from the polar ice sheets accounts for the remainder. The sum of individual contributions is consistent (within uncertainties) with the observed total rise in sea levels.

5. The observed decreases in the total amount of snow and ice are also consistent with warming (Fig. 1.2). Annual average extent of Arctic sea ice has shrunk by 2.7[2.1 to 3.3]% per decade, with larger decreases in summer – about 7.4[5.0 to 9.8]%. Additionally, the Arctic Ocean and north Eurasian coast is rapidly advancing towards perennial ice-free conditions. Since the late 1970s, these regions have lost nearly half of their end-of-summer extent. In September 2007, sea-ice extent was only around 60% of the average value for 1979–2000. The sea-ice retreat in 2007 occurred particularly in areas to the north of Siberia, Alaska, and the Northwest Passage. The first time in living memory this area was ice-free. The sea ice thickness has also been noticeably reduced. This development changes regional albedo and dramatically affects the cold season heat fluxes from the ocean to the atmosphere. These and other rapid ice-losses are expected to be largely reversible in the short-term (over a few years) (Groisman and Soja, 2009; Pope *et al.*, 2008).

There is a tendency towards a decrease in *snow cover*, while the amount of snow that falls during the cold season has generally increased, particularly in the western portion of Russia (Fig. 1.3 as an example). A significant increase in the maximum snow depth has been observed across the northern part of Russia (Bulygina *et al*., 2009).

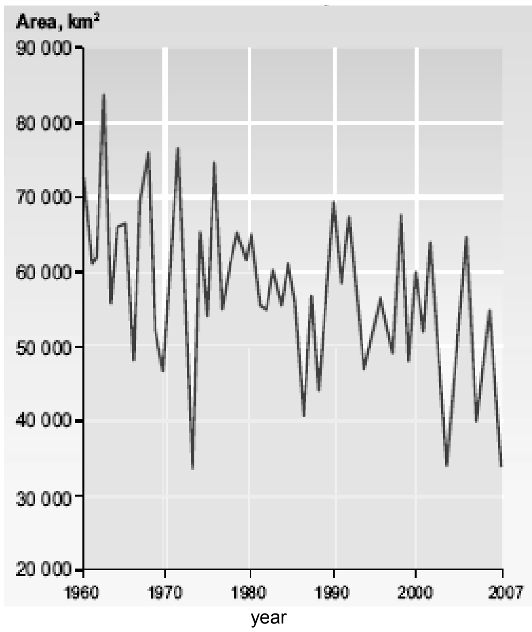


Fig. 1.3 Extent of winter ice cover in the northern Caspian Sea. *Source:* Zoï Environment Network, 2009

[5] The Holocene Thermal Maximum was a warm period during roughly the interval 9,000 to 5,000 yr B.P.

6. Nearly all mountain glaciers are shrinking and on average have declined in both hemispheres. Since 1900 the maximum extent of seasonally frozen ground has decreased by about 7% in the Northern Hemisphere, with decreases in spring up to 15%; since the 1980s the temperatures at the top of a permafrost layer have generally increased in the Arctic by up to 3°C. As temperatures increase, the massive banks of ice melt much faster than in the past. Fresh snow cannot make up for this loss, as glaciers retreat upslope and grow smaller. A recent review of world glaciers demonstrates that they have been retreating in nearly all areas since at least 1980, with an average loss in length of about 10 m per year; this pace is accelerating in many regions (Fig. 1.4). Unlike many other consequences of climate change, glacier retreat is highly visible and widely recognized by people (Lemke *et al.*, 2007; Orlove, 2009).

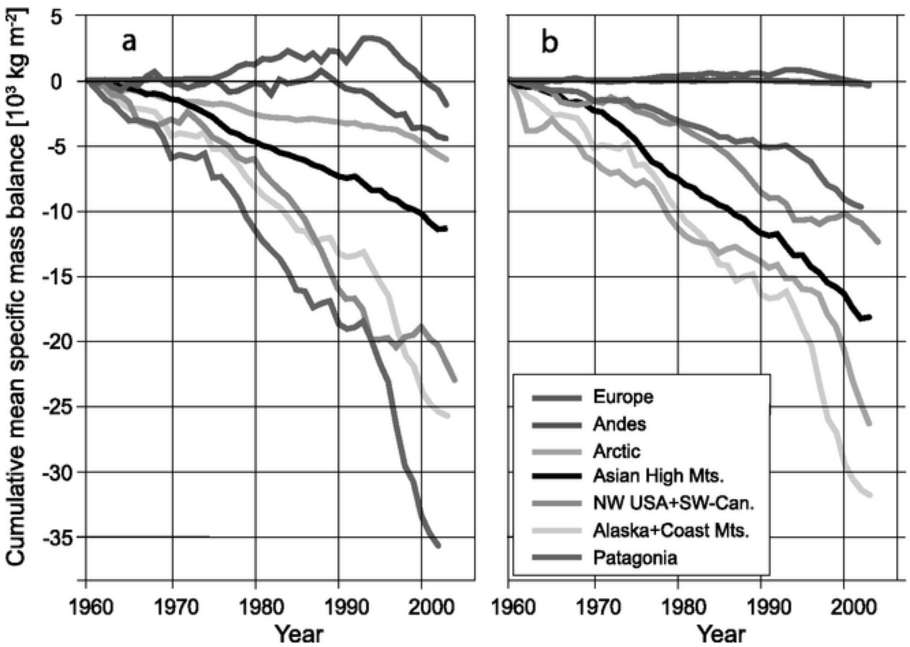


Fig. 1.4 World glacier trends: *a* – the loss of glacier ice per unit area in different regions; *b* – the contribution of each region to sea-level rise in sea-level equivalent (mm SLE). *Source:* Lemke *et al.*, 2007

The Fedchenko Glacier (Tajikistan) retreat is an example of a shrinking glacier (see picture below). This glacier, which exceeds 70 km in length and 2 km in width, and has ice thickness of 1 km, shrank by 1 km in length during the 20th century. On the whole, in the last 50-60 years between 14% to 30% of the Tien Shan and Pamir glaciers have melted in Central Asia. This trend is comparable with ice reduction in the European Alps and the Caucasus (Zoï Environment Network, 2009).

Fedchenko glacier retreat in the 20th century. *Source:* Zoï Environment Network, 2009

7. Precipitation increased significantly in eastern parts of the American continent, northern Europe, northern and central Asia, while declining in the Sahel and southern Africa, in the Mediterranean and parts of southern Asia. Globally, the area affected by drought has *likely* increased since the 1970s. The observations also show that while total amounts of rainfall might undergo little change, the values corresponding to extreme monthly precipitation in the past are becoming more frequent, indicating an overall increase in the frequency of precipitation-related hazards in Europe. Changes in the seasonal distribution of precipitation strongly affect both ecosystems and human activities (Benestad, 2006; Tapiador and Sánchez, 2008).

8. Over the last 50 years some extreme weather events have changed in frequency and/or intensity, namely:

- The cold days, cold nights and frosts have become less frequent over most land areas, while hot days and hot nights have become more frequent *(very likely);*
- The heat waves have become more frequent over most land areas *(likely);*
- The frequency of heavy precipitation events has increased over most areas *(likely);*
- The incidence of extreme high sea level has increased at a broad range of sites worldwide since 1975 *(likely)*.

There is much evidence to support these claims of the increased frequency of weather events. For example, Table 1.2 demonstrates a sharp increase in the last decades' hazardous hydrometeorological events in Russia. We can also add that extremely hot summer of 2010 in this country, followed by numerous forest fires, cannot be understood without taking global warming into account. The well documented heat waves in 2003 in Western Europe (see, for example, Parry *et al*., 2007c) and the European autumn in 2006 when high temperatures were recorded over large parts of the continent (van Oldenborgh, 2006) further support the increase of extreme weather events. That year, in September–November, as compared to the 1971–2000 mean, it was more than +3ºC warmer across Europe (from the northern side of the Alps to southern Norway). The validity of this general conclusion was based on records in central England going back to 1659, in the Netherlands – to 1706 and in Denmark – to 1768. With respect to natural climate variations, the observed temperatures were *very unlikely,* with a probability of their occurring once every 10,000 years, and with 95% confidence interval – once every 2,000 years (van Oldenborgh, 2006).

Table 1.2 Dynamic of hazardous hydrometeorological events with social and economic losses in Russia

Year	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Cases	153	142	163	195	254	206	150	175	160	193	285	258	220	331	361

Source: The Fourth National Communication of Russian Federation to UNFCCC, 2006

The assessments of observed climatic trends, human influence and their likelihood in the future are summarized in Table 1.3.

From these evidences and as Crutzen and Steffen (2003) concluded, the Earth System is currently operating in a *'no-analogue state'*. In terms of key environmental parameters, it is moving well outside the range of natural variability exhibited over at least the last half million years. The nature of changes simultaneously occurring in the Earth System now, their magnitudes and rates of change are unprecedented and unsustainable. Crutzen and Steffen quote, as a warning, the famous Russian scientist Vladimir Vernadsky who had written over 80 years ago that the Earth's surface had been *transformed unrecognizably*. There is no doubt that far greater changes are yet come, and mankind will be confronted with a new form of biogenic migration resulting from the human activity.

One can hope that latest findings and evidence are strong enough to dispel continuous skepticism of some scientists and politicians on the existence of climate change[6], although the conclusions of individual authors are rather categorical. For example,

> *"Our review suggests that the dissenting view offered by the skeptics or opponents of global warming appears substantially more credible than the supporting view put forth by the proponents of global warming"* (Khandekar *et al.*, 2005, p. 1557).

[6] See: The Independent Institute, 2003: *New Perspectives in Climate Science: What the EPA Isn't Telling Us.* The Independent Institute, Oakland, California; Khilyuk L.F. and G.V. Chilingar, 2004: Global Warming and long-term Climatic Changes: A Progress Report. *Environmental Geology* **46**:970–979; Khandekar, M.L., T.S. Murty and P. Chittibabu, 2005: The Global Warming Debate: A Review of the State of Science. *Pure appl. geophys* **162**:1557–1586; Lindzen R.S., 2005: *Is There a Basis for Global Warming Alarm?* Accessed 10/21/2005 at: *http://www.independent.org/publications/publist.asp?pid=3*

Table 1.3 Recent climatic trends, assessment of their likelihood, human influence and projections for the future

Phenomenon and direction of trend	Likelihood that trend occurred in late 20th century (typically post 1960)	Likelihood of a human contribution to observed trend	Likelihood of future trend based on projections for 21st century
Warmer and fewer cold days and nights over most land areas	*Very likely*	*Likely*	*Virtually certain*
Warmer and more frequent hot days and nights over most land areas	*Very likely*	*Likely (nights)*	*Virtually certain*
Warm spells/heat waves. Frequency increases over most land areas	*Likely*	*More likely than not*	*Very likely*
Heavy precipitation events. Frequency (or proportion of total rainfall from heavy falls) increases over most areas	*Likely*	*More likely than not*	*Very likely*
Area affected by droughts increases in many regions since 1970s	*Likely*	*More likely than not*	*Likely*
Intense tropical cyclone activity increases in some regions since 1970	*Likely*	*More likely than not*	*Likely*
Increased incidence of extreme high sea level (excludes tsunamis)	*Likely*	*More likely than not*	*Likely*

Source: Adapted from IPCC (2007c)

> *"A rarely asked but important question is whether promoting alarmism is good for science? The situation may not be so remote from the impact of Lysenkoism on Soviet genetics. However, personally, I think the future will view the response of contemporary society to 'global warming' as simply another example of the appropriateness of the fable of the Emperor's New Clothes. For the sake of the science, I hope that future arrives soon. In the mean time, we can continue to play our parts in this modern version of The Emperor's New Clothes. Our descendents will be amused for generations to come"* (Lindzen, 2005, p. 10).

However, a discussion on the validity of climate change is not a goal of this book.

1.1.2.2 Regional evidences

When climate impacts are evaluated the regional and temporal high-resolution studies and reconstructions are critically important. They illuminate key climatic features that may be masked in a hemispheric or global reconstruction (Brohan *et al.,* 2006; Luterbacher *et al.,* 2004). At seasonal to annual resolutions, the hemispheric and regional climate change for recent centuries has been highlighted in a number of studies. These studies have also included climate modeling experiments with estimated natural and anthropogenic radiative-forcing changes, as well as empirical global reconstructions. However, because most adaptation measures are regional or local by definition, they are needed in corresponding detailed climatic information.

The practice of environmental management also increasingly recognizes the importance of scale and cross-scale dynamics in understanding and addressing global challenges. As to climatic changes, they are regional in their manifestation, but not by their origin (IPCC, 2007a). Good *et al.* (2006, p. 20) defined the term ‘pattern scaling’ as “… a few experiments with complex climate models to estimate (often linear)

Box 1.5 Dependence of annual air temperatures in Moldova on global and hemispheric processes in the climate system

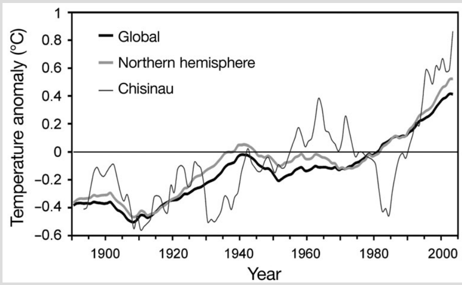
The relationships of annual air temperature in Moldova with the large-scale atmospheric processes were estimated, using data of the weather station in Chisinau (Moldova’s capital). The long-term temperature series at this station (expressed as anomalies from the baseline climate) was correlated with the analogous global and northern hemispheric anomalies (see Figure below). The corresponding HadCRUT3 datasets were obtained from the Climatic Research Unit of the University of East Anglia (CRU UEA) website – *http://www.cru.uea.ac.uk/cru/info/warming/*.

While the directional trend of global temperatures is broadly reflected in Moldova, it is evident that the overwhelming part of regional climate variability is locally specific. So, the clear interruptions of Chisinau’s general warming trend during the last century by interim warmer or colder temperature periods are not always ‘in phase’ with deviations in large-scale trends. The simple correlation (r) between global and regional anomalies is 0.405 ($p < 0.001$). Thus, from the coefficient of determination (r^2), global climatic processes explain only 16.4% of air temperature variability in Moldova. For a comparison with Northern Hemisphere temperatures these values are 0.457 ($p < 0.001$) and 20.1%, respectively. Moreover, it appears that temperature trends are modified in Chisinau compared with global and hemisphere means, supporting the IPCC (2007a) conclusion that on a regional scale many factors other than anthropogenic ones, such as variation in atmospheric circulation and topography, may influence change in climate.

The range of correlations for monthly temperatures is noticeably greater.

Relationships of surface air temperature anomalies in Chisinau with the Global and Northern Hemisphere anomalies

Month	Global temperature			Northern Hemisphere temperature		
	r	r^2, %	p	r	r^2, %	p
1	0,342	11,73	0,000	0,442	19,54	0,000
2	0,237	5,61	0,013	0,235	5,53	0,014
3	0,215	4,61	0,024	0,332	10,99	0,000
4	0,269	7,24	0,005	0,310	9,58	0,001
5	0,110	1,22	0,250	0,232	5,38	0,015
6	0,296	8,78	0,002	0,350	12,26	0,000
7	0,307	9,42	0,001	0,398	15,34	0,000
8	0,187	3,50	0,051	0,264	6,98	0,006
9	0,177	3,12	0,066	0,266	7,05	0,005
10	0,080	0,65	0,406	0,160	2,54	0,098
11	0,220	4,83	0,022	0,320	10,32	0,001
12	0,086	0,75	0,371	0,137	1,89	0,154
Year	*0,405*	*16,40*	*0,000*	*0,457*	*20,10*	*0,000*



Anomalies (from baseline 1961–1990 climate: zero line) of global, Northern Hemisphere and Chisinau annual air temperatures, smoothed with 11 yr running means

Source: Corobov *et al.*, 2010

relationships between a scalar predictor (e.g., global mean temperature) and the local quantity of interest (the predictant, e.g., annual mean temperature). These relationships are assumed to be robust such that given any value of the scalar predictor, a value of the predictant may be estimated for each location". We used this concept to correlate the temperature series in Moldova (expressed as anomalies from the baseline climate) with the global and northern hemispheric anomalies (Box 1.5).

As to climate extremes, such as the hot summers of 2003, 2007 and 2010 in many European areas or extraordinarily cold winter of 2010 in Russia and most European countries, they at regional scales exhibit much larger amplitudes than those at the global scale, and may thus markedly affect the local to regional natural environment, society, and economy, including the most vital aspects such as water supply and agriculture.

Box 1.6 Observed trends in European climate

The well established warming trend throughout Europe is +0.90°C for 1901 to 2005. However, the recent period (1979 to 2005) showed a trend considerably higher than the mean (+0.41°C/ decade). For the 1977 to 2000 period, trends are higher in central and north-eastern Europe and in mountainous regions, while lower in the Mediterranean region. Temperatures are increasing more in winter than in summer. During this period an observed increase of daily temperature variability was due to an increase in warm extremes, rather than a decrease of cold extremes. Precipitation trends are more spatially variable. Mean winter precipitation is increasing in most of Atlantic and northern Europe. In the Mediterranean area, yearly precipitation trends are negative in the east, while they are non-significant in the west. An increase in mean precipitation per wet day is observed in most parts of the continent, even in some areas which are becoming drier.

Source: Adapted from Alcamo *et al*. (2007)

Our analysis does not go beyond the general summary of changes in European climate (Box 1.6) and the demonstrations of one approach to statistical identification of changes in local climate, using Moldova's climate as a case study.

Air temperature trends and extremes: Moldova case

The analysis of long-term trends in climatic variables and, moreover, in extreme events, which are rare by definition, requires as long a time series as possible to aid in the modeling of extremes; ideally, the observations should extend backwards into at least the 19th century (Benestad, 2004). Given such necessity, the completed study (Corobov *et al.*, 2010) analyzed air temperature records from the weather station in Chisinau, which had the longest and most reliable series of instrumental observations in Moldova. This series included the monthly mean temperatures (Tmean) for the 122 yr period of 1887–2008, and mean monthly maximum and minimum temperatures (Tmax and Tmin, respectively) since 1945. Because of the small size of Moldova, the relatively homogeneous terrain, and the location of Chisinau near its geographic centre, the research results could be considered as representative of the whole country. As the early 1980s are usually taken as the breakpoint, after which anthropogenic influence on the atmosphere was reflected more prominently in the climate records (IPCC, 2007b), the temperature trends were evaluated for 2 periods: 1887–1980 (with 2 sub-periods of 1887–1940 and 1945–1980)[7], and 1981–

[7] The breakpoint of 1940–1945 coincides with the availability of Tmax and Tmin data and the interruption of observations by the Second World War

2008. The year 1981, *a priori* selected for the research, is the same as the last year (1981) in the second subsample of Gil-Alana[8] (2008).

As one can see from Table 1.4, from 1887–1940 non-significant decreases of Tmean were observed in Chisinau in all seasons except summer when the trend was non-significantly positive. From 1945–1980, the annual decrease continued with a statistically significant value in summer temperatures and non-significant positive trends in autumn and winter temperatures. Since 1981, all trends have been positive at $p < 0.05$ for annual and summer temperatures, and $p < 0.10$ for spring temperatures. Trends of winter and autumn Tmean in this period were not statistically significant. Thus, for the entire period of instrumental observations in Chisinau the general positive trend of Tmean was mainly determined by climate warming in the last 3 decades. The sharp changes between the 2 periods were observed for Tmax. During 1945–1980 this temperature trend was negative in all seasons; since 1980 it has been positive, with statistically significant changes in summer, autumn and for the year as a whole. In contrast, an upward trend in Tmin was observed before the 1980s. Initially, it was significant only for annual ($p < 0.10$) and autumn ($p < 0.05$) minima, but was followed by a sharp increase in later years.

Table 1.4 Linear slope (°C yr^{-1}) of trends in air temperature and their statistical significance (p) in Chisinau

Season	*Mean air temperature*							
	1887–1940		1945–1980		1887–1980		1981–2008	
	slope	*p*	*slope*	*p*	*slope*	*p*	*slope*	*p*
Winter	-0.0062	0.718	0.0234	0.519	0.0075	0.487	0.0497	0.231
Spring	-0.0033	0.768	-0.0155	0.541	0.0001	0.991	0.0637	0.060
Summer	0.0021	0.815	-0.0534	0.003	0.0018	0.687	0.0950	<0.001
Autumn	-0.0005	0.974	0.0116	0.517	0.0046	0.399	0.0389	0.126
Year	**-0.0020**	**0.761**	**-0.0084**	**0.531**	**0.0035**	**0.437**	**0.0619**	**0.004**

Season	*Mean maximal temperature*				*Mean minimal temperature*			
	1945–1980		1981–2008		1945–1980		1981–2008	
	slope	*p*	*slope*	*p*	*slope*	*p*	*slope*	*p*
Winter	-0.0031	0.922	0.0322	0.478	0.0320	0.335	0.0835	0.086
Spring	-0.0505	0.099	0.0421	0.340	0.0228	0.267	0.0756	0.038
Summer	-0.0957	0.000	0.1157	<0.001	-0.0060	0.631	0.0700	<0.001
Autumn	-0.1049	<0.001	0.0899	0.028	0.0371	0.046	0.0606	0.012
Year	**-0.0635**	**<0.001**	**0.0701**	**0.012**	**0.0213**	**0.068**	**0.0724**	**0.003**

In Table 1.4 an increase in the rate of trend can also be observed. During 1887–1980, the annual Tmean trend was upwards at 0.035°C $decade^{-1}$; since 1981 it has been about 0.6°C $decade^{-1}$. The equivalent trends for winter and summer were 0.5°C $decade^{-1}$ and 0.95°C $decade^{-1}$, respectively, from 1981 to 2008, compared with 0.075 and 0.018°C $decade^{-1}$ in the previous period. Moreover, 8 yr in the last 2 decades are among the warmest 20 yr in the history of instrumental observations in Chisinau.

The significance of changes in temperature from 1981–2008 against previous years is shown in Table 1.5. In essence, this procedure examines the stationarity of the observation

[8] Gil-Alana (2008) estimated the breaks in global and hemispheric temperature long-term time series using a technique based on segmented trends and fractional integration

Table 1.5 Comparison of air temperature in 1887–1980 (subscript 1) and 1981–2008 (subscript 2) at Chisinau weather station. Mean values are compared, using a *t*-test; standard deviation, using an *F*-test, and distributions, using a Kolmogorov-Smirnov (K-S) test. *Dn*: maximum distance between 2 cumulative distributions

Season	Statistics							
	Mean values, °C			*Standard deviations, °C*			*K-S test*	
	x_1	x_2	*p*	σ_1	σ_2	*p*	*Dn*	*p*
Mean temperature, 1887–1980 *(1)* and 1981–2008 *(2) periods*								
Winter	-2.15	-1.06	0.012	2.05	1.75	0.343	0.288	0.058
Spring	9.39	10.10	0.019	1.35	1.46	0.584	0.320	0.025
Summer	20.47	21.11	0.008	1.07	1.16	0.563	0.276	0.077
Autumn	9.98	10.26	0.325	1.41	1.08	0.122	0.181	0.498
Year	**9.42**	**10.10**	**<0.001**	**0.78**	**0.96**	**0.158**	**0.378**	**0.005**
Mean temperature, 1945–1980 *(1)* and 1981–2008 *(2) periods*								
Winter	-1.63	-1.06	0.257	2.13	1.75	0.290	0.186	0.657
Spring	9.61	10.09	0.195	1.48	1.46	0.926	0.293	0.139
Summer	20.69	21.11	0.147	1.12	1.16	0.836	0.271	0.202
Autumn	10.12	10.26	0.594	1.05	1.08	0.858	0.200	0.562
Year	**9.69**	**10.10**	**0.069**	**0.78**	**0.96**	**0.256**	**0.329**	**0.069**
Mean maximum temperature, 1945–1980 *(1)* and 1981–2008 *(2) periods*								
Winter	1.35	1.54	0.694	1.93	1.89	0.931	0.099	0.998
Spring	15.05	14.75	0.532	1.91	1.85	0.882	0.127	0.961
Summer	26.42	26.40	0.955	1.80	1.37	0.144	0.159	0.822
Autumn	14.42	13.59	0.077	1.88	1.78	0.779	0.218	0.448
Year	**14.31**	**14.07**	**0.393**	**1.00**	**1.23**	**0.239**	**0.238**	**0.336**
Mean minimum temperature, 1945–1980 *(1)* and 1981–2008 *(2) periods*								
Winter	-4.59	-3.37	0.021	2.04	2.08	0.906	0.294	0.132
Spring	5.10	6.25	0.002	1.27	1.58	0.214	0.464	0.002
Summer	15.17	16.49	<0.001	0.77	0.86	0.505	0.635	<0.001
Autumn	5.93	6.81	0.003	1.17	1.07	0.629	0.401	0.013
Year	**5.40**	**6.54**	**<0.001**	**0.73**	**1.11**	**0.022**	**0.575**	**<0.001**

series. A stationary temporal process presupposes that its probability distribution does not change over time. Different research and simulations suggest that both mean and variance are likely to change with a change in climate, and their relative contribution to a new temperature regime depends on how much each statistics (mean and variance) changes. In Chisinau's case, in the last 3 decades the seasonal (except autumn) and annual Tmean are different with high confidence from previous years. The variance of air temperature remains (statistically) the same, thus supporting the suggestion of Meehl *et al*. (2000b, p. 430) that "the change in the mean is usually larger than the change in variance for most climate change simulations". The synergetic effect of change in means and variability results in a distribution change. Thus, results suggest that over the last 3 decades Chisinau has had a new mean climate (at a significance level of 10% or less), in comparison with the previous long-term period, for all seasons except autumn ($p \approx 0.5$). However, when the most recent decades are compared with 1945–1980, there are only significant differences in the distribution of Tmean at the annual level.

This study supports the results of other research (IPCC, 2007a, b) in detecting an asymmetry between the change in maximum and minimum temperatures. There are practically no significant differences between the 3 statistics of seasonal Tmax in the present climate in comparison with the 1940s–1970s (see Table 1.5). However, Tmin changed significantly in its mean values, the variability of annual values, and in its distribution, at $p < 0.05$ in all seasons except winter ($p = 0.132$). Thus, one can conclude that in the last 3 decades the observed general warming of Chisinau is caused primarily by an increase of minimum temperatures.

Aside from trends over time, the analysis of the occurrence of extreme events is also a useful area for gaining a better understanding of regional climate change (Meehl *et al.*, 2000a, b). The IPCC Glossary (IPCC, 2007d, p. 875) defines an *extreme weather event* as "an event that is rare within its statistical reference distribution at a particular place. Criteria of 'rarity' vary from place to place and are normally calculated as rare as (or rarer than) 10th or 90th percentile value". Meehl *et al.* (2000b) noted that the frequency of extremes changes nonlinearly with a change in the means, and a small change in the mean can result in a large change in the frequency of extremes. In turn, a change in the variance would have a larger effect on the frequency of extremes than would a change in the mean. This becomes more complicated when the mean, variance and even the form of distribution are all changing simultaneously, affecting the occurrence of extremes in different ways. In the case of a long observation period, trends can describe the alteration of all statistics of an initial distribution, often specified as a normal Gaussian. For example, some authors[9] have attempted to explain the very high summer temperatures in western Europe in 2003 by an increase in the variance of the Gaussian model.

In the described case study, the means and extremes of seasonal Tmax and Tmin have been analyzed to assess whether significant changes emerged over recent decades, and whether there is a relationship between mean values and the upper extreme values defined by the 90th and 95th percentiles. For each of the 2 subperiods (1945–1980 and 1981–2008) the seasonal averages of Tmax and Tmin, the averages of absolute maxima and minima, as well as the number of years with values in excess of a selected threshold were analyzed (Table 1.6). Since the duration of the periods is different, the total numbers of exceedance were formulated into frequency per decade.

Several findings were noted. The change in frequency and intensity of air temperature extremes differed for maximum and minimum temperatures. There was a lack of significant differences between Tmax values for the 2 periods, which corresponded with no difference in the number of extremes occurring in winter and summer, and a small increase in annual extremes for Tmax. For extreme absolute maxima, an increase was observed in winter and for annual exceedance of the 90th percentile threshold. In contrast, many more significant changes were observed in Tmin distributions, supporting the above conclusion that the general warming in Chisinau was primarily associated with the increase in these temperatures. Here, the statistically significant change in summer and annual distributions has resulted in more frequent extreme events. In particular, in the 1940s–1970s almost no one seasonal or annual Tmin value was higher than the 90th percentile, but it was exceeded 6 times (winter) and 7 times (summer and annual) after 1980. The 95th percentile was exceeded 5 times in summer and autumn, and 3 times for the annual temperatures.

---

[9] Schär C. and G. Jendritsky, 2004: Hot news from summer 2003. *Nature* **432**:559–569; Schär C., P.L. Vidale, D. Lüthi *et al.*, 2004: The role of increasing temperature variability in European summer heatwaves. *Nature* **427**:332–336

Table 1.6 Occurrence of extreme mean and absolute maximum and minimum seasonal temperatures (total number/number per decade) above different temperature thresholds in Chisinau during 2 periods of observation

Season	Period	Maximum temperature, °C									
		Mean maximum temperature					*Mean of absolute maxima*				
		Observed			Equal or more than		Observed			Equal or more than	
		$\bar{x}$	P_{90}	P_{95}	P_{90}	P_{95}	$\bar{x}$	P_{90}	P_{95}	P_{90}	P_{95}
Winter	1945–1980	1.4	3.8	4.2	3/0.8	2/0.6	10.1	13.3	13.8	1/0.3	1/0.3
	1981–2008	1.5			3/1.1	2/0.7	10.1			5/1.8	3/1.1
Summer	1945–1980	26.4	28.6	28.9	5/1.4	2/0.6	32.5	34.6	35.8	3/0.8	2/0.6
	1981–2008	26.4			2/0.7	1/0.4	33.0			3/1.1	2/0.7
Year	1945–1980	14.3	15.6	15.8	2/0.6	1/0.3	22.5	24.2	24.5	2/0.6	2/0.6
	1981–2008	14.1			4/1.4	2/0.7	22.8			4/1.4	2/0.7
Season	Period	Minimum temperature, °C									
		Mean minimum temperature					*Mean of absolute minima*				
Winter	1945–1980	-4.6	-1.5	-1.3	1/0.3	0/0.0	-13.9	-10.5	-9.7	4/1.1	3/0.8
	1981–2008	-3.4			6/2.1	5/1.8	-13.1			3/1.1	1/0.4
Summer	1945–1980	15.2	17.0	17.2	0/0.0	0/0.0	10.2	12.3	12.7	0/0.0	0/0.0
	1981–2008	16.5			7/2.5	5/1.8	11.1			7/2.5	4/1.4
Year	1945–1980	5.4	7.2	7.6	0/0.0	0/0.0	-1.8	0.1	0.5	2/0.6	2/0.6
	1981–2008	6.5			7/2.5	3/1.1	-0.8			5/1.8	2/0.7

Note: $\bar{x}$ – temperature average; *mean* – mean of daily maximum/minimum temperatures; *mean of absolute values* – mean of seasonal absolute maxima/minima for the observation period; P_{90} and P_{95} – 90^{th} and 95^{th} percentiles, respectively, considered as excess threshold temperatures

1.1.3 Observed effects attributable to climate change

The famous American mathematician and meteorologist Edward Lorenz put in use the well-known facetious explanation of the distinction between weather and climate: *"Climate is what you expect, weather is what you get"*. M. Allen (2003, p. 892) went further, when paraphrasing this expression has noticed: *"In the twenty-first century, climate is what you affect, weather is what gets you"*. And then pessimistically added: *"Hence we can never be sure, with finite observations and imperfect models, of what the climate is or how it is changing. This uncertainty can nevertheless be rigorously quantified, allowing formal probabilistic attribution statements"*.

To date the number of observed trends in the physical and biological environment and their attributions to regional climate changes has greatly increased. This has allowed a broader and more confident assessment of the relationship between observed warming and impacts. Evidences from the last decade, for all continents and most of the oceans, show that many natural systems are being affected by regional climate change and, especially, by temperature increases.

In particular, there is ***high confidence*** that (IPCC, 2007a):

- Natural systems related to snow, ice and frozen ground (including permafrost) are affected. For example, there are documented enlargement and increased numbers of glacial lakes, increasing ground instability in permafrost regions and rock avalanches

in mountain regions, changes in some Polar ecosystems, including those in sea-ice biomes and predators at high levels of the food web.
- The evident effects on hydrological systems are occurring, including increased runoff and earlier spring peak discharge in many glacier- and snowfed rivers, warming of lakes and rivers in many regions, with effects on their thermal structure and water quality.
- Recent warming is strongly affecting terrestrial biological systems**,** including such changes as earlier timing of spring events (e.g., leaf-unfolding, bird migration, egg-laying, etc.) and poleward and upward shifts in ranges of plant and animal species. Since the early 1980s there has been a trend in many regions towards earlier 'greening' of vegetation linked to longer thermal growing seasons caused by recent warming.
- The observed changes in marine and freshwater biological systems are associated with rising water temperatures, as well as with related changes in ice cover, salinity, oxygen levels and circulation. One can name shifts in ranges and changes in algal, plankton and fish abundance in high-latitude oceans; increases in algal and zooplankton abundance in high-latitude and high-altitude lakes; range changes and earlier fish migrations in rivers.

With ***medium confidence*** effects of temperature increases have been documented in the following managed and human systems:

- Agricultural and forestry management at Northern Hemisphere higher latitudes, such as earlier spring planting of crops, and alterations in disturbances of forests due to fires and pests.
- Some aspects of human health, such as excess heat-related mortality and changes in infectious disease vectors in different parts of Europe, and earlier onset of and increases in seasonal production of allergenic pollen in Northern Hemisphere high and mid-latitudes.
- Some human activities in the Arctic (e.g., hunting and shorter travel seasons over snow and ice) and in lower-elevation alpine areas (such as limitations in mountain sports).

Observed effects of climate change in Europe are summarized in Table 1.7. It is obvious that some of the European systems and sectors have shown particular sensitivity to recent trends in temperature and (to a lesser extent) precipitation.

Observed changes provide additional evidence that the world is warming. Of the more than 29,000 observational data series from 75 studies that show significant change in physical and biological systems, more than 89% are consistent with the direction of change expected as a response to warming. The figures for Europe and Asia are shown in Table 1.8.

The general picture of global warming and its evident effects are the basis of the principal conclusion of the IPCC Fourth Assessment Report: "Most of the observed increase in global average temperatures since the mid-20th century is *very likely* due to the observed increase in anthropogenic GHG concentrations. Discernible human influences now extend to other aspects of climate, including ocean warming, continental-average temperatures, temperature extremes and wind patterns" (IPCC, 2007b, p. 10).

Table 1.7 Recent changes in European natural and managed systems attributed to recent temperature and precipitation systems

Region	*Observed change*
	Coastal and marine systems
North-east, Atlantic, North Sea	Northward movement of plankton and fish
	Terrestrial ecosystems
Europe	Upward shift of the tree line
	Phenological changes (earlier onset of spring events and lengthening of the growing season)
	Increasing productivity and carbon sink of forests during 1950 to 1999 (in 30 countries)
Alps	Invasion of evergreen broad-leaved species in forests; upward shift of *Viscum album*
Scandinavia	Northward range expansion of *Ilex aquifolium*
Fennoscandian mountains and sub-Artic	Disappearance of some types of wetlands *(palsa mires1*) in Lapland; increased species richness and frequency at altitudinal margin of plant life
High mountains	Change in high mountain vegetation types and new occurrence of alpine vegetation on high summits.
	Agriculture
Northern Europe	Increased crop stress during hotter, drier summers; increased risk to crops from hail
Britain, southern Scandinavia	Increased area of silage maize (more favorable conditions due to warmer summer temperatures)
France	Increases in growing season of grapevine; changes in wine quality
Germany	Advance in the beginning of growing season for fruit trees
	Cryosphere
Russia	Decrease in thickness and areal extent of permafrost and damages to infrastructure
Alps	Decrease in seasonal snow cover (at lower elevation)
Europe	Decrease in glacier volume and area (except some glaciers in Norway)
	Human health
North, East	Movement of tick vectors northwards and possibly to high altitudes
Mediterranean, West, South	Northward movement of *Visceral Leishmaniasis* in dogs and humans
Mediterranean, Atlantic, Central	Heatwave mortality
Atlantic, Central, East, North	Earlier onset and extension of season for allergenic pollen

Source: Adapted from Alcamo *et al.* (2007)

Table 1.8 The number (*N*) of data series with significant changes in physical and biological systems and percentage (%) of the changes consistent with warming observed in Europe and Asia over the period 1970-2004

Continent	*Physical systems*		*Biological systems*	
	N	*%*	*N*	*%*
Europe	119	94	28,115	89
Asia	106	96	8	100

Source: Adapted from IPCC (2007a)

Some further details on the effects of climate change include:

- It is *likely* that increases in GHG concentrations alone would have caused more warming than observed because volcanic and anthropogenic aerosols have offset some warming that would otherwise have taken place.
- The observed widespread warming, together with ice mass loss, support the conclusion that it is *extremely unlikely* that global climate change of the past 50 years can be explained without external forcing, and *very likely* that it is not due to known natural causes alone.
- Attribution studies have established anthropogenic contributions to all of the changes: in surface and atmospheric temperatures, in the upper several hundred meters of the ocean, and in sea level rise. The observed pattern of tropospheric warming and stratospheric cooling is *very likely* due to the combined influences of GHG increases and stratospheric ozone depletion.
- It is *likely* that significant averaged anthropogenic warming over the past 50 years has been over each continent except Antarctica. The observed patterns of warming and their changes over time are only simulated by models that include anthropogenic forcing. The ability of coupled climate models to simulate the observed temperature evolution provides stronger evidence of human influence on climate (see Fig. 1.5 as an example).
- Difficulties remain in reliably simulating and attributing observed temperature changes at smaller scales where natural climate variability is relatively larger, making it harder to distinguish changes expected due to external forcings. Uncertainties in local forcings and feedbacks also make it difficult to estimate the contribution of GHG increases to observed small-scale temperature changes.
- Anthropogenic forcing is *likely* to have contributed to changes in wind patterns, affecting extratropical storm tracks and temperature patterns, although the observed changes in the Northern Hemisphere circulation are larger than simulated in response to 20th century forcing change.
- Temperatures of the most extreme hot nights, cold nights and cold days are *likely* to have increased due to anthropogenic forcing. It is *more likely than not* that anthropogenic forcing has increased the risk of heat waves.

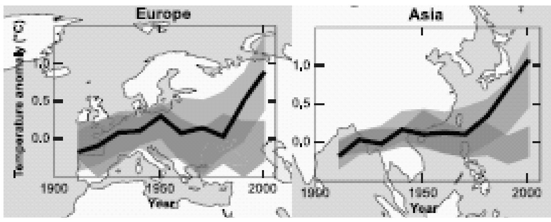


Fig. 1.5 Comparison of observed changes in surface temperature over Europe and Asia with results simulated by climate models using natural and anthropogenic forcings. *Note*: Decadal observations averages (black line) are plotted relative to the corresponding average for 1901–1950. Light gray bands show the 5–95% range for climate models simulations using only the natural forcings; dark gray bands – for the simulations using both natural and anthropogenic forcings. *Source:* Adapted from Fig. SPM.4 of IPCC (2007b)

1.1.4 Future climate change in the near and long term

Climate-change impact, adaptation and vulnerability (CCIAV) assessments usually require information on how conditions such as climate, social and economic development, and other environmental factors are expected to change in the future. This commonly entails the development of scenarios, storylines[10] or other characterizations of the future, often disaggregated to the regional or local scale (Parry *et al.,* 2007). The IPCC Special Report on Emissions Scenarios (SRES) (Nakicenovic and Swart, 2000) provided scenarios of future GHG gas emissions accompanied by storylines of social, economic and technological development (see Fig. 1.6) that are widely used in recent CCIAV studies.

Economic emphasis →

↑ **Global integration** | **Regional emphasis** ↓

A1 storyline *World:* market-oriented *Economy:* fastest per capita growth *Population:* 2050 peak, then decline *Governance:* strong regional interactions; income convergence *Technology:* three scenario group: • **A1F1:** fossil intensive • **A1T:** non-fossil energy sources • **A1B:** balanced across all sources	**A2 storyline** *World:* differentiated *Economy:* regionally oriented *Population:* continuously increasing *Governance:* self-reliance with preservation of local identities *Technology:* slowest and most fragmented development
B1 storyline *World:* convergent *Economy:* service and information based; lower growth than A1 *Population:* same as A1 *Governance:* global solutions to economic, social and environmental sustainability *Technology:* clean and resource-efficient	**B2 storyline** *World:* local solutions *Economy:* intermediate growth *Population:* continually increasing at lower rate than A2 *Governance:* local and regional solutions to environmental protection and social equity *Technology:* more rapid than A2; less rapid, more diverse than A1/B1

← **Environmental emphasis**

Fig. 1.6 Summary characteristics of the four SRES storylines. *Source:* Parry *et al.*, 2007a

A) Global climate projections. According to IPCC assessments (IPCC, 2007b), during the 21st century the continued GHG emissions at or above current rates would cause further warming and induce changes in the global climate system that would be *very likely* larger than those observed during the last century. Even if all radiative forcing agents were held constant at year 2000 levels, a warming of about 0.1°C per decade would be expected due mainly to the slow response of the oceans. About twice as much warming (0.2°C per decade) would be expected if emissions are within the range of the SRES scenarios, although temperature projections depend increasingly on specific scenario. Best-estimate projections from models indicate that decadal average warming over each inhabited continent by 2030 is insensitive to the choice among SRES scenarios and is *very likely* to be at least twice as large as the corresponding model-estimated natural variability during the 20th century. Confidence in these near-term projections in now strengthened by the

[10] *Scenarios* are plausible and often simplified descriptions of possible future states of the world. *Storylines* are qualitative, internally consistent narratives of how the future may evolve, which often underpin quantitative projections of future change that, together with the storyline, constitute a *scenario*

comparison of observed values of about 0.2°C per decade with the projections that have been made since the IPCC's first report, which suggested global averaged temperature increases between about 0.15°C and 0.3°C per decade from 1990 to 2005 (IPCC, 2007c).

Table 1.9 shows the best estimates and *likely* ranges for global average surface air warming for six SRES marker emissions scenarios, including associated uncertainties, as well as model-based projections of global average sea level rise at the end of the 21st century (2090–2099). The sea level projections do not include uncertainties in climate-carbon cycle feedbacks nor do they include the full effects of changes in ice sheet flow because a basis in published literature is lacking. Therefore the upper values of the given ranges are not to be considered as maximum sea level rise. The projections include a contribution due to increased ice flow from Greenland and Antarctica at the rates observed for 1993–2003, but these flow rates could increase or decrease in the future. If this contribution were to grow linearly with global average temperature change, the upper ranges of sea level rise for SRES scenarios shown in Table 1.9 would increase by 0.1 to 0.2 meters.

Table 1.9 Projected global average surface warming and sea level rise at the end of the 21st century (2090–2099) relative to 1980–1999

Case	*Temperature change, °C*		*Sea level rise, m*
	Best estimate	Likely range	Model-based range
Constant year 2000 concentrations	0.6	0.3 – 0.9	Not available
B1 scenario	1.8	1.1 – 2.9	0.18 – 0.38
A1T scenario	2.4	1.4 – 3.8	0.20 – 0.45
B2 scenario	2.4	1.4 – 3.8	0.20 – 0.43
A1B scenario	2.8	1.7 – 4.4	0.21 – 0.48
A2 scenario	3.4	2.0 – 5.4	0.23 – 0.51
A1FI scenario	4.0	2.4 – 6.4	0.26 – 0.59

Source: IPCC, 2007b

Projected warming in the 21st century shows scenario-independent geographical patterns similar to those observed over the past several decades. Warming is expected to be the greatest over land and at most high northern latitudes, including parts of the North Atlantic Ocean, continuing recent observed trends, as follows:

- ➡ Snow cover area is projected to contract. Widespread increases in thaw depth are projected over most permafrost regions. Sea ice is projected to shrink, and under some projections Arctic late-summer sea ice disappears almost entirely by the latter part of the 21st century.
- ➡ It is *very likely* that hot extremes, heat waves and heavy precipitation events will become more frequent.
- ➡ Extra-tropical storm tracks are projected to move pole-ward, with consequent changes in wind, precipitation and temperature patterns, continuing the broad pattern of observed trends over the last half century.
- ➡ Increases in the amount of precipitation are *very likely* in high-latitudes, while decreases are *likely* in most subtropical land regions (by as much as about 20% in the A1B scenario in 2100), continuing observed patterns in recent trends.

- There is *high confidence* that by mid-century the annual river runoff and water availability are projected to increase at high latitudes (and in some tropical wet areas) and decrease in some dry regions in the mid-latitudes and tropics.
- There is *high confidence* that many semi-arid areas will suffer a decrease in water resources due to climate change.

B) Climate projections for Europe, presented below, are based mainly on IPCC AR4 general conclusions (Alcamo *et al.*, 2007), with some additions from other sources.

The available studies show that Europe undergoes a warming in all seasons and in the range of change, depending on the emissions scenarios (SRES A2: 2.5 to 5.5°C, SRES B2: 1 to 4°C). By 2071–2100 the greatest warming is expected over eastern Europe in winter (December to February) and over western and southern Europe in summer (June to August) (Giorgi *et al.*, 2004). Use of the regional climate models (Christensen and Christensen, 2007) showed a larger warming in winter than in summer in northern Europe and the reverse in southern and central Europe. The yearly maximum temperature is expected to increase much more in southern and central Europe than in northern Europe. In summer, the warming of large parts of central, southern and eastern Europe may be more closely connected to higher temperatures on warm days than to a general warming. Beniston *et al.* (2007) estimated that countries in central Europe would experience the same number of hot days as currently occur in southern Europe. A large increase is also expected for yearly minimum temperature across most of Europe that at many locations exceeds the average winter warming by a factor of two to three. Much of the warming in winter is connected to higher temperatures on cold days, which indicates a decrease in winter temperature variability. An increase in the lowest winter temperatures, although large, would primarily mean that current cold extremes would decrease[11]. In contrast, a large increase in the highest summer temperatures would expose Europeans to unprecedented high temperatures.

Mean annual precipitation generally increases for all scenarios in northern Europe and decreases further south, whilst the change in seasonal precipitation varies substantially from season to season and across regions in response to changes in large-scale circulation and water vapor loading. Different authors found that increased winter Atlantic cyclonic activity leads to enhanced precipitation (up to 15-30%) over much of western, northern and central Europe, decreasing over Mediterranean Europe in response to increased anti-cyclonic circulation. Summer precipitation decreases substantially (in some areas up to 70% in scenario A2) in southern and central Europe, and to a smaller degree in the North. The identified enhanced anti-cyclonic circulation in summer over the north-eastern Atlantic induces a blocking structure (ridge) over western Europe and a trough over eastern Europe that deflects storms northward, causing a substantial and widespread decrease in precipitation (up to 30-45%) over the Mediterranean Basin as well as over western and central Europe. Both the winter and summer changes were found to be statistically significant (*very high* confidence) over large areas of the regional modeling domain. Relatively small precipitation changes were found for spring and autumn.

It is expected a substantial increase in the intensity of daily precipitation events. This holds even for areas with a decrease in mean precipitation, such as central Europe and the

[11] Is to consider more recent observations, this conclusion requires further confirmation

Mediterranean. This region and even much of eastern Europe may experience an increase in dry periods by the late 21st century. The longest yearly dry spells could increase by as much as 50%, including central Europe, although there is some evidence that these projections for droughts and heatwaves may be slightly overestimated due to possible uncertainties in parameterization of soil moisture in regional climate models.

The best picture of future climatic conditions, especially from a regional perspective, is given by the assessment of combined temperature and precipitation changes' effects. For example, Lapin and Hlavcova (2003) found an increase in short duration (1 to 5 days) summer rainfall events in Slovakia up to 40% for a 3.5°C summer warming. The combined effects of warmer temperatures and reduced mean summer precipitation would enhance the occurrence of heatwaves and droughts. One approach to combine temperature and precipitation projections in one index is shown in Box 1.7.

Change in *wind speed* is highly sensitive to the differences in large-scale circulation that can result from different global models. From some regional simulations, the mean annual wind

Box 1.7 Projections of change in Moldova's humidity conditions

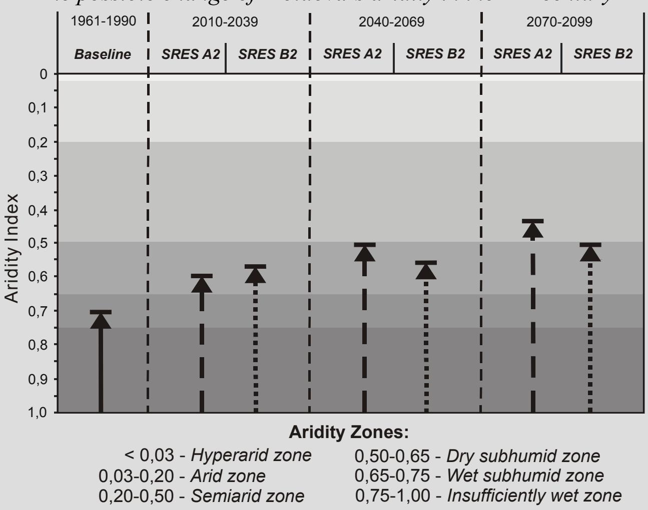
The country-wide projections for Moldova's climate change were developed through downscaling of three Coupled Atmosphere-Ocean General Circulation Models *(HadCM3, CGCM2 and CSIRO Mk2)* for *SRES A2* and *B2* emission scenarios and three time-slices *(2010–2039; 2040–2069; 2070–2099)*. The results of model simulations were used as model-ensemble averages (see table).

Projections of expected change in annual climatic variables in Moldova as to baseline (1961–1990) climate

Variable	*Time-slices and emission scenarios*					
	2010–2039		2040–2069		2070–2099	
	A2	*B2*	*A2*	*B2*	*A2*	*B2*
Solar radiation, W m^{-2}	31.1	47.5	52,2	54,5	75,2	60,3
Mean temperature, ^{o}C	1.7	2.0	3.4	3.2	5.4	4.1
Max temperature, ^{o}C	1.4	2.0	3.3	2.8	5.2	3.5
Min temperature, ^{o}C	1.4	1.9	2.9	2.4	4.6	3.5
Precipitation, mm	-9.0	-17.0	-38.0	-11.0	-64.0	-23.0

Annual temperatures will likely increase for all scenarios, while annual precipitation will mainly decrease. Maximal warming is expected in winter; minimal – in summer. If to take into account the rise in winter precipitation, Moldova will be faced with warmer and wetter winters, but hotter and drier summers (20-30% precipitation decrease by the 2080-s). To assess what new humidity conditions are expected, the annual projections of temperature and precipitation were transformed in the *Aridity Index* (a ratio of annual potential evaporation to annual precipitation). The likely dynamic of Aridity Index is shown in the figure. It demonstrates the country transition from wet subhumid to dry subhumid and semiarid zones.

The possible change of Moldova's aridity in the 21st century



Source: Corobov, 2009

speed increases over northern Europe by about 8% and decreases over the Mediterranean. The increase for northern Europe is largest in winter and early spring, when the increase in the average north-south pressure gradient is largest. Simulations for central Europe indicate a slight increase in mean wind speeds in winter and some decrease in spring and autumn. None of the reported simulations show significant change during summer for northern Europe. An increase in extreme wind speeds was found for western and central Europe, although the changes were not statistically significant for all months of the year. Beniston *et al.* (2007) found that extreme wind speeds increased for the area between 45°N and 55°N that could generate more North Sea storms leading to increases in storm surges along the North Sea coast.

1.1.5 Current knowledge about future climate change impacts

More specific information is now available across a wide range of systems and sectors concerning the nature of future impacts. The key findings regarding possible impacts in each system, sector and region for the range of IPCC climate changes projections over this century, which are judged to be relevant for people and the environment, are discussed in detail in Parry *et al*. (2007). The magnitude and timing of impacts will vary with the amount and timing of climate change and, in some cases, with the capacity to adapt, frequently reflecting the projected changes in precipitation and other climate variables in addition to changes in temperature, sea level or concentrations of atmospheric CO_2. Here, we would like only to present, as examples, the possible impacts of climate change due to changes in extreme weather and climate events (Table 1.10) that are general by their character for all regions, as well as the summary of possible impacts in Europe.

Table 1.10 Examples of possible impacts of climate change due to changes in extreme weather and climate events, based on projections to the mid–late 21st century

Phenomenon and direction of trend	Likelihood of future trends[1]	Examples of major projected impacts by sector			
		Agriculture, forestry and ecosystems	*Water resources*	*Human health*	*Industry, settlement and society*
Over most land areas, warmer[2] and fewer cold days and nights, warmer and more frequent hot days and nights	*Virtually certain*	Increased yields in colder and decreased – in warmer environments; increased insect outbreaks	Effects on water resources relying on snow melt; effects on some water supplies	Reduced human mortality from decreased cold exposure	Reduced energy demand for heating and increased demand for cooling; declining air quality; reduced disruption to transport due to snow ice; effects on winter tourism
Warm spells/heat waves. Frequency increases over most land areas	*Very likely*	Reduced yields in warmer regions due to heat stress; increased danger of wildfire	Increased water demand; water quality problems, e.g., algal blooms	Increased risk of heat-related mortality, especially for the elderly, chronically sick, very young and socially-isolated	Reduction in quality of life for people in warm areas without appropriate housing; impacts on the elderly, very young and poor

Table 1.10 (continued)

Phenomenon and direction of trend	Likelihood of future trends[1]	Examples of major projected impacts by sector			
		Agriculture, forestry and ecosystems	*Water resources*	*Human health*	*Industry, settlement and society*
Heavy precipitation events. Frequency increases over most areas	*Very likely*	Damage to crops; soil erosion, inability to cultivate land due to water-logging of soils	Adverse effects on quality of surface and groundwater; contamination of water supply; water scarcity may be relieved	Increased risk of deaths, injuries and infectious, respiratory and skin diseases	Disruption of settlements, commerce, transport and societies due to flooding; pressures on urban and rural infrastructures; loss of property
Area affected by drought increases	*Likely*	Land degradation; lower yields/crop damage and failure; increased livestock deaths; increased risk of wildfire	More widespread water stress	Increased risk of food and water shortage; malnutrition, water-and food-borne diseases	Water shortages; reduced hydropower potentials; a potential population migration
Intense tropical cyclone activity increases	*Likely*	Damage to crops; windthrow (uprooting) of trees; damage to coral reefs	Power outages causing disruption of public water supply	Increased risk of deaths, injuries, water- and food-borne diseases; post-traumatic stress disorders	Disruption by flood and high winds; withdrawal of risk coverage by private insurers, loss of property
Increased incidence of extreme high sea level (excludes tsunamis)[3]	*Likely*[4]	Salinisation of irrigation water, estuaries and freshwater systems	Decreased freshwater availability due to saltwater intrusion	Increased risk of deaths and injuries by drowning in floods; migration-related health effects	Costs of coastal protection, land-use and infrastructure relocation; migration of populations (see also cyclone above)

Note: 1 – The likelihood estimates relate to the phenomena listed in Column 1; *2* – Warming of the most extreme days and nights each year; *3* – Extreme high sea level is defined as the highest 1% of hourly values of observed sea level at a station; *4* – In all scenarios, the projected global average sea level at 2100 is higher than in the reference period. The effect of changes in regional weather systems on sea level extremes has not been assessed. *Source:* Adapted from Parry *at al.* (2007)

Impacts on European sectors and systems

The principal impacts, which can be caused by projected changes in European climate, are summarized by Alcamo *et al.* (2007) as follows:

- Climate-related hazards will mostly increase, although changes will vary geographically *(very high confidence).* Winter floods are *likely* to increase in maritime regions and flash floods – throughout Europe. Coastal flooding related to increasing storminess and sea-level rise is *likely* to threaten up to 1.6 million additional people annually.

- Sea-level rise is likely to cause an inland migration of beaches and the loss of up to 20% of coastal wetlands, reducing habitat availability for several species that breed or forage in low-lying coastal areas. Low lying, geologically subsiding coasts are likely to be unable to adapt to sea-level rise.
- In cryosphere, the retreat of glaciers and extent of permafrost is *likely*. Small glaciers will disappear and larger glaciers substantially shrink during the 21st century. Many permafrost areas in the Arctic are projected to disappear. Due to destabilization of mountain walls by rising temperatures and melting of permafrost, the frequency of rock falls will increase.
- Warmer, drier conditions will lead to more frequent and prolonged droughts, as well as to a longer fire season, increasing fire risks. During dry years, catastrophic fires are expected on drained peatlands in central and east Europe. Differences in water availability between regions are anticipated to become sharper (annual average runoff increases in the North and North-west, against a decrease in the South and South-east). Water stress will increase as well as the number of people living in river basins under high water stress *(high confidence)*. The percentage area under high water stress is likely to increase from 19% today to 35% by the 2070s, and the additional number of people affected by the 2070s is expected to be between 16 and 44 millions. The most affected regions are southern Europe and some parts of central and eastern Europe, where summer flows may be reduced by up to 80%.
- The warming trend and spatially variable changes in rainfall will affect composition and functioning of both the natural and managed ecosystems. It is anticipated that Europe's natural ecosystems and biodiversity will be substantially affected *(very high confidence).* The great majority of ecosystems and organisms are likely to have difficulty in adapting to climate change *(high confidence),* and options for adaptation are likely to be limited for many of them. For example, there are no obvious climate adaptation options for either tundra or alpine vegetation. New sites for conservation may be needed because climate change is *very likely* to alter conditions of suitability for many species in current sites. The adaptive capacity of ecosystems can be enhanced by reducing human stresses.
- Forests are projected to expand in the North and retreat in the South. Under some scenarios the northward expansion of forests is projected to reduce current tundra areas. Forest productivity and total biomass is likely to increase in the North and decrease in central Europe, while tree mortality is likely to accelerate in the South. Mountain plant communities are expected to face up to a 60% loss of species under high emissions scenarios. A large percentage of the European flora is likely to become vulnerable, endangered, or committed to extinction by the end of this century. In the Mediterranean, many ephemeral aquatic ecosystems are projected to disappear, and permanent ones to shrink.
- Climate change is estimated to pose challenges to many European economic sectors and is expected to alter the distribution of economic activity *(high confidence)* as well as to magnify regional differences of Europe's natural resources and assets *(very high confidence).*
- Agriculture will have to cope with increasing water demand for irrigation in southern Europe and with additional restrictions due to increases in crop-related nitrate leaching. Crop suitability is likely to change throughout Europe, and crop productivity (given all other factors remaining unchanged) is likely to increase in northern Europe, but decrease along the Mediterranean and in south-eastern Europe. Another

example[12]: over last decades the climate-governed part of cereal crops productivity increased by 10-30% in the European South oblasts of Russia, but the increase of dryness of East Siberia climate resulted in about 20% decline in spring crops. Recruitment and production of marine fisheries in the North Atlantic are likely to increase.

- Winter heating demands are expected to decrease vs. increasing summer cooling demands. Peak electricity demand is likely to shift in some locations from winter to summer, while by the 2070s the hydropower potential of Europe is expected to decline on average by 6%.
- Tourism along the Mediterranean and South seas is *likely* to decrease in summer and increase in spring and autumn. Winter tourism in mountain regions is anticipated to face reduced snow cover.
- Without adaptive measures, health risks due to more frequent heatwaves and flooding, as well as to greater exposure to vector- and food-borne diseases are anticipated to increase. Some impacts may be positive, as the reduced risk of extreme cold events, however, on balance, health risks are *very likely* to increase.

The Centre for European Policy Studies (CEPS) presented the latest evidence on the possible effects of climate change (Behrens *et al.*, 2010), based on potential impacts on 11 key indicator categories and 3 large regions covering the entire EU (Table 1.11). In spite of the considerable degree of uncertainty about local and regional affects that still remains, the strong distributional patterns are evident. In particular, the Mediterranean will be mostly negatively affected; low and medium impacts are expected for most CEE indicators, while Northern Europe might even experience some positive effects.

However, Pope *et al.* (2008) believe that if we are concerned about keeping the risks of dangerous climate change to a minimum, we should consider the worst-case outcomes. Such outcomes will occur if the climate turns out to be particularly sensitive to increases in GHG concentrations and the Earth's biological systems cannot absorb very much carbon. "Hence, the risks of dangerous climate change will not increase slowly as greenhouse gases increase. Rather, the risks will multiply if we do not reduce emissions fast enough" (p. 15). These authors also argue that if no action is taken to curb global warming, temperatures are likely to rise by 5.5°C and could rise by as much as 7°C above preindustrial values by the end of this century that would lead to significant risks of severe and ireversible impacts. In the judgment of Steffen (2006), more dramatic consequences are likely if some critical thresholds in the Earth System carbon cycle are crossed (Box 1.8).

Table 1.11 Summary of climate change impacts in Europe and their intensity

Climate change indicators	*NE*	*CEE*	*MT*
Direct losses from weather disasters	M(-)	M(-)	H(-)
River flood disasters	M(-)	H(-)	L(-)
Coastal flooding	H(-)	M(-)	H(-)
Public water supply	L(-)	L(-)	H(-)
Crop yields in agriculture	H(+)	M(-)	H(-)
Crop yields in forestry	M(+)	L(-)	H(-)
Biodiversity	M(+)	M(-)	H(-)
Energy for heating and cooling	M(+)	L(+)	M(-)
Hydropower and cooling for thermal plants	M(+)	M(-)	H(-)
Tourism and recreation	M(+)	L(+)	M(-)
Health	L(-)	M(-)	H(-)

Notes: 1. *NE* – Northern Europe, *CEE* – Central and Eastern Europe, *MT* – Mediterranean; 2. H – High; M – Medium; L – Low; 3. (+) – Positive impact; (-) – Negative impact. *Source:* Behrens *et al.*, 2010

[12] The Fourth National Communication of Russian Federation, Moscow, 2006

Bennewitz (2009) added a new component into this discourse. A basic summary of the Second Law of thermo-dynamics states: *"No process is possible in which the sole result is the absorption of heat from a source and its complete conversion to work"*. Thus, some heat is always wasted, and the heat we cannot use any more is the anergy that measures entropy and irreversibility of all processes. The results of Bennewitz's calculations, based on primary energy consumption for 2003, show that the increase of entropy, originated by the people living on our planet, is remarkable, and due to entropy (without considering the diminishing factors) the additional yearly temperature increase amounts to 0.075°C.

A second factor, which should be taken into account, is a high nonlinearity of the Earth's climate system: inputs and outputs are not proportional, change is often episodic and abrupt, rather than slow and gradual, and multiple equilibria are the norm (Rial *et al.*, 2004). While this is widely accepted, there is a relatively poor understanding of the different types of nonlinearities, how they manifest under various conditions, and whether they reflect a climate system driven by astronomical forcing, by internal feedbacks, or by a combination of both. Rial and co-authors consider these interactions as the main source of nonlinear behavior, and thus one of the main sources of uncertainty in our attempts to predict the effects of global environmental change. In sharp contrast to familiar linear physical processes, nonlinear behavior in the climate results in highly diverse, usually surprising and often counterintuitive observations.

Thus, any approach to defining dangerous climate change can itself be dangerous if it ignores the systemic nature of the global environment. Feedbacks and nonlinearities are the rule, not the exception, in the functioning of the Earth System (Steffen, 2006). Past records of climate change are perhaps the most frequently cited examples of nonlinear dynamics, especially where certain aspects of climate, e.g., the thermohaline circulation of the North Atlantic Ocean, suggest the existence of thresholds, multiple equilibria, and other features that may result in episodes of rapid change.

Box 1.8 *'Sleeping giants'* in the carbon cycle

In an Earth System context the carbon cycle can work as a buffer to keep the planetary environment within well defined limits. However, if some critical thresholds are crossed, it can act as a giant flywheel that helps to push the Earth System into another state. These so-called *"sleeping giants"* in the carbon cycle are processes that have the potential to accelerate the rate of warming beyond that attributed to human emissions of GHG. As such, the following processes are considered:

1. The impact on soil respiration of rising temperature and changing soil moisture, as an example of a response of ecosystem physiology to climate change. The general consensus is that increasing temperature will cause an increase in the emission of CO_2 from soil carbon.
2. The increase in disturbance in terrestrial ecosystems often associated with pulses of carbon to the atmosphere. The most notable of such disturbance are wildfires and pest outbreaks, both sensitive to warming and changes in the moisture regime. Although they are natural phenomena in the dynamics of terrestrial ecosystems, an increase in their frequency or extent results in a net loss of carbon to the atmosphere. In a worst case scenario, the additional warming by 2100 due to these carbon cycle feedbacks could be about 1.5°C.
3. Permafrost soils in the high latitudes of the northern hemisphere and moist peatlands contain hundreds of gigatons of carbon that is currently stored away from contact with the atmosphere. These pools of carbon are vulnerable to rising temperatures that could melt much of the current permafrost areas and dry out peatlands leading to additional emissions of CO_2 and CH_4.
4. The marine carbon cycle may also provide surprises in the future.

Sourse: Steffen, 2006

1.2 Climate change impacts and dangers: recent interpretations

1.2.1 Conceptual background

An important aspect of the international climate debate currently focuses on interpretations of the ***'danger'*** of climate change. This is the essence of Article 2 of the 1992 UN Framework Convention on Climate Change (UNFCCC, 1992):

> *"The ultimate objective of this Convention and any related legal instruments that the Conference of the Parties may adopt is to achieve, in accordance with the relevant provisions of the Convention, stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Such a level should be achieved within a time-frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner."*

However, although the question of which impacts might constitute 'dangerous anthropogenic interference with the climate system' (DAI) has recently attracted a high level of attention, the literature on the problem still remains relatively sparse (Schneider *et al.,* 2007). After signing of the Kyoto Protocol there was a gap in interest in Article 2 in the legal, political, and diplomatic communities, and during this period discussion focused largely on implementation of the Kyoto agreements. The question of what constitutes DAI proceeded largely on a separate track, with IPCC (Smith *et al.*, 2001) undertaking a scientific assessment of *key vulnerabilities* that would eventually form the basis of current discussions on Article 2 (for reviews, see, e.g., Oppenheimer and Petsonk, 2005). Scientists and economists attempted to interpret Article 2 and to create frameworks for its actual implementation by determining emissions pathways consistent with various particular interpretations.

However, the UNFCCC does not attempt to define the concept of dangerous interference with the climate system because precise statements of what is 'dangerous' are not possible since (a) the degree of harm from any level of climate change is subject to a variety of uncertainties and (b) the extent to which any level of risk is 'acceptable' or 'dangerous' is a value judgment (Sanden and Azar, 2005). The concern is about change in climate that is comparable in magnitude to the difference between a glacial and an inter-glacial climate in the past. The observed environmental shifts are enormous and unlike anything the world has seen for more than 800,000 years. If to take into account that the difference in air temperatures between our world and the last ice age is only 5ºC (the warming projected to occur in a mere 100 years), the implications for ecological and human systems are unprecedented. Consequences for human populations, which are extremely dependent on the climate for food, water and life, are serious even with relatively low 2ºC temperature increases (Pittock, 2003; World Bank, 2009).

Meanwhile, understanding what may constitute danger in relation to climate change is of increasing importance for scientific analysis and climate policy, particularly following the ratification of the Kyoto Protocol in February 2005, and the growing attention towards post-Kyoto negotiations. By the opinion of Dessai *et al.* (2004), it is not possible to make progress on arriving at an operational notion of climate change danger or in developing the sustainable responses without recognizing the central role played by perceptions in defining ‘danger’. As an initial premise it is possible to consider the IPCC statement: “The references to adverse effects, as significant deleterious effects in Article 1 UNFCCC, and to natural ecosystems, food production, and sustainable development in Article 2 provide guidance as to which impacts may be considered relevant to the definition of DAI” (Schneider *et al.*, 2001 p. 784). However, this general statement needs more detailing.

Generally, the interpretation of ‘***dangerous***’ is relative and contextual rather than absolute. What is dangerous in an actual situation is, in the end, often determined by a society’s capacity to cope with and to adapt to climate change. To add to the complexity, danger can be interpreted externally by objective measurements such as actual loss of physical property, or internally by perceived danger and subjectively experienced fear (Dessai *et al.*, 2004). If a society’s adaptive capacity is low, even minor climate changes might entail danger (Jerneck and Olsson, 2008).

The UNFCCC’s term ‘*dangerous anthropogenic interference with the climate system’* may be defined or characterized in terms of the consequences (impacts) that can be related to the levels and rates of changes in climate parameters. The new parameters, in turn, will be caused by the evolution of emissions and consequent atmospheric GHG concentrations. Evaluating the consequences of climate change outcomes to determine those that may be considered ‘dangerous’ is a complex undertaking, involving substantial uncertainties and value judgments. In other words, as Patwardhan *et al.* (2004) are inclined to believe, the term ‘dangerous’, used in Article 2 with regard to the anthropogenic interference, is related, on the one hand, to the consequences or impacts of climate change and, on the other hand, to the levels of GHG concentrations that are responsible for the change. The evaluation of the dangerous anthropogenic interference requires therefore not only the understanding of undesirable consequences of climate change, but also the sustainability implications of both climate impacts and climate stabilization levels, including their timing.

Harvey (2007) also makes a distinction between dangerous anthropogenic interference in the climate system (UNFCCC Article 2 call) and dangerous climatic change, defining them as follows:

- *Dangerous anthropogenic interference* in the climate system is a set of increases in GHGs concentrations that has a non-negligible possibility of provoking changes in climate that in turn have a non-negligible possibility of causing unacceptable harm to humans, human societies, or natural systems;
- *Dangerous climatic change* is a change of climate that has actually occurred or is assumed to occur and that has a non-negligible possibility of causing unacceptable harm to humans, socio-economic or natural systems;
- *Harmful climatic change* is a change in climate that does in fact cause harm to one or more of the above.

A fundamental problem with 'dangerous climate change' is that it can mean virtually all things to all people. As Risbey (2006, p. 529) noted, *"...the issue is not whether dangerous climate change is difficult to define. It is. But rather, the issue is whether we can come up with robust, non-arbitrary criteria to use for the definition about which reasonable people can agree"*. What looks dangerous depends on many factors which Risbey has formulated as follows:

- *Point of view:* The very same climate event or impact may appear threatening to some people and benign to others, depending on their attitude to risk, sense of compassion, sensibility, political commitments, and so on.
- *Point of stance:* Climate change manifests itself with very different impacts in different places, ranging from the complete submergence of some nations to a mixture of costs and benefits for others. Where one stands can influence the view of the impacts and the sense of danger.
- *Impact selection and metric:* Climate change has impacts across a huge range of different segments of human and natural systems, thus critically determining the views of climate change on the set of considered impacts and the metrics used to measure them.
- *Impact time-frame:* The impacts generally increase with the greater amount of change in the climate and the longer the time period. Thus, the impacts can look very different depending on what time period is chosen.
- *Discounting:* The perceived dangers of future impacts depend heavily on the choice of whether to discount future costs and benefits.
- *Uncertainty:* Invariably large uncertainties entailed in projecting the impacts of climate change allow a disagreement over a fairly broad range about what the impacts associated with particular dangers might be.
- *Ignorance:* Along with uncertainties associated with dangers, there is ignorance about what the complete set of dangers may be. Climate change may pose dangers about which we currently have no comprehension and therefore can have no real ability to plan.

Lowe and Lorenzoni (2007) distinguish 'external' and 'internal' definitions of danger. *External definitions* are usually based on risk analyses and assessments of system characteristics of the physical and social world interpreted by expert knowledge, derived from observations or modeling of descriptive theories of decision making and behaviors. *Internal definitions* of danger acknowledge that, to be real, danger has to be either experienced or perceived; in other words, it is the individual or collective experience or perception of insecurity or lack of safety that signals what is dangerous. Perceptions of danger are therefore shaped by psychological, social, cultural and institutional processes. The authors stressed also that external and internal definitions interact and influence each other: information on a potential threat may alter an individual's behavior. These perspectives are not in contrast; rather, they mutually shape each other.

Further, eliciting the expert perceptions for managing climate change, Lowe and Lorenzoni pointed to three areas of danger, to which they referred in relation to UNFCCC Article 2:

- ☑ Influences on the climate system, via human drivers and natural causes, through emissions and changes to atmospheric GHG concentrations.
- ☑ Impacts of climatic changes upon human and natural systems, referred to by some respondents as 'dangerous climate change'. Modifications to the natural system as well as social, political and economic forces affect the ability to adapt. 'Dangerous climate change' exists only when impacts are beyond a system's ability to adapt – a situation, it was suggested, which is likely to exacerbate conditions of existing vulnerability and inequality.
- ☑ Threats to the status quo. This conceptualization encapsulates the social interpretations of risk and danger, reflecting the prevalent opinion among the European public and some policy makers, and exemplifying the perceived unacceptability of radical precautionary action to deal with climate change due to the current costs from pre-emptive mitigation and adaptation.

Thus, 'danger' associated with climate change can be schematically defined in three ways, or three separate but inter-related areas of danger. The degree of human interference with the climate, the impacts of climate change and the policy "…reflect the complexity and pervasiveness of climate change, as well as the perspectives of different societal actors on the question of climate change and the importance and relevance assigned to present and future developments" (Lowe and Lorenzoni, 2007, p. 143).

United Nation Development Program (UNDP) also sees a starting point for avoiding dangerous climate change in recognition of three distinctive features of the problem (UNDP, 2007a):

(i) The *first feature* is the combined force of inertia and cumulative outcomes of climate change, that is once emitted CO_2 and other long-living GHG stay in the atmosphere for a long time;
(ii) The *second feature* is a corollary of inertia – urgency of the climate change challenge. If in many other areas of international relations the inaction or delayed agreements have limited costs, in the case of climate change every year of delay in reaching an agreement adds to GHG stocks, locking the future into a higher temperature. Doing nothing offers a guaranteed route to the further build-up of GHGs and to mutually assured destruction of human development potential. Fortunately, most governments also accept that solutions to climate change are affordable—more affordable than the costs of inaction;
(iii) The *third important dimension* of the climate change challenge is its global scale.

Additionally, UNDP considers climate change in the 21st Century as the threat of a *'twin catastrophe'*. The first catastrophe is an immediate threat to human development that is not a distant future scenario. Climate change affects all people in all countries, with the world's poorest people on the front line. It is unfolding today, slowing progress towards the Millennium Development Goals (MDGs) and deepening inequalities within and across countries. Left unattended, it will lead to human development reversals throughout the current century. Immediate risks are heavily skewed towards the world's poorest countries and their most vulnerable citizens. The second catastrophe is located in the future. The world current path offers a one-way route to ecological disaster, and climate change poses risks for future generations, not just for the poor, but for the entire planet.

Interpreting Article 2 – ultimately the obligation of the Conference of the Parties to the UNFCCC – involves a *scientific assessment* of what impacts might be associated with different levels of GHG concentrations or climate change (e.g., Parry *et al.,* 2008a, 2009). However, the determination of DAI cannot be based on scientific arguments alone, but involves other judgments informed by the state of scientific knowledge, e.g., the *normative evaluation* by policy-makers of which potential impacts and associated likelihoods are significant enough to constitute, individually or in combination, DAI. This assessment is informed by the magnitude and timing of climate impacts as well as by their distribution across regions, sectors and population groups. Interpreting Article 2 is necessarily a dynamic process because the assessment of what levels of greenhouse gas concentrations may be considered 'dangerous' would be modified based on the advance and changes in scientific knowledge, social values and political priorities. So, Keller *et al.* (2005) propose to explore other interpretations of "dangerous interference" including, for example, low-latitude vegetation transition, changing ENSO properties or climate change impacts exceeding a certain threshold level in social vulnerability.

The social, cultural and ethical dimensions of DAI, which have drawn recently increasing attention, are summarized by Schneider *et al.* (2007).

1.2.2 Critical levels, thresholds and key vulnerabilities

Lorenzoni *et al.* (2005) noted that 'danger' resides fundamentally in the threat of not being able to cope with a certain degree of change, be it in the climate system or refers to current lifestyles. The timing and rate of change were considered fundamental: a rapid climate change could be dangerous to all, whereas gradual changes are generally manageable, although dangerous to some. Emerging recognition that climate change is already occurring and the continued change is inevitable shifted the attention of climate policy towards defining *tolerable limits* to climate change, within which unacceptable impacts can be avoided (Carter, 2004). *"…the question of what is 'tolerable' lies at the heart of the policy questions we now face"*, – Baer and Risbey (2009, p. 32) argue.

That is why, regarding the problem of necessity to control negative consequences of the climate change caused by anthropogenic impacts on the environment, the basic question is whether the problem exists and what constitute *a dangerous limit* of the impact, which can result in destruction of the now existing climate system or in serious consequences for both the human-beings and biosphere. Obviously, *'dangerous'* limits for the climate system are those changes that do not allow it to come back into its initial state. From this point of view, the threshold concept is similar to the concept of *critical load,* often used successfully in applied environmental science where critical levels have been employed in setting of ceilings for environmental pollution (Radunsky, 2003); it also have been widely accepted as a basis for political decisions on different emission reductions (Keller *et al.*, 2008). The concept of critical load presumes that absolute values for a system response can be found to establish a response function. This approach follows Izrael's (1983) general concept of critical limits in the state of biosphere; he also proposed (Izrael, 2004) to assume under 'dangerous' conditions namely those, about which we are most worrying, defining them as '*critically dangerous'*.

Potential threshold responses in natural and social systems play an important role in the interpretation of UNFCCC Article 2. *"Persistent deep uncertainties about climate thresholds impede the design of climate policy under the Convention. They cast doubt on the location of the critical boundaries and the attribution required to connect policy levers with policy targets. They also combine with uncertainty about climate sensitivity to question our ability to link specific concentration thresholds to reducing the likelihood of 'dangerous interference'"*, – Keller *et al.* (2008) stated in their editorial essay. Critical dangers for the set of elements of existing natural and social systems are characterized by certain criteria, the identification of which is necessary to estimate a real, or *harmful* (Harvey, 2007) critical danger.

The question "At what point does climate change become dangerous?" invites another question: "Dangerous for whom?" UNDP (2007a) is confident that dangerous climate change cannot be inferred from a set of scientific observations alone. The dangerous threshold depends on value judgments over which there is an unacceptable cost in social, economic and ecological terms at any given level of warming. Determination of what is an acceptable upper-limit target for future global temperature increases raises fundamental questions about power and responsibility, because for millions of people and for many ecosystems the world has already passed the danger threshold.

In particular, the UNDP's team, in its Human Development Report 2007/2008 (2007a, p. 26), identified five specific risk-multipliers of climate change that are dangerous for ***human development*** **—** five human development 'tipping points':

- *Reduced agricultural productivity*
- *Heightened water insecurity*
- *Increased exposure to coastal flooding and extreme weather events*
- *The collapse of ecosystems*
- *Increased health risks.*

These five drivers for major human development reversal cannot be viewed in isolation. They will interact with each other, and with pre-existing human development problems, creating powerful downward spirals.

Meze-Hausken (2008) tries to answer the question whether climatic thresholds, associated with human responses to climate variability and change, beyond which a specific human action or behavior is initiated or ends, can be specified and measured. In the treatment of these thresholds, she proposes to adapt two approaches referred correspondingly to two different points of view: "Can climate thresholds for society be established or measured?" and "Can human thresholds to climate be established or measured?" This differentiation defines the goals of questions. In the first case we establish and measure a threshold value for a climatic variable, or a combination of climatic variables (e.g., temperature, humidity, wind, etc.), which play a key role in the well-being of a society; in the second case we define social, economic and other conditions representing the state of a society that will result in its reaction to a given climatic stimulus. In other words, while climatic thresholds refer explicitly to the climatic drivers of social/individual change, the societal thresholds determine whether a specified climatic stress is experienced as acceptable or problematic for the exposed (social) system. Because culture and technology as well as human physiological adjustment differ between regions and over time, in most cases the thresholds of both kinds can be quantified only partially and are case-specific, differing in almost every situation.

Inclusion of social science aspects in the investigation of human thresholds to climate change means that a specific climatic condition is not a sufficient cause for reaching a threshold which initiates a human response; physiological, subjective and social conditions have also to be taken into consideration as well.

Meze-Hausken (2008) presented a conceptual stimulus-response model which tries to capture these complex interactions (Fig. 1.7). In this model the *STIMULUS* is a climatic event, which has time-frame ranges from short-term climatic hazards or stochastic meteorological situations to slow climatic changes, with or without superimposed changes in variability. *PHYSIOLOGICAL THRESHOLDS* to climate are encountered due to direct exposure to climate variables such as temperature extremes. However, *SUBJECTIVE THRESHOLDS* cannot be approached in a straightforward manner and surrogates (e.g., statistical relationships) have to be found by surveys. *RESPONSE* refers to a reaction to a stimulus done by a system, and *IMPACT* is the direct outcome of a stimulus, i.e. something that is done to a system. *ADAPTATION* is the adjustment to a response or impact with the possible consequence of increasing/reducing the threshold level. And at last, the *POLICY* response is the broader, fuzzy background in which the system operates, and which stimulates or hampers potential adaptation (e.g., institutional barriers, laws and regulations). Presenting the stimulus-response relationship in shells, rather than with arrows, allows a dynamic perspective.

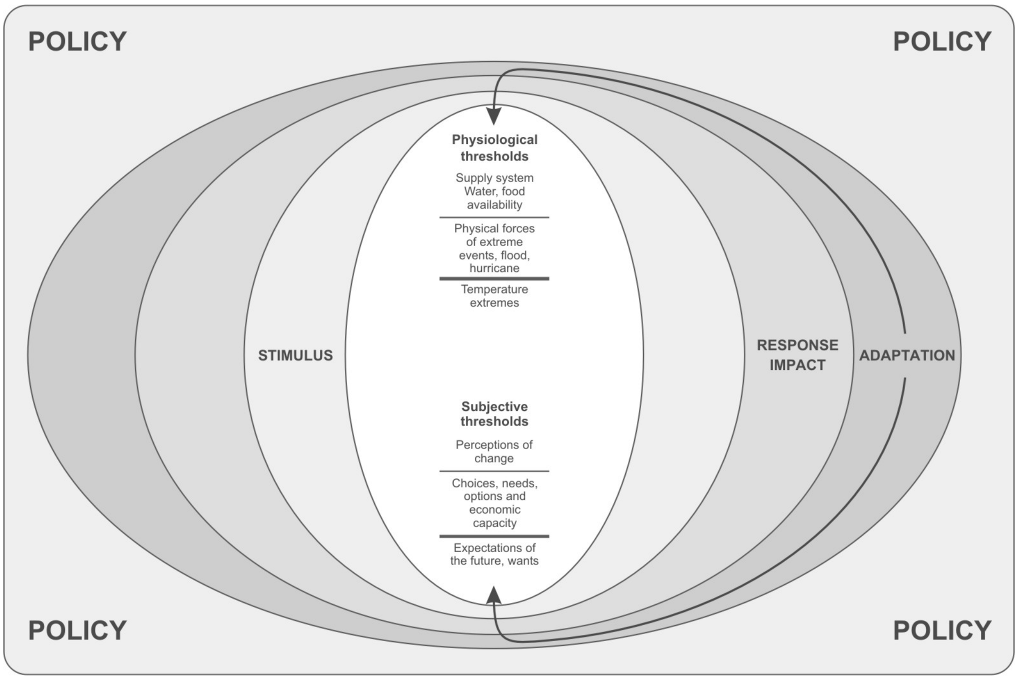


Fig. 1.7 Conceptual model of a stimulus-threshold-response relationship. When a stimulus reaches a threshold, it will trigger a certain response or impact. Adaptation, performed within a certain policy background, can act upon the threshold level and thus change the (likelihood of a) response. *Source:* Meze-Hausken, 2008

Consideration of multiple impacts compounds the issue because *"Even if we could determine thresholds for any given impact with useful precision, there are a plethora of different impacts to worry about, each with their own thresholds, and we don't know which of these many impacts to condition responses on"* (Risbey, 2006, p. 529).

Admissible (critical) load on an individual organism or an element of the climate system is *a value* (usually, upper and lower) at which the deviation from their 'normal' state does not exceed on average the natural fluctuations and does not break down the system as a whole. To determine the admissible loads, it is necessary to have a detailed prediction of the future influence of different impacts on a wide set of elements of the biosphere or the climate system that do not lead to a partial or entire destruction of the system under consideration. Critical state and dangerous levels of impacts should also to take into account the vulnerability of elements or systems on the whole and a degree of their tolerance.

The above theoretical discussions can be also framed around *thresholds (boundaries*) or *critical limits* for changes (Carter *et al.,* 2007; Izrael, 2004; Patwardhan *et al.*, 2004). Thresholds denotes some limit of tolerable risk and marks the point where stress on an exposed system or activity, if this threshold is exceeded, results in their non-linear response. As an example, in Box. 1.9 there is shown a heat temperature threshold, identified as tolerable for human well-being in Moldova's urban area.

IPCC AR4 distinguishes two types of thresholds (Carter *et al.,* 2007).

Type I – *systemic threshold* – denotes a non-linear change in state, where a system shifts from one identifiable set of conditions to another. Such thresholds are simply *target values* of linear or other smooth changes that after some point would lead to damages that might be considered as 'unacceptable'. Thus, a systemic threshold can often be objectively measured. For example, Hansen *et al.* (2006) concluded that global warming of more than ~1°C (relative to 2000) will constitute 'dangerous' climate change as judged from likely effects on sea level and extinction of species. On balance, they proposed these two foci in defining DAI because of their potential tragic consequences and practical irreversibility on human time scales. It is also likely that such thresholds would be determined as the outcome of a socio-political process that weighs the relative risks to different sectors and regions. For example, a certain amount of sea level rise might be considered 'unacceptable' for the particular near-shore low-lying Baltic States, while the same rise falls within a coping range for the mountainous regions of Georgia.

Type II – *impact threshold* – denotes a level of change in condition, measured on a linear scale, regarded as 'unacceptable' and inviting some form of response. Exceeding the *impact threshold* will result in a change of legal, regulatory, economic, or cultural behavior. Impact thresholds might be those that are linked directly to the key intrinsic processes of the climate system itself and might be related to maintaining stability of those processes or some of elements of the climate system. Such intrinsic or systemic thresholds where nonlinear processes cause a system to shift from one major state to another (such as a hypothetical sudden change in the Asian monsoon) may lead to large and widespread consequences considered as 'dangerous', e.g., damaged natural and managed ecosystems or infrastructure in the Russian Arctic.

The IPCC (2007d) once again confirmed that anthropogenic warming could lead to impacts that are abrupt or irreversible, depending upon the rate and magnitude of the climate change. This normally brings to mind abrupt climate changes on decadal time scales, as involving ocean circulation changes. On longer time scales, ice sheet and

Box 1.9 Identification of a heat-wave mortality threshold for Chisinau (Moldova)

Roughly speaking, a heat wave is a "prolonged period with an unusually high heat load" (Menne and Matthies, 2009) and is usually characterized by a steep increase of ambient air temperatures of several days' duration. Although heat waves are meteorological events, from the viewpoint of their human impacts they can be also defined as "…an extended period of unusually high atmosphere related heat stress, which causes temporary modifications in lifestyle, and which may have adverse health consequences for the affected population" (Robinson, 2001). Thus, a critical moment in heat-wave identification is the determination of a threshold above which it is believed that ambient temperatures may be hazardous to human well-being.

The summer months of 2007 were extremely hot in Chisinau. With few exceptions, mean *(Tmean)*, maximum *(Tmax)* and minimum *(Tmin)* daily temperatures were significantly higher (up to 12ºC and more) than their baseline norms (Fig. 1). As a result, the average total daily mortality was higher than in 'normal' summers by 6.5-6.9%. Excess deaths were especially pronounced during heat-waves episodes (Fig. 2).

Heatwave identification was based on the combination of relative threshold temperatures *(Ti)* with their durations. A selected two-level criterion defined a heat wave as the longest continuous period satisfying the following three conditions:

(i) The daily Tmax must be above *T1* for at least three consecutive days;
(ii) The average daily Tmax must be at least *T1* for the entire period;
(iii) The daily Tmax must be above *T2* for every day of the entire period.

T1 and *T2* were identified in such a way as to cover the 90-99th percentile tails of *Tmax* distribution in the last-decade local climate. *T1* – the 99th percentile (~32°C) – identified heat days of exceptional intensity; *T2* – the 90th percentile of Tmax (~30°C) – defined the temperature extremes in the IPCC (2007d) definition and allowed the inclusion of days with temperatures that were associated with excess mortality. Heatwaves, identified by these criteria, are shown in Fig. 3. On the whole, in May-September six heat waves and two heat days, with a total duration 47 days, were observed. The most intensive heat wave (16-31 July) resulted in 116 excess deaths.

Source: Corobov *et al*. (forthcoming)

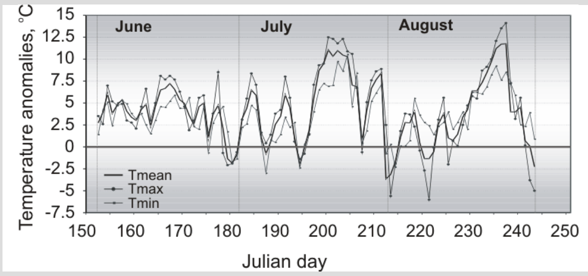


Fig. 1 Deviations of Chisinau daily air temperatures in summer 2007 from their baseline (1961–1990) values *(horizontal zero line)*

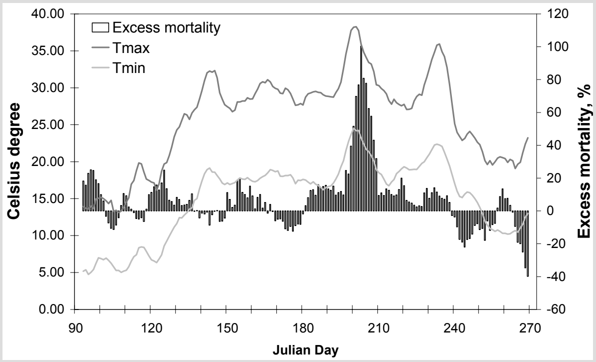


Fig. 2 Dynamic of the excess mortality *(columns)* and temperatures *(curves)* in Chisinau in the summer of 2007

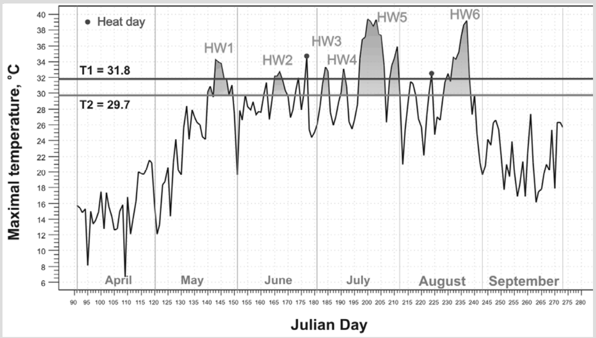


Fig. 3 Heat waves *(HW)* and heat days *(HD)* sequence in Chisinau in 2007

ecosystem changes may also play a role. If a large-scale abrupt climate change were to occur, its impact could be quite high, *likely* leading to some irreversible consequences. Undoubtedly, the irreversibility and scale of such changes would be qualified as ‘dangerous’ and considered as ‘unacceptable’ by virtually all policy-makers. For example, stability of thermohaline circulation or loss of mountain glaciers appear to be of global or regional significance and thus these are some of the natural boundaries which, if exceeded, would lead to major potentially irreversible impacts.

Thresholds used to assess risk are commonly value-laden, or normative. Critical thresholds are used to define the coping range of climate (Carter *et al.,* 2007).

And, at last, a few words about ***climate surprise***. Strictly speaking, any unexpected outcome is a ‘*surprise’*. In the context of climate change, Schneider (2004) considers a ‘surprise’ to be any event when a climate change-induced phenomenon with a very low probability of happening to occur became reality, or if an event never before imagined took place. Potential climate change, and more broadly, global environmental change is replete with such surprises due to enormous complexities of the processes and interrelationships involved and to their insufficient understanding. As a result, it is not even clear whether such surprises actually are the ‘low probability’ phenomenon or just very uncertain at this point given the state of knowledge is still evolving. That is why Schneider (2004) proposes to define the events that are not truly unanticipated as *imaginable abrupt events*. For other events – *true surprises* – while the outcome may be unknown, it may be possible to identify imaginable conditions for surprise.

Setting a target based on a thresholds approach, as Article 2 would suggest, may indeed still endanger ecosystems and human populations who will be affected below a prescribed (international) threshold (Pittock, 2003). Perhaps the most alarming conclusion was made by the UNDP (2007a, p. 22-23): “The window of opportunity for successful mitigation is closing” because we are nearing the limits to the amount of carbon dioxide that the Earth’s sinks can absorb without creating dangerous climate change effects, and “if the next decade looks the same as the last one, then the world will be locked on course for the avoidable ‘twin catastrophe’ of near-term human development reversals and the risk of ecological disaster for future generations. There is less than a decade to ensure that the window of opportunity is kept open. It is not a decade to decide on whether to act and to formulate a plan, but rather a decade in which to start the transition to new policies”.

Thus, defining the danger is a political debate. Zahran *et al.* (2007) characterize global climate change as a *tragedy of the commons* because, with the absent of coercive leverage to coordinate individual and group interests in use/abuse of the common pool resource of climate, it is rational for an individual country to defect and ride the efforts of others. It is rational to freeload off others because the transition costs of participation are high, and the benefits of improved climate are non-excludable.

Climate thresholds also pose deep intellectual challenges at the interface of pure science and policy relevant science because there are large gaps in our knowledge of climate thresholds relevant to human systems today, and of socio-economic thresholds for climate change in the future (Meze-Hausken, 2008). Reducing the risk of future surprises requires a balanced and diversified *research portfolio* that analyzes and covers the range of potential thresholds. Keller *et al.* (2008) ranked possible elements of such a portfolio according to their importance as follows:

(i) refining the probabilistic analysis of paleo-events to improve predictions of future climate change;
(ii) characterizing the connections between monitoring and early prediction of threshold crossings;
(iii) reducing the uncertainty of decision-critical parameters, such as climate sensitivity;
(iv) estimating the impacts of threshold crossings;
(v) analyzing strategies to reduce the risk of threshold crossings;
(vi) investigating ways of representing and communicating key uncertainties to decision-makers, stakeholders and the general public.

Many impacts, vulnerabilities and risks merit particular attention by policy-makers because characteristics that might make them are key ones.

Generally, *vulnerability* to climate change, which will be discussed in more detail in Chapter 3, is the degree to which geophysical, biological and socio-economic systems are susceptible to, and unable to cope with, adverse impacts of climate change (Schneider *et al.,* 2007). Therefore, the term 'vulnerability' may refer to the vulnerable system itself, to the impacts to this system or to the mechanism causing these impacts.

Key vulnerabilities and *key impacts* that may be associated with them are found in many climate sensitive systems, including, for example, food supply, infrastructure, health, water resources, ecosystems, and so on. Their study is intended to provide guidance for decision-makers in identifying levels and rates of climate change that may be associated with DAI (using the terminology of UNFCCC Article 2).

Determining which impacts of climate change are potentially *'key'* and which are *'dangerous'* is a dynamic process involving, among other things, the combination of scientific knowledge with factual and normative elements because some aspects of confidence in the climate change–impact relationship are factual, while others are subjective (Dessai *et al*., 2004; Patwardhan *et al*., 2004; Schneider *et al.,* 2007). Largely *factual*, or objective, criteria include the scale, magnitude, timing and persistence of the harmful impact. The choice of which factual criteria to employ in assessing impacts has a *normative* component. The normative, or subjective elements are embedded in assessing the uniqueness and importance of the threatened system, equity considerations regarding the distribution of impacts, the degree of risk aversion, and assumptions regarding the feasibility and effectiveness of potential adaptations (IPCC, 2001c; Tol *et al.,* 2004). Normative criteria are also influenced by the perception of risk, which depends on the cultural and social context.

Schneider *et al.* (2007) distinguished seven criteria that may be used to identify key vulnerabilities:

1. ***Magnitude of impacts*** that is determined by its scale and intensity. Impacts of large magnitude are more likely to be evaluated as *key* than impacts with more limited effects. Therefore, most studies associated key vulnerabilities and dangerous anthropogenic interference primarily with large-scale geophysical changes in the climate system. The most widely used quantitative measures for climate impacts are monetary units such as welfare, income or revenue losses, costs of anticipation and adaptation to certain biophysical or environmental impacts such as a large sea-level rise. For some impacts, qualitative rankings of magnitude are more appropriate. Qualitative methods have been applied to reflect social preferences related to the potential losses of biodiversity, cultural heritage, etc.

2. ***Timing of impacts.*** A harmful impact is more likely to be considered *key* if it is expected to happen soon rather than in the distant future. Another important aspect of timing is the rate at which impacts occur. In general, adverse impacts occurring suddenly (and surprisingly) would be perceived as more significant than the same impacts occurring gradually because in the former case the potential for adaptation would be much more limited. Moreover, very rapid change in a non-linear system can exacerbate other vulnerabilities, particularly where such a change curtails the ability of systems to prevent or prepare for particular kinds of impacts.

3. ***Persistence and reversibility of impacts.*** A harmful impact is more likely to be considered *key* if it is persistent or irreversible. Examples of climate impacts that could become *key* due to persistency include the emergence of near-permanent drought conditions (e.g., in semi-arid and arid regions). Examples of impacts that are irreversible, at least on time-scales of several generations, include changes in regional or global biogeochemical cycles and land cover, the extinction of species, the loss of unique cultures, etc.

4. ***Likelihood***, as estimates of the uncertainty of impacts and vulnerabilities, and ***confidence*** in those estimates. *Likelihood* is the probability of an outcome having occurred or occurring in the future; *confidence* is the subjective assessment that any statement about an outcome will prove correct (see Box 1.4). An impact characterized by high likelihood is more apt to be seen as *key* than the same impact with a lower likelihood of occurrence. Since risk is defined as consequence (*impact*) multiplied by its likelihood (*probability*), the higher the probability of occurrence of an impact the higher its risk, and the more likely it would be considered as *key*.

5. ***Potential for adaptation.*** The lower the availability and feasibility of effective adaptations, the more likely such impacts would be characterized as *key vulnerabilities*. Here it is considered not only the technical feasibility of certain adaptations but also the availability of required resources, the costs and side-effects, the timeliness of adaptation options and so on (see Sect. 3.3).

6. ***Distributional aspects of impacts and vulnerabilities.*** Impacts and vulnerabilities that are highly heterogeneous or which have significant distributional consequences are likely to have higher salience and therefore a greater chance of being considered as *key*.

7. ***Importance of the vulnerable system(s) at risk.*** A salient, though subjective, criterion for the identification of *key vulnerabilities* is the importance of the vulnerable system's property. Various societies and peoples may value the significance of impacts and vulnerabilities on human and natural systems differently. For example, the transformation of an existing natural ecosystem may be regarded as important if it presents the unique habitat of many endemic species or contains endangered charismatic species. On the other hand, if the livelihoods of many people depend crucially on the functioning of a system, this system may be regarded as more important than a similar system in an isolated area.

Most studies of impacts in the context of *key vulnerabilities* have focused on aggregate impacts, grouping developing countries or populations with special needs or situations. Research on vulnerability has often focused on groups of people, for example those living in coastal or flood-prone regions, or socially vulnerable groups such as the elderly. No single metric for climate impacts can provide a commonly accepted basis for climate policy decision-making.

1.2.3 Climate risks and *'reasons for concerns'*

The IPCC, rather than attempt to define *'dangerous'*, which it views as beyond its legal ambit, in its Third Assessment Report (IPCC, 2001c; Smith *et al.*, 2001) organized the vulnerabilities of individuals as well as socioeconomic and ecological systems in five categories called '***reasons for concern'.*** These *'reasons for concern'* were intended to synthesize information on climate risks and key vulnerabilities and to "aid readers in making their own determination" about risk.

Generally, the risks of climate change for a given exposure unit can be defined by criteria that link climate impacts to potential outcomes. This allows a risk to be analyzed and management options to be evaluated, prioritized, and implemented (Carter *et al.,* 2007).

Risk is understood to be the product of the likelihood of an event and its consequences. As applied to climate change, the concept of risk is formed by the combination of a climate change impact magnitude, with the probability of its occurrence, uncertainties in the underlying processes, exposure, sensitivity and adaptation. Thus, local decision-makers face the challenging task of understanding and acting on three overlapping factors that together constitute ***climate risk:*** (1) the threat already posed to society from today's climate; (2) development paths that might put greater population and value at risk; and (3) the potentially devastating but still largely uncertain additional risks presented by climate change. The framework for assessing and addressing total climate risk, also proposed by the *"Economic of adaptation"* team (ECA, 2009) poses five questions, each driving a core set of analyses (Fig. 1.8). This framework could be considered as a tool to assist decision-makers in managing the total climate risk of a country, region or city.

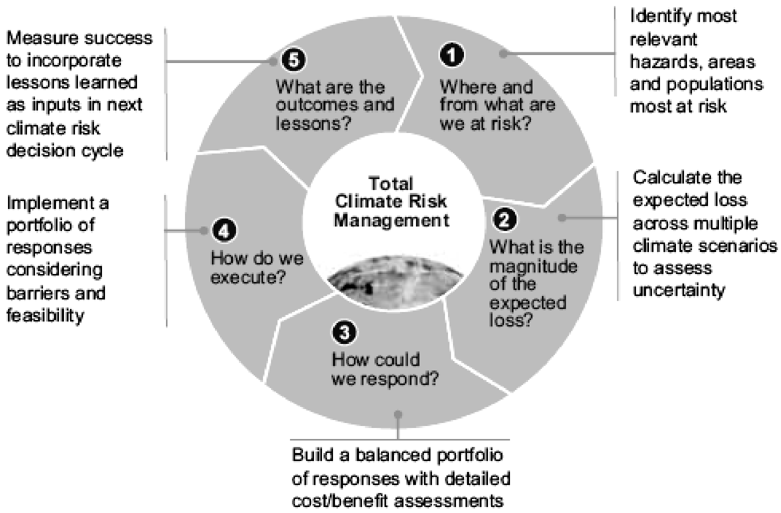


Fig. 1.8 A framework for assessing and addressing total climate risk. *Source:* ECA, 2009

Climate risk management techniques can explicitly accommodate sectoral, regional and temporal diversity, but their application requires information not only about impacts resulting from the most likely climate scenarios, but also about impacts arising from lower-probability yet higher-consequence events and the consequences of proposed policies and measures.

The IPCC identified five ***'reasons for concerns'*** about projected climate change. For each '*reason for concern',* the risks of the potential range of climate change adverse impacts at different levels of projected global mean annual temperature from 1990 to 2100 have been represented graphically by the IPCC Working Group 2 (Fig. 1.9) as colored bars using a classification that ranged from *white* (little or no risk) through *grey* and *dark grey* to *dark* (high risk). This figure, also known as the 'burning embers diagram', shows that the most potentially dangerous climate change impacts typically occur after only a few degrees Celsius of warming (Carter, 2004; Schneider, 2004).

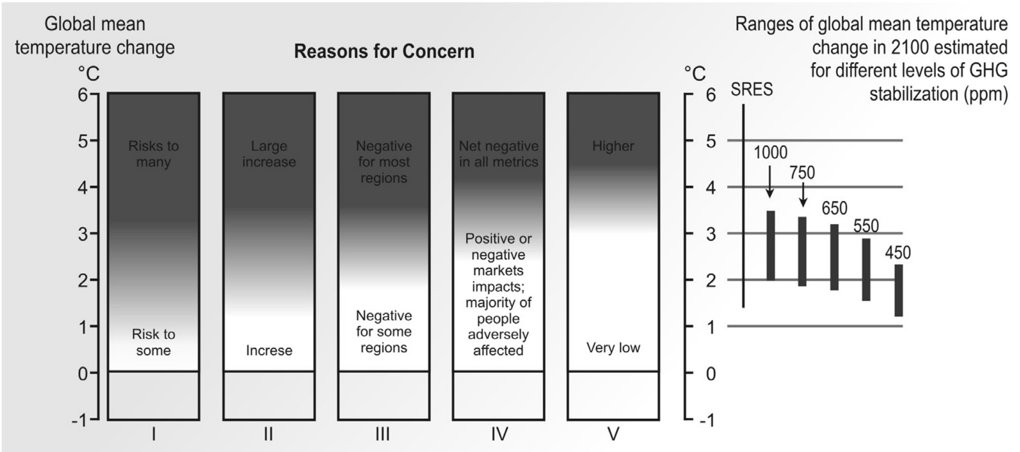


Fig. 1.9 Reasons for concerns about projected climate change impacts. *Note:* I – Risk to unique and threatened systems; II – Risk from extreme weather events; III – Distribution of impacts; IV – Global aggregate damages; V – Risks from large-scale discontinuities. *Source:* IPCC, 2001c

The reasons for concerns, identified in the IPCC TAR, remain a viable framework to consider key vulnerabilities, and as such have been updated in the AR4 (Box 1.10). Now they are assessed to be stronger with many risks identified with higher confidence. Some risks are projected to be larger or to occur at lower increases in temperature. This is due to:

(1) Better understanding of the magnitude of impacts and risks associated with increases in global average temperature and GHG concentrations, including vulnerability to present-day climate variability. Understanding about the relationship between impacts (the basis for 'reasons for concern' in the TAR) and vulnerability (that includes the ability to adapt to impacts) has also improved;
(2) More precise identification of the circumstances that make systems, sectors, groups and regions especially vulnerable;
(3) Growing evidence that the risk of very large impacts on multiple century time scales would continue to increase as long as GHG concentrations and temperature continue to increase.

Box 1.10 'Reasons for concerns' about projected climate change, summarized by the IPCC Fourth Assessment Report

– ***Risks to unique and threatened systems.*** There is new and stronger evidence of observed impacts of climate change on unique and vulnerable systems, such as polar and high mountain communities and ecosystems, with increasing levels of adverse impacts as temperatures continue to increase. In particular, scientists have identified various *geo-boundaries* – locations such as coastlines and mountaintops that are more prone than other areas to irreversible losses. If these areas become unsuitable for their present occupants or disappear altogether, many of the plant and animal species that dwell there will be unable to find suitable alternative habitats, making their extinction much more probable. The severity of climate change effects will vary among species, implying a dismantling of some existing plant and animal communities as individual species' responses to climate unfold, which could create disruptions in ecosystem goods and services. At present there is *medium confidence* that approximately 20 to 30% of plant and animal species assessed so far are *likely* to be at increased risk of extinction if increases in global average temperature exceed 1.5 to 2.5°C over 1980–1999 levels. Over time, the confidence has increased in ways that such warming poses significant risks to many unique and threatened systems, including biodiversity hotspots. As the global average temperature increase exceeds about 3.5°C, model projections suggest more significant extinction of species around the globe (40 to 70% of assessed).

– ***Risks of extreme weather events.*** Responses to some recent extreme climate events reveal higher levels of vulnerability in both developing and developed countries. There is a higher confidence in the projected increases in droughts, heat waves and floods, as well as in their impacts. These increases are projected in many regions and would have mostly adverse impacts, including increased water stress and wild fire frequency, adverse effects on food production and human health, increased flood risk and extreme high sea level with damage to infrastructure.

– ***Distribution of impacts and vulnerabilities.*** There is greater confidence in the projected regional patterns of climate change and in the projections of regional impacts, enabling better identification of particularly vulnerable systems, sectors and regions. There are sharp differences across regions, and those in the weakest economic position are often the most vulnerable to climate change and are frequently the most susceptible to climate-related damages, especially when they face multiple stresses, for example in dry areas. There is an increasing evidence of greater vulnerability of specific groups such as the poor and elderly not only in developing but also in developed countries.

– ***Aggregate impacts.*** Compared to the TAR, initial net market-based benefits from climate change are projected to peak at a lower magnitude and therefore sooner than was assessed before. It is *likely* that there will be higher damages for larger magnitudes of global temperature increase, and the net costs of impacts of increased warming are projected to increase over time. Aggregate impacts, having been quantified in other metrics, show that climate change over the next century is *likely* to adversely affect hundreds of millions of people through increased coastal flooding, reductions in water supplies, increased malnutrition and health impacts.

– ***Risks of large-scale singularities.*** There is better understanding that the risk of additional contributions to sea level rise from both the Greenland and possibly Antarctic ice sheets may be larger than that, projected earlier, and could occur on century time scales. For example, complete deglaciation of the Greenland ice sheet would raise sea level by 7 m and could be irreversible.

Source: IPCC, 2007d

But the IPCC taxonomy itself is by no means the sole way to categorize potential dangers, and it leads to other difficult questions. For example, *"How might countries globally, in large regional groupings, or in groupings of common economic interest* – a question that Oppenheimer and Petsonk (2005, p. 207) have expressed – *agree on which reasons for concern could be used to define danger, and thereby begin the process of implementing Article 2?"* One plausible view they see in that the larger, more abrupt, less reversible, and more global the impact is, the easier may be agreement on a particular definition of danger regardless of uncertainty. Also, the more certain and immediate the impact is, the easier to reach an agreement. The fact that these and other sets of characteristics are not overlapping for many of the impacts presupposes some of the political difficulties that lie ahead.

1.2.4 To evaluation of danger climate change impacts

Generally, a *climate change impact* means a specific change in a natural or human system caused by its exposure to the change, regardless of the fact either an impacts is judged to be harmful or beneficial (Schneider *et al.,* 2007). As such, climate change impacts depend on the characteristics of natural and human systems, their development pathways and specific locations.

The *potential* impacts or *consequences* of climate change differ in several fundamental ways from changes for which well-developed methods for evaluation and decision-making are available (Morgan *et al.*, 1999; Parson *et al*., 2003). In particular, climate change simultaneously affects many resources and diverse aspects of the natural, social, and economic environment, of which some are directly or indirectly represented in a market and others are not. Changes are global in scope, but vary strongly among affected locations and people, depending on many dimensions of the local environmental and socioeconomic context. Changes can extend decades or centuries into the future and, consequently, be experienced by people whose choices, perceptions, and values may strongly differ; they will not necessarily be marginal and gradual, but may be large and in some cases sudden. Many important dimensions of potential changes, by the opinion of quoted authors, are not adequately represented. Changes extending far into the future and affecting people and regions worldwide, with vastly different cultures and levels of development, may render invalid conventional procedures for aggregating valuations across individuals or for discounting future changes. Moreover, people’s preferences and values may change over time or adjust in response to realized socioeconomic and environmental changes, thereby diverging from valuations that would be made from the present perspective.

And finally, when we talk about climate change impacts we need to be clear whether we are talking about the direct effects without adaptation or about effects after some ‘automatic’ or planned adaptation (Schneider, 2004). The degree to which the particular impact assessments have yielded prevention measures and their costs have taken into account is often not clear. Furthermore, future adaptation will depend on future technological and social developments which cannot be perfectly predicted. So, any estimates of realistic climate impacts can only be approximate, providing rough guidelines to what may occur and how it might be optimized.

These preconditions make deeply problematic the basis for evaluating the potential climate change effects and tradeoffs with other valued conditions, and the assessment of climate change danger and key vulnerabilities involves substantial scientific uncertainties and value judgments.

Any comprehensive *scientific analysis* requires consideration of the responses of biophysical and socio-economic systems to changes over time in climatic and non-climatic conditions (e.g., changes in population, economy or technology) as well as in important non-climatic developments that affect adaptive capacity across regions, sectors and social groups. Scientific analysis can inform policy processes, but choices, about which vulnerabilities are 'key', and preferences for policies appropriate for addressing them, necessarily involve *value judgments* about the acceptability of potential risks and potential adaptation/mitigation measures. To achieve transparency in such complex assessments, the scientists and analysts need to provide a 'traceable account' of all relevant assumptions. "Natural, technical and social sciences can provide essential information and evidence needed for decision-making on what constitutes 'dangerous anthropogenic interference with the climate system'. At the same time, such decisions are value judgments determined through sociopolitical processes, taking into account considerations such as development, equity and sustainability, as well as uncertainties and risk" (Schneider *et al.,* 2007, p. 784).

In the process of determining criteria or defining critical thresholds, including both target values (Type I) and intrinsic thresholds (Type II) (see Sect. 1.2.2), *uncertainty* is an important factor to be considered. Scientific knowledge is always limited, and capability of policymakers to adequately assimilate scientific information for making decisions is also limited. Therefore, selection of key elements and establishing critical thresholds implies differing levels of confidence (Patwardhan *et al.*, 2004).

Schneider (2004) see the role of science in the estimation of the impacts in each category, their distribution across sectors, regions and income groups, their relative likelihood and the confidence in each category as well as a "traceable account" in any aggregation metrics.

While the notion of 'dangerous' involves value judgments, the science could certainly provide inputs to help policymakers consider these judgments. The three criteria mentioned in Article 2 may be evaluated as purely scientific questions to varying degrees. At the same time, it is important to recognize that these criteria are normative in nature, that is, they may be considered as objectives of policy, and not only as indicators or markers, per se. For example, while evaluating the questions of whether ecosystems can adapt naturally and whether food production is threatened, it will be necessary to examine not only the range of climate outcomes, but also the adaptive capacity of the system at risk that, in turn, is determined by human perception, evaluation and response (Patwardhan *et al.,* 2004).

Developing their vision of the problem further, these authors proposed to examine the 'dangerous' impacts of climate change in the *WEHAB* (**W**ater, **E**nergy, **H**ealth, **A**griculture and **B**iodiversity) framework, or in areas introduced during the 2002 World Summit (UN, 2002) as essential for *human well-being (HWB),* particularly for such its components as social development, health, prosperity, and ecosystem services. This umbrella term is now well-recognized, being used in assessments of other global changes, including, for example, the Millennium Ecosystem Assessment (2005) and encompassing the range of trade-offs not only within its own components, but also ethnical and distributional issues (UNDP, 2007). The consequences of climate change for HWB are not amenable to high-confidence quantification in all important sectors or regions because the socio-natural system is a set of interacting processes. So, examinations of impacts on sectors one at a time (a classical scientific approach) will not describe in the end the systemic nature of the coupled components that determine overall impacts, being bounded in certain framework (Patwardhan *et al.,* 2004). The ‘reasons for concern’ (Fig. 1.9) is a typical illustration.

The climate system may play different roles with regard to the WEHAB framework, both determining the availability, quality and variability of respective resources and influencing our ability to use them. Describing the climate change consequences for the WEHAB, it is important to construct appropriate metrics or *’numeraires’* of damage which go beyond a simple, binary market and non-market characterization. An example of one set of numeraires was proposed by Schneider *et al.* (2000) who summarized the effects of climate change in terms of the “Five Numeraires”, each calculated per ton Carbon *(C)*: market system costs, or monetary loss in dollars; loss of human life in persons; species or biodiversity lost; distributional effects in changes in income differentials between rich and poor (mal-distribution/equity); and degraded quality of life changes, such as conflict over resources, heritage sites lost or coercion to migrate.

Thus, the WEHAB framework includes both market and non-market dimensions. While economic theory provides a number of approaches for valuing changes in market goods and services, there is a little agreement on how to value and monetize changes in the non-market goods and services that form a part of HWB. Most research (e.g., Patwardhan *et al.,* 2004; Schneider, 2004) note difficulties in assigning a monetary value to non-market categories of damages, for example, place a dollar value on a human life and the quality of life, or to value ecosystem goods and services. Nevertheless, it is clear that any comprehensive attempt to evaluate the societal value of climate change should include both market and non-market goods and services, as well as aspects of intergenerational and distributional equity. It is also well recognized that the environment has a variety of sources of value, including, e.g., existence value when priority is placed on preserving the environment.

Patwardhan *et al.* (2004) identified main sequential steps in the analysis of ‘dangerous’ climate change that can be combined in two principal operations:

- To identify key elements of the climate system and to map linkages between these elements and numeraires for HWB;
- To establish, where feasible, critical outcomes affecting HWB and to calculate for such outcomes the associated critical limits of climate system parameters (temperature, percentage ice-cover, sea level rise, water balance, etc.) and/or rates of their changes. Since some degree of uncertainty will always remain in scientific knowledge, data, calculations and judgments, in most cases (instead of assessing precise critical limits) the ranges and probabilities are all that can be produced. Of course, such limits/range(s) are generally regionally specific and dependent upon other non-climatic factors.

The following categorization of outcomes encompasses the earlier classification of thresholds (type I and type II), with mapping type I into Categories 2 and 3 and type II – into Category I:

Category 1. In the first instance, assessors can look at those climate outcomes that would lead to widespread negative consequences for each of the WEHAB categories. That is, in these types of outcomes in socio-economic sectors there are no ‘winners’, only ‘losers’ viewed at virtually any scale of decision-making – temporally or spatially. For ecosystems these would include, for instance, loss or near total loss of an ecosystem and a large fraction of its endemic species.

Category 2. These limits are associated with consequences that with high degree of confidence are unambiguously negative for specific regions, sectors, populations or ecosystems. In this category, 'dangerous' interference could be evaluated in light of rights-based or other ethical or cultural considerations. For ecosystems this would imply that there are substantial negative effects on specific ecosystems and substantial increase in vulnerability or risk of extinction over reasonable time frames for some taxa.

Category 3. These kinds of outcomes are those where gains and losses are widely distributed. The determination of 'unacceptability' may be partly informed by examining costs and benefits. Scientific assessment can help delineate components that would aid in making such judgments.

Particular measures and indicators used in analysis of dangerous climate change impacts are tracked out in the following chapters.

On the whole, a suitable template for understanding the relationship between changing climate hazards and society is the concept of *the coping range of climate,* described in the TAR as the capacity of systems to accommodate variations in climatic conditions (Smith *et al.,* 2001). This concept has since been expanded to incorporate concepts of adaptation, planning and policy horizons, likelihood and so on, and now can therefore serve as a conceptual model to integrate analytical techniques with a broader understanding of climate-society relationships (Carter *et al.,* 2007; Morgan *et al.*, 2001). The coping range is used to link the understanding of current adaptation to climate with adaptation needs under climate change.

In Fig. 1.10 this discourse is depicted as one or more climatic or climate-related variables upon which socio-economic responses are mapped. The core of the coping range contains beneficial outcomes. Towards one or both edges of the coping range the outcomes become negative but tolerable. Beyond the coping range, the damages or losses are no longer tolerable and denote a vulnerable state – the limits of tolerance describing a

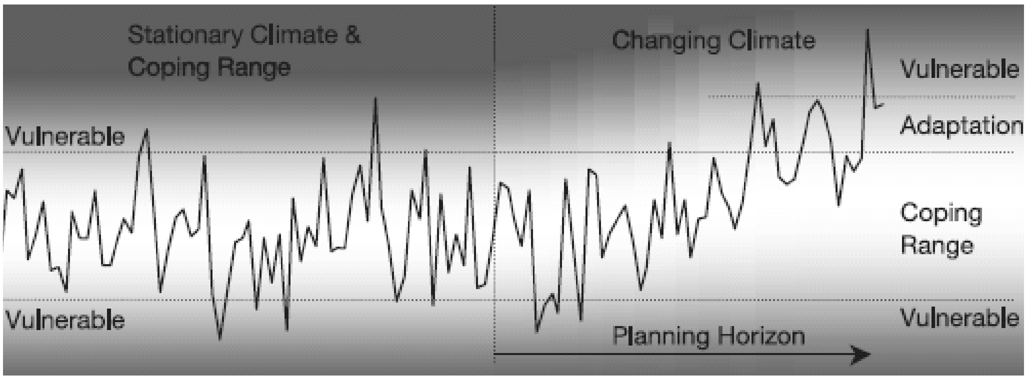


Fig. 1.10 Idealized version of a coping range showing the relationship between climate change and threshold exceedence, and how adaptation can establish a new critical threshold, reducing vulnerability to climate change. *Source:* Carter *et al.,* 2007

critical threshold (left side of the Figure). Risk is assessed by calculating how often the coping range is exceeded under given conditions. Climate change may increase the risk of threshold exceedence, but adaptation can ameliorate the adverse effects by widening the coping range (right side of the Figure). The probability of exceeding these thresholds is a function of both natural climate variability and climate change. Historical frequency of exceedence can serve as a baseline from which to measure changing risks, using a range of climate scenarios.

1.3 Climate change – a new type of strategic problems and policy support

As it was mentioned in previous sections, the science of climate change deals solely in probabilities and does not guarantee certainties. However, at least the *political debate* is rooted in scientific evidence, although there is a large gap between scientific evidence and political action (UNDP, 2007a). In spite of recognition that addressing the climate change risks poses a particularly important challenge, other priorities, mainly from political and individual perspectives, are perceived as more immediate and often outweigh the climatic ones considered as comparatively more distant concerns (Lowe and Lorenzoni, 2007). *"We are now facing a situation in which the critical task is the reframing of the problem as one of understanding the consequences of existing knowledge—including its uncertainties—for the choice of action, at a time when there is substantial evidence that we are already at or near a variety of possible "tipping points"*, – Baer and Risbey (2009, p. 31) note. In this situation crucial questions are: (1) how should society and policy respond to current indications of rapid climate change, and (2) what should human responses be if the evidence becomes clearer? (Charlesworth and Okereke, 2010). These questions are already being addressed in the seminal scholarship and highly influential policy documents (e.g., Hulme, 2008; IPCC, 2007; Stern Report, 2006).

If to return to the UNFCCC's Article 2 defining the international policy efforts in terms of avoidance of greenhouse gas concentrations at the level beyond which the climate change effects would be considered to be 'dangerous', the immediate problem is to cope with or to minimize any adverse effects and to take advantage of any potential benefits, while seeking a way to minimize the magnitude of human-induced climate change and its consequences. Yang and Oppenheimer (2007) estimate the global warming problem as "a chronic yet unprecedented threat to civilization" (p. 199) and suppose that it can be solved in a timely fashion only through a crash research and development program similar to the Manhattan or Apollo Projects. But to use these projects as a rhetorical symbol might make sense to create only a rallying point for the body politic because "good politics is not equivalent to wise policy" (p. 200). A policy strategies used in these projects will fail to reflect the broader socioeconomic context of the climate problem. To base this conclusion Yang and Oppenheimer showed that even if the financial scope, for example of the Manhattan Project, might be appropriate, its style of operation is fundamentally mismatched to the specific of climate change.

Much has been said in the literature about the complexities of this problem. Legions of scientists in multiple disciplines have attempted for decades to assess the causal relations between human and non-human factors and changes in the earth's climate. This issue has already undergone several phases in the policy cycle and has been widely accepted as a problem that requires political regulation. International negotiations have led to broad definitions of goals, and a wide variety of policy responses have been developed. Many of these responses are already in the process of implementation, but their failure to deliver sufficient outputs causes development of new policy responses and new technical solutions (Engels, 2005).

That is why a question arises: *Climate change: what type of a policy problem?* Its understanding and solving requires the synthesis and co-development of many disciplines, with different traditions and links among them. Such understanding follows first from the multiplicity of possible global warming impacts (Fig. 1.11) that differentiates widely the problem on the whole.

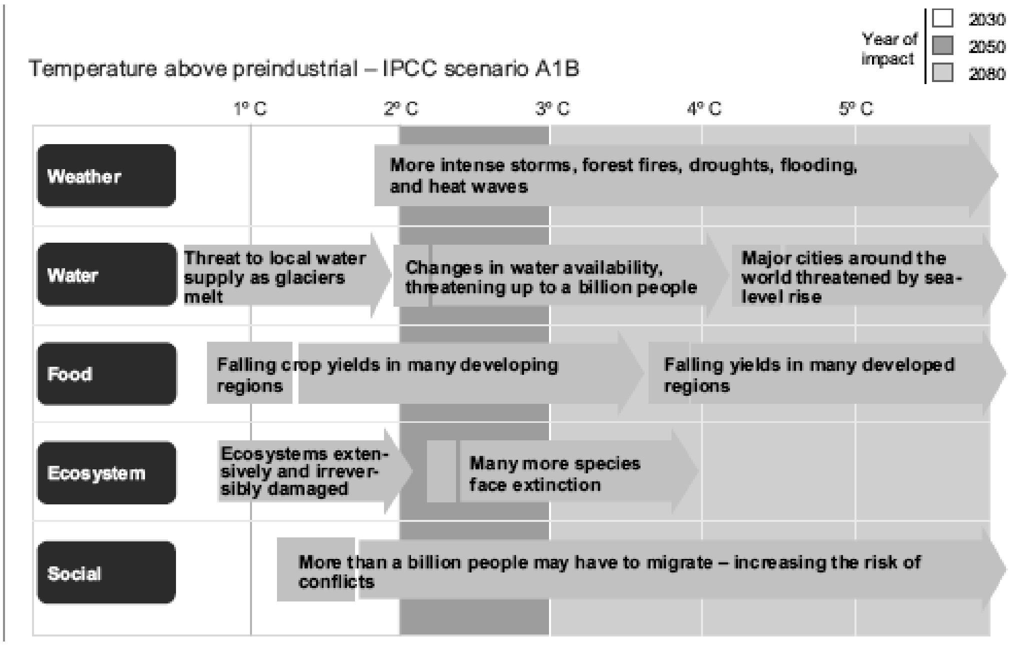


Fig. 1.11 Possible impacts of global warming on different sectors. *Source:* ECA, 2009

1.3.1 Climate change as environmental problem

Climate change, undoubtedly, is an environmental problem, providing a hard lesson in a basic fact of human life: all nations and all people share the same planet and the same atmosphere, which are unique. Global warming is evidence that the carrying capacity of the Earth's atmosphere is overloading, and ecological interdependence is not an abstract concept. *"Wherever people live…they are part of an ecologically interdependent world. Just as flows of trade and finance are linking people together in an integrated global economy, so climate change draws our attention to the environmental ties that bind us in a* *shared future"*, – UNDP (2007a, p. 58) states. As such, climate change is different from other problems facing humanity and challenges us to think differently at many levels, and first of all – to think about what it means to live as part of an ecologically interdependent human community. UNDP estimations show that if all of the world's people will generate greenhouse gases at the same rate as some developed countries, we would need nine planets. *"The emerging risks and vulnerabilities associated with climate change are the outcomes of physical processes. But they are also a consequence of human actions and choices. This is another aspect of ecological interdependence that is sometimes forgotten"* (p. 3).

Schneider (2004a) approaches this problem from the viewpoint of an *inter-species equity.* Because global warming also affects species other than humans, the discussion of the effects cannot be only anthropocentrically-focused. To some groups of species these concerns are more vague since natural systems have limited adaptive capacity and are expected to be less resilient than human systems, particularly for rapid changes, for which they all (may be except micro-species with short generational times) have generally no evolutionary mechanisms to adapt quickly (Mustin *et al.*, 2007). We should also agree with Schneider's half-joking remark that natural systems are likely the most "undeserving victims" of future climate change as they obviously have no influence on the policymaking process, except to the extent that humans value their services and survival. Furthermore, the ecological systems are likely to be more affected than human ones if/when dangerous thresholds are exceeded.

Let us consider, as an example of interdependence between global warming and environmental problems, their links with air pollution. Although these two environmental problems have, to a large extent, a common cause (emissions from fossil fuel burning) up until now they have been addressed by separate policies. As a basis for the following discourse we took the work of F. Raes (2006).

It is well known that fossil fuel combustion emits conventional air pollutants: carbon monoxide, volatile organic compounds (VOC), carbonaceous aerosols ('soot'), nitrogen oxides and sulphur dioxide. Some of these compounds react in the atmosphere and form secondary pollutants such as ozone, particulate sulphate, nitrate and organic matter, which impact on ecosystems and human health. Reducing the use of fossil fuel would address both climate change and air pollution, but this fuel provides over 80% of the current global energy supply, and will likely be the dominant energy source for decades to come. Moreover, GHGs differ from conventional air pollutants in their physicochemical properties, leading to differences in the relative atmospheric longevity and easiness of removal from combustion effluents. Therefore, in recent decades the separate policy frameworks to confront air pollution and climate change have been developed. The first policy has developed faster than the second primarily due the cheaper end-of-pipe control technologies as well as due to short pollutant lifetimes; the impacts occurring relatively close to emission sources allow using of local- or regional-scale solutions. On the contrary, long-lived GHGs mix throughout the global atmosphere, resulting in climatic effects than cannot be traced back to specific sources or regions, and a mitigation policy requires therefore global commitments, irrespective of the local or regional sources of emissions and impacts. While the air quality pollution of any emitter was for a long time considered local, the emerging scientific consensus is that its impact on the earth's climate is indeed already global (Parks and Roberts, 2006).

Nevertheless, in recent years it has been increasingly recognized that air pollution and climate change are linked in several ways, and could be beneficially addressed by an *integrated policy* (Swart *et al.*, 2004). The push for policy integration is mainly driven by implementation costs; this is particularly true for developed countries where relatively cheap air pollution control technologies are already widely implemented, and further reductions are likely to require structural and behavioural measures. However, in developing and transition countries a work toward economic growth and supporting development of energy production systems also provides wide opportunities to tackle air pollution and GHG emissions simultaneously. Policy integration means finding the mix of end-of-pipe, structural and behavioural measures that meet air pollution and climate change targets at the lowest cost. Finding this optimal mix is achieved using an integrated assessment model (Raes, 2006) that is discussed later.

At the same time, mainly according to the latest IPCC assessments, global warming is considered as vastly different from other environmental and public policy issues. Baumert and Kete (2002)[13] formulated six characteristics of the climate change problem, which help to explain why this is so and militate against easy solutions. These characteristics, with some additions from other publications, can be interpreted as follows:

1. The problem is global. Although some countries are very large GHG emitters and others very small, acting alone they all will have a small overall effect on emissions reduction. This conclusion is rooted in the general features of global problems and falls neatly into one of two classes: cumulative or systemic (Rosa, 2001). The first class comprises, e.g., deforestation or the loss of biodiversity and refers to environmental impacts that are generally localized but have effects worldwide because of their cumulative nature. The second class comprises problems that are systemic in nature because their causes are initiated anywhere on earth and because their effects are felt everywhere, for example, ocean pollution or ozone depletion. The global climate change, due to its systemic pervasiveness, is not only among these, but also one of the most important environmental issues facing humankind. Being a ‘global property’, as a policy problem it is tightly linked to international negotiations with global participation.

2. The problem is long-term. The relation of GHG concentrations to the accumulation of gases over long time periods raises complicated intergenerational ethical questions because future generations that will be most affected by climate change have no ‘chances’ to participate in today's decisions. The delays and time-lags in the socioeconomic and climate systems, which mean that actions taken now may have repercussions in decades or centuries to come, leads to necessity in ’a foresight to take action now that will forestall adverse effects in the future’ (Pittock, 2003).

3. Associated human activities are pervasive. In addition to well-known sources of GHG emissions, the wide range of policies affecting technological innovation, economic growth, and population size shape emissions further.

4. Uncertainty is pervasive. Uncertainty and risk are crucial to understand the nature of climate change as a policy problem. Many uncertainties exist regarding the magnitude

[13] The idea from: Toth, F. and M. Mwandosya, 2001: Decision-making frameworks. In: *Climate Change 2001: Mitigation.* Contribution of Working Group III to the Third Assessment Report of IPCC, B. Metz *et al.,* eds. Cambridge, Cambridge University Press, pp. 606-609

of future climate change and its consequences, as well as the costs, benefits, and barriers to implementation of possible solutions. The high degree of uncertainty regards to effects for different regions (Addink *et al.,* 2003). Attempts to reduce the uncertainties of climate models have contributed to the new understanding of uncertainty in policy-making. In these conditions, a necessity to take into account a range of uncertainties is an inherent feature of modeling. Meanwhile, the wide reaching and potentially catastrophic consequences of climate change for human populations imply a high risk for policymaking in this field (Engels, 2005).

5. The consequences are potentially irreversible and distributed unevenly. Additionally to physical irreversibility and unequal distribution of causes and effects, the societies and countries differ in their vulnerability to climate change impacts. Parks and Roberts (2006) added to climate change as a political issue its highly asymmetric distribution of burdens and benefits, and the tremendous gulf in responsibility for the problem.

6. The global institutions needed to address the issue are formed but are very far from unquestioning efficiency, especially as to developing and transition countries.

From other discussions on this item, it would be useful to emphasize the following:

- Climate change policies and innovations in this field are also structured by a changing context. So, general processes of globalization, political modernization and legal innovation have changed (and are changing) the context in which national and international environmental policymaking takes place. This rapidly changing context changes the content and substance of national, regional and international laws and policies, and vice versa, hence, is both a medium for and outcome of climate change policy: *it structures it but is also the result of the challenges presented by climate change* (Addink *et al.,* 2003).
- Overall, studies indicate that climate change is perceived as a distant and impersonal threat, removed in space and time, when compared to other hazards and environmental risks. Risks to society from climate change are also generally considered to be higher than to the individual personally. These findings denote the interplay of various mechanisms and approaches in individual evaluations of its threats and risks (Lowe and Lorenzoni, 2007).
- The UNFCCC's Article 2 demand on prevention dangerous anthropogenic interference with the climate system – '…to enable economic development to proceed in a sustainable manner' – expresses clearly *ethical values* of the climate change policy. At the same time, the human endeavours devoted to realizing the ethical objective in preserving the present climate for future generations must nonetheless compete with other demands on human resources, and the main distinction between the climate problem and other ethical issues is that effective stewardship in climate requires concerted political action at an international level (Hasselmann, 1999, p. 338).

Thus, at first glance, the global climate change is an environmental issue. However, at closer examination, the challenge is unprecedented and is as much an environmental issue, as well as an economical, political, scientific and technological one. Combating global warning and meeting its consequences require fundamental changes in the ways energy is used and produced, in land-use, behavior of consumers, and so on. Given that energy is a prerequisite input to economic growth and a necessity for all human beings, the climate change is in reality an economic and social issue. A transition away from a global economy dependent on fossil fuels to one based on renewable and more energy-efficient technologies demands a coordinated approach of all countries. Powerful vested interests in the sectors, which are important not only to economic growth but also to national security, compare the problem with 'an uphill political climb' (Baumert and Kete, 2002).

1.3.2 Confronting climate change as economic problem

1.3.2.1 Economic features of climate change

Economics is relevant to understanding and solving the climate problem because it explains why human behavior might lead to climate change and provides systematic methods for assessing and monetizing costs and benefits of different activities and policies. The political recognition of the urgency of the problem has become clearly evident at a global scale since the publication of the Stern Review on the economics of climate change (Stern, 2007)[14]. In his editorial essay, Barker (2008) addresses the question of how and why the focus of climate change economics has shifted from the single-discipline cost-benefit analysis to the multi-criteria approach (with multi-disciplinary uncertainty analyses) of the latest IPCC Reports and radically different policy prescriptions of the Stern Review.

Climate change is an important economic issue, given the scale of the costs that it may impose on society. Furthermore, the characteristics of these potential cost origins are well recognizable by the economist: climate change is a classic case of an '*economic externality'*[15]. However, some characteristics of climate change differ from more customary externalities, mainly due its general features. So, the global causes and consequences of climate change and uneven distribution of impacts across countries pose particular welfare-economic concerns; long-term persistence of impacts raises the question of how to account for the economic interests of future generations; large uncertainties and risks raise the general issue of decision making under uncertainty, and so on (Stern, 2007). There are numerous shortcomings in *regionalized* studies of the economic impacts existing so far. In particular, Elsner (2005) noted some respects, which (additionally to a widely

---

[14] Additional discussion on the Stern Review can be found in: Dietz S., C. Hope, N. Patmore, 2007: Some economics of 'dangerous' climate change: Reflections on the Stern Review. *Global Environmental Change* 17: 311-325; Neumayer E., 2007: A missed opportunity: The Stern Review on climate change fails to tackle the issue of non-substitutable loss of natural capital. *Ibid,* pp. 297-301; Pielke R. Jr., 2007: Mistreatment of the economic impacts of extreme events in the Stern Review Report on the Economics of Climate Change. *Ibid,* pp. 302–310; Ackerman F. and I.J. Finlayson, 2006: The economics of inaction on climate change: a sensitivity analysis. *Climate Policy* 6: 509-526; Grubb M., 2006: The economics of climate damages and stabilization after the Stern Review. *Ibid,* pp. 505–508; Hasselmann K. and T. Barker, 2008: The Stern Review and the IPCC fourth assessment report: implications for interaction between policymakers and climate experts. An editorial essay. *Climatic Change* 89:219–229

[15] *Economic externalities* – which may be positive or negative – arise when an action, whether by an individual, a firm, or a country, imposes costs (or benefits) on parties other than the entity taking the action

discussion on deficiency in well-developed regional specifications of the global climate change projections) include the following limitations that are principal for an economic analysis:

- They confine themselves to the impacts on capital stocks; none has examined the secondary effects of stock impacts on flow indicators such as sectoral and regional value-added ones;
- In terms of sectoral analyses, the existing literature is focused on agriculture, forestry and fishery; impacts on core manufacturing industries have not been explored so far;
- The long-run climate change projections (focusing on the years 2050 and 2100) have never been connected with a long-run economic forecast.

The close relationships of climate change with such a fundamental characteristic of the contemporary economic system as energy consumption as well as with the functioning of other, not less important systems, for example, agriculture or forestry, posed a legitimate question: *Do the confronting costs and benefits of climate change support the case for urgent actions?* Estimating the likely economic cost of climate change brings a host of empirical difficulties, not least because the calculations must take, as their starting point, projections extending many decades into the future.

Generally, it is accepted that the scale of the costs that will result from changes in climate will depend on, among other things, the size of the temperature increase.

In the late 1990s, Lempert *et al.* (2000) noted that a large body of research on impacts due to climate change suggested that damages would not be larger than about 1-2% of Gross World Product (GWP), although some researchers supposed that impacts might be significantly larger, either because of effects inadequately treated in most analyses or because future generations may place a high value on non-economic loses, such as changed ecosystems or political concerns about the risk of unpredicted and potentially more severe damages.

Partially, this question was addressed by the Stern Review. Unlike other economic studies, quoted for example in Llewellyn (2007) where as a starting assumption the ‘business as usual’ temperature increases of 2ºC to 3ºC by 2100 was taken, the Stern Review is based on 5-6ºC warming and also includes the risk of abrupt and large-scale climate change together with a number of more pessimistic assumptions. Using the results from formal economic models, the Review estimates that if we don’t act, the overall costs and risks of climate change will be equivalent to losing 5-10% of GWP, with developing countries suffering costs of more than 10% annually, now and forever. The review also considers that even those estimates may be too optimistic if to take into account a wider range of risks and impacts, such as those that might derive from consequential migration and human conflicts. The consideration of aggregate impacts, e.g., inclusion of direct impacts on the environment and human health (‘non-market’ impacts), increases the estimate of the total (average) cost of climate change to 11%; the inclusion of indications that the climate system may be more responsive to GHG emissions than previously thought increases these estimates to 14%. Using equity weights to reflect the expectation that a disproportionate share of the climate-change burden will fall on the world’s poor regions, raises the estimated reduction in equivalent consumption per head to 20% (IPCC, 2007d).

In contrast, the costs of only one action – reducing GHG to avoid the worst impacts of climate change – can be limited to around 1% of GWP each year. The European Commission's Communication "*Winning the battle against global climate change*"[16] demonstrated that, for example, reducing CO_2 emissions in the EU by 10% by 2020 would generate health benefits estimated at €8 to 27 billion.

Our actions now and over the coming decades could create risks of major disruption to economic and social activity on a scale similar to those associated with the great wars and the economic depression of the first half of the 20th century. And it will be difficult or impossible to reverse these changes. A principal Stern Review's conclusion is: *the prevention of a further climate change is better, and cheaper, than inaction.*

A rise in the Earth's surface temperature and the threat of climate change raised difficult issues about the basis of economic growth. Dyson (2005), in his comments on the global warming problem, shows that the process of modern economic development has been based on the burning of fossil fuels and will continue to be so in the foreseeable future. All pre-industrial economies were *'organic'* because virtually all of their products were ultimately dependent upon capturing solar energy through the exploitation of wood and other vegetative matter. The Industrial Revolution transformed this situation through the mass exploitation of coal, which in turn spurred a host of cumulative economic interactions. As of the beginning of 2005, the annual coal production was roughly 4.1 billion tons, or about 2.8 million tons in oil equivalent (British Petroleum, 2005), continuing to rise. The 20th century saw rapid rises in the exploitation of oil and natural gas. These trends for world energy use are shown in Table 1.12. Oil has been the most important fuel since the 1960s, by 2004 accounting for about 37% of global energy use, followed by coal and gas in roughly equal proportions (about 27 and 24% respectively). By 2004 the global use of fossil fuels was equivalent to the annual burning of about 8.96 billion tons of oil. With the exception of some EE and FSU countries that experienced

Table 1.12 World energy supply 1950–2005

Year	*Coal production (mtoe)*	*Oil production (mill. tons)*	*Natural gas production (mtoe)*	*Total fossil fuels (mtoe)*	*Nuclear energy consumption (mtoe)*	*Hydro consumption (mtoe)*	Total
1950	884	518	187	1589	–	–	1589
1960	1271	1049	458	2778	–	–	2778
1970	1359	2355	919	4633	17	269	4919
1980	1708	3088	1311	6107	161	387	6655
1990	2254	3168	1800	7222	453	494	8169
2000	2112	3604	2190	7906	584	614	9104
2004	2778	3767	2420	8965	624	634	10223

Notes: All figures are in million tons of oil equivalent (*mtoe*) and should be regarded as only broadly indicative. One million tons of oil equivalent equals approximately 1.5 million tons of hard coal. World nuclear generating capacity was insignificant in 1960, but the total figures given above for 1950 and 1960 are slight underestimates because they contain no allowance for hydro. There were minor discrepancies between some of the time series used above, but they can safely be ignored for present purposes. *Source*: Dyson, 2005

[16] European Commission, 2005: *Winning the Battle against Global Climate Change.* COM (2005) 35 final, Brussels. Available at: *http://ec.europa.eu/environment/climat/pdf/comm_en_050209.pdf*

economic decline caused by the costs of the transition, only a handful of countries were burning smaller quantities of fossil fuel in 2004 compared to 1994.

"*The basic message*, – Dyson (2005, p. 122) concludes, – *is extremely clear: countries have been unable to escape from conditions of material poverty in the absence of having access to supplies of fossil fuel energy*". Modern economic growth has been the main engine of growth in humanity's use of fossil fuel energy. If in the second part of 20th century the world's population increased by roughly 140%, the rise in fossil fuel energy consumption was almost 400%.

According to the *Reference Scenario* of International Energy Agency (IEA)[17], global primary energy demand on a 'business as usual' basis is projected to grow by more than 50% between now and 2030, at around 1.6% per year. During this period fossil fuels remain the predominant source of energy, accounting for 83% of the overall increase in the demand, and coal sees the biggest increase in absolute terms, driven by power generation. The IEA's *Alternative Policy Scenario* assuming stronger policy actions of governments to enhance energy security (improving efficiency in energy production and use, increasing reliance on non-fossil fuels and sustaining the domestic supply of oil and gas within net energy-importing countries) projects a world primary energy demand in 2030 only about 10% lower as to the Reference Scenario. However, another important conclusion of this scenario is that the new policies and measures yield financial savings far exceeding the initial extra investment cost for consumers, especially investment in electricity-related branches. On average, one additional dollar invested in more efficient electrical equipment, appliances and buildings obviates the need for more than two dollars in electricity supply investment. The analysis also demonstrates that each year of delay in implementing the policies would have a disproportionately larger effect on emissions. If the policies were to be delayed by 10 years, the cumulative avoided emissions by 2030 vis-à-vis the Reference Scenario would be only 2% compared with 8% in the Alternative Policy Scenario (Llewellyn, 2007).

These considerations must be supplemented by the increasing impact of population growth. In 1950 the world was home to 2.5 billion people; by 2009 this figure had reached 6.8 billion. Over the same period, world GDP grew almost tenfold. Population growth is expected to proceed apace, with a global population of around 9 billion projected by 2040. "By multiplying the overall pool of population and economic value, this pattern of growth increases the scale of losses from weather and climate. In many cases it has also heightened humankind's vulnerability to the weather, for example, by degrading natural systems that historically have absorbed some extreme weather" (ECA, 2009, p. 21).

1.3.2.2 Cost and benefits of climate impacts

Climate has a long memory. Thus, the severest impacts of continuing greenhouse gas emissions will accrue several centuries in the future, and expressed as present-day costs the climate damages in the long term appear acceptable at almost any level, creating a false vision of economic impacts. The question *"How the cost-benefit analysis should be modified?"* is not straightforward and leads ultimately to the next fundamental problem: *"How sustainable development concept should be quantified in establishing an optimal*

---

[17] International Energy Agency, 2006: *World Energy Outlook 2006*

climate protection strategy?", – Hasselmann (1999, p. 334) argues. In contrast to the value attached to our present and future climate that depends strongly on non-monetary factors such as the quality of life and ethical commitments to future generations, the means by which the present climate can be preserved is mainly a problem of technology, leading to unavoidable cost. Both adaptation and prevention measures involve mixed costs of different categories. For example, the construction of flood protection barriers is a purely monetary cost; the economic activities involves social adjustment costs as well as technological investments, and so on. Thus, an optimal climate protection strategy must take into account a wide spectrum of costs of different categories. Moreover, *"...the state of our climate is clearly a common asset of humankind whose value is not established by market transactions, but by governments in response to public value judgments"*, – the author concluded (*ibid*).

Although interest in adaptation as a complementary policy response to projected climatic changes has grown in the last years, much of the policy and analytical discourse to date has been characterized by asymmetric attention to the costs of mitigation commitments, on the one hand, and the potential benefits of adaptation – on the other. As a consequence, the analysis of the latter is very limited (Corfee-Morlot and Agrawala, 2004). Assessing adaptation costs and benefits is difficult, and they are rarely reported separately from the overall calculation of economic costs of climate change, except for some particularly vulnerable sectors (for example, coastal protection). Whatever the costs of adaptation may be, they are likely to rise more than proportionately with the extent of global warming, depending on the rate of climate change. Costs of adaptation are even more difficult to assess for developing countries, notably because of uncertainty about the precise impacts of climate change and its various effects (Llewellyn, 2007).

The determination of both near- and long-term goals for climate policy also requires a shared conception among nations of what is at stake. But in practice, *"...because of different attitudes to risk, problems of valuing non-market effects, and disagreements about aggregation across rich and poor nations, no single benefit measure is possible that can provide commonly accepted basis for judgment"*, – was noted by Jacoby (2004, p. 287). The essence of his recommendations, with some additions mainly from Llewellyn (2007), can be shortly summarized as follows.

The responses to the question *"What actions are justified to ease adapt to change we may experience in any climatic event?"* may reflect the viewpoint of a country, or they may be intended to represent a group like transition countries or the sum of all nations. They may also incorporate different uncertainties and include different assumptions about future behavior since it influences the benefits of today's action. But no matter how it is formulated, any recommendation of limits on human influence in the long term, or of the level of current efforts, implies the weighing-up of expected 'benefits' in comparison with the 'costs' to be borne. An ability to communicate about perceived benefits is thus essential for authorities seeking a common response to the threat of human-caused change. They are needed in some shared conception of what is at stake in the choice of one or another level of effort, and in a common terminology for incorporating these considerations into international negotiations and domestic decision-making.

One example of such an analysis, which was made in Lehman Brothers Inc. (Llewellyn, 2007), is shown in Box 1.11.

Box 1.11 Climate change impacts on business

Generally, regional, sectoral and firms business may be impacted by climate change through various domains of influence:

- ***Regulatory exposure*** from national and international policies and regulation designed to reduce greenhouse gases emissions;
- ***Physical exposure*** resulting from temperature rises and extreme weather events;
- ***Competitive exposure*** from a rise in the costs of energy-intensive processes, and a decline in demand for energy-intensive products;
- ***Reputational – including litigation – exposure*** from customers' and investors' perceptions of action or inaction on climate change; and
- ***New technological and business opportunities*** resulting from increased demand for low-carbon, high efficiency goods and services.

Some of these factors may affect regions similarly, but industries differently; the other – may affect differently regions, but similarly industries. As to firms, they perhaps will be affected differently, resulting in important winners and important losers. Despite what implications of climate change may be at the sectoral level, the ultimate consequences are manifested at a firm level. Regardless of whether, overall, a sector benefits from or is harmed by climate change, there will be some firms within this sector that will do well and others firms – that will do badly. Lehman Brothers Inc. considers climate change as likely another major factor that alters the economic environment in which firms operate and may well prove to be somewhat akin to globalization – a slow, but powerful and inexorable force that progressively changes relative prices, relative costs, structures of demand, and hence the structure of production. Within the overall framework of good management practice this is likely to involve:

→ Inculcating a constructive culture of benefiting from change in senior and middle management;
→ Encouraging employees to embrace change and enabling them to do so through a structured program of staff training;
→ Undertaking the requisite research and development, which is often highly industry- or even firm-specific; and
→ Translating this research and development into appropriate investments in physical and human capital formation.

In short, the pace of a firm's adaptation to climate change is likely to prove to be another of the forces that will influence whether any given firm survives, prospers or likely dies.

Source: Llewellyn, 2007

Benefit-cost considerations are inescapable in any policy choice. Projections of the environmental and economic effects of climate change anticipate a wide range of uses in the policy process – from the presentation of impressed pictures of likely natural events (Al Gore's film *'An Inconvenient Truth'* as the best example), intended to stir public interest in the issue, to concrete projections of adverse effects to inform public and private managers about opportunities for effective adaptation (e.g., the IPCC's Working Group II activity). The nature of this information influences the policies selection, while the main purpose of any cost-benefit analysis of a policy is to inform decision-makers about actions to be taken now. Nations are limited in their capacity to commit to actions in the distant future, and the key decision is what to do in the near term. Discussions of intended actions over longer time horizons are important, but mainly for what they may imply about desired activity today.

Most often, the benefit side of climate change policy assessments is implicit. Various categories of climate impacts may be presented, but their integration takes place in the mind of the observer. Less often, aggregate benefit assessments are made explicit, including the calculation of the value of impacts avoided by today's efforts. Jacoby (2004, p. 291) sees a challenge presented by the climate issue in that the concepts and analytical methods of economics and its sub-fields "must be adapted to choices of a scope, magnitude, and complexity never foreseen by earlier generations of thinkers. The underlying economic theory is sound, but severe problems of empirical estimation are revealed in application to the climate issue. The task is to help inform multiple-nation negotiations where participants have different understandings of the world, and national decisions where different segments of the population hold widely varying views of the issue".

The next link in the chain from actions to *benefit* would be the conversion of the many physical, chemical and biological effects of climate change into a common measure that can be directly compared with *cost*. The task falls into two categories: effects that can be reasonably represented by calculations using market prices or near-market analogies and those that cannot. Several types of climate impacts where market prices are available to value the physical changes, which may be estimated to occur, can be credibly formulated in monetary terms. As obvious examples, Jacoby (2004) names the effects of environmental (in our discussion – climatic) change on agriculture and commercial forestry. When prices are not available, valuation can sometimes be achieved by appeal to what in economic analysis is called the 'revealed preference' of consumers – monetary value being imputed from observed behavior in markets that do exist. Where direct market-origin data are absent, an approach is to apply contingent valuation – seeking an estimate of what consumers would pay for a 'good environment'. In one case, people are surveyed to determine their willingness to pay for an environmental improvement, in another – what they would have to pay to be willing to accept the loss of some aspects of environmental quality they already enjoy.

However, the complexities of the climate issue rule against the formulation of a single, widely accepted approach in seeking a single estimation procedure, with all benefits converted to a common monetary unit, to allow direct comparison with estimates of the costs of control. To deal with this difficulty, H. Jacoby recommends focusing the efforts on the development of a portfolio of benefit measures, structured to provide transparency when viewing alternative estimates. The development of such a portfolio is a research task, and the author outlines the work needed. Unfortunately, benefits, considered by him, are limited to the damage caused by climate change that could be prevented by emissions mitigation. The accountings for adaptation costs, which arise mainly in the context of monetary estimates, are not treated in detail, and it is simply assumed that estimates of climate damage (or the benefits of avoiding it) include the effects and costs of economic adaptation.

The conclusion that Jacoby (2004, p. 293) has drawn from his discourse is that "no single benefits measure is going to be universally applicable and no single method for calculating the magnitude of the marginal benefits of climate change confronting measures, stated in the same units as marginal costs, are going to be widely accepted". In this circumstance, a 'desired' framework for future benefits estimation (studies) should be a portfolio of estimates. Their development involves a set of parallel tasks because the different indicators, need to be coordinated, are related to one another but at different scales, in different units, and with alternative degrees of aggregation. The proposed 'benefits portfolio' would include estimates at a global aggregate level with three components: (1) global physical variables that can be represented and analyzed in probabilistic terms, (2) indicators of impacts that can be measured at regional scale—most likely in natural units, and (3) exercises in integrated monetary valuation. With this structure, variables that might gain broad acceptance are given prominence, and a foundation of common information is laid for the more problematic matters of non-market valuation and aggregation.

Considering the overwhelming uncertainty that pervades the climate issue, an ideal would be to formulate climate policy as a way of reducing the risk of damage at *all levels* of aggregation. Unfortunately, today's climate models cannot support this type of analysis at a regional or local level. Although measures of impacts at these scales, in general, would be stated in natural units, short of monetary valuation, in some cases economic valuation may in fact provide the most convenient measuring rod. The challenge is to develop a small number of indicators in natural units that together convey as comprehensive as possible the picture of different levels that climate change might involve. In developing a set of such measures, Jacoby (2004) see as important the following criteria:

- *Definition* that should be clear to allow consistent measurement across regions and thus providing for g*lobal application* of measures or indexes to all, or at least most, regions;
- *Independence:* such measures or indices should be independent of one another, and of impacts that may be estimated in monetary units. The objective would be to preserve additivity, to facilitate integration with one another and incorporation in attempts at wide-scale monetary valuation and aggregation;
- *Baseline comparison,* that is, should be some basis to have an idea whether a change is large or small.

The final component of the portfolio should be the construction of benefit functions at regional and global levels aggregated in monetary units.

Once more complication of the analysis at each step is the fact the options, which future decision makers will face, are influenced by actions of their predecessors. Today's actions influence not only the available set of future technological options, but also the inheritance of institutional capability and public understanding. *"The distance between estimates of climate change effect and the choices made today is great"* (Jacoby, 2004, p. 295).

Climate change is a century-scale problem, and the development of a portfolio of measures to help inform the policy process requires continuous, long-term efforts. While the discussion above makes some tentative recommendations regarding the content of such a portfolio, it should be emphasized that what was proposed is best seen as the outline of a research agenda. An example of endeavors in this direction is presented in Box 1.12.

Box 1.12 Incorporating climate change into the investment process

Investment management professionals, usually focused on providing attractive long-term returns for their clients, are cognizant of and frustrated by the inherent conflict between company management teams that are pressured by investors to maximize short-term performance yet at the same time see the need to address longer term issues such as climate change. Moreover, when corporate disclosure on climate change is far from comprehensive or standard, it is necessary to obtain a baseline understanding of a potential investment's exposure.

Judging that climate change is too important to the future longevity and success of corporations to be ignored for an extended period of time, and that failure to do so will have economic consequences, Lehman Brothers Inc. sought to understand the following:

? What strategy, if any, a company has in place as regards climate change;
? What data they manage and disclose; and
? What types of systems are in place to support their strategy.

A corresponding investment framework for analysis is shown in the Figure.

Investment framework for climate change analysis

Industry Research	*Management Profile*
• Characterize end market competitive dynamics • Identify and measure the company's total and served markets • Understand secular/cyclical dynamics • Monitor industry specific social issues – Regulatory environment – Emission intensity – Energy intensity – Range of technological advances in marketplace	• Track record of success • Alignment of management's economic interest with common shareholders – Environmental health and safety programs – Supply chain management • Check for stated disclosure statement/strategy on global climate change • Corporate governance and culture respects interest of multiple stakeholders • Reputation of management with regulators

Company Research

- Understand business model, management strategy, and customer value proposition
  - Emission / energy intensity of manufacturing
  - Environmental attractiveness of products or services
- Determine the source and sustainability of the company's competitive advantage
  - Spending on IT and research & development
  - Environmental health and safety programs
- Quantify potential return on invested capital and earnings power for the business
- Evaluate historic social record / understand future road map
  - Stated climate change strategy combined with supportive systems / data

Source: Llewellyn, 2007

1.3.3 Climate change and security

1.3.3.1 Environmental Security

That environmental problems can become security problems is now well recognized in policy, and the links between environment and security are the focus of debate in international policy circles and the academic community. 20th century and the new century's first decade witnessed dramatic changes in the global security situation and public awareness. New threats, including environment degradation or scarcity, affect people, countries and whole continents; concerns persist over the possible impacts of global and regional environmental change on social and political institutions and relations within and between states. The human-induced changes in the planetary environment now exceed the extent of natural variability, producing serious threats to human progress globally. The environmental risks that impinge upon the well-being of people are often either transboundary in nature or affect social groups differentially, and are a growing source for both potential conflicts and cooperation.

In a general sense, *security* is the condition of being protected from or not exposed to danger or loss. It has historically been concerned with safety and certainty from contingency.

The natural environment is an essential and unappreciated component of the dominant *security* paradigm. *"The concept of environmental security rises out of a concern that environmental changes and events, especially degradation, are increasingly serious pressures on livelihood security and perhaps contribute to violent conflict"*, – Maltais *et al*. (2003, p. 1) believe. However, while the role of the environment in providing security for humans has been a prominent concern since the 1970s, *'environment security'* as a specifically named field of research has gained increasing attention over the past two decades based on the arguments that the traditional definition of security need to be rethought in recognition of significant environmental dependencies (*ibid*).

The beginning of the use of *'environmental security'* as an official term is marked by publication of the Brundtland Report (UN, 1987), and already by 1989 "the argument that environmental change was a security issue for nations and people was increasingly made in both environmental and security journals" (Barnett, 2003). In the academic sphere environmental security was initially defined as the relationship between security concerns such as armed conflicts and the natural environment[18]. However, despite a wide range of semantic and academic debates, it is now widely acknowledged that economic and military strength are not the only measures of national security. Security is multidimensional in nature, and environmental dimensions are amongst the military, political, economic, societal, and other concerns, 'weaving together in a strong web of linkages' (Barnett, 2003). This 'redefinition' of the security concept was a reaction against its focusing on the security interests in terms of wars between states or their avoidance (Maltais *et al*., 2003). Today, environmental factors play direct and indirect roles in political disputes and violent conflicts, and the environmental security shares equal place with the threat, e.g., of nuclear warfare: both are global in reach and the effects of both could be highly devastating. In such understanding the term means that some forms of environmental changes in combination with socio-economic drivers increasingly threaten basic human interests and thus should be considered as high order threats to human well-being in the same way as a military threat. Well-known examples of these new threats are ozone depletion, land degradation, demographic pressures, water scarcity, increased spread of infectious diseases, and others. Undoubtedly, climate change is among them.

[18] See, for example, Wikipedia; *http://en.wikipedia.org/wiki/Environmental_security*

Thus, the concept of environmental security was introduced in an attempt to expand the conceptualization of security by suggesting that human-induced environmental degradation create new emerging security problems at the national and international levels. On the whole, Maltais *et al*. (2003) see arguments for an environmental security perspective in three key suppositions:

- ✓ *environmental threats can have catastrophic outcomes;*
- ✓ *traditional security thinking does not prepare society to deal with these threats, and*
- ✓ *unlike traditional security issues, environmental threats are not confined by national boundaries.*

In particular, environmental changes can be considered as a security issue, depending on who is to be secured and how and what sorts of changes threaten. Typically, the traditional understanding of national security focuses on threats to a state's sovereignty and the survival of the state as such. However, security is not only applicable to the nation state and *per se* has no spatial limitations: all individuals, communities, nations and a global population are all equally entitled to security from aggression, oppression, poverty, hunger, ill health and cultural, and environmental degradation (UNDP, 1994). Environmental security is an important subcomponent of this more comprehensive conceptualization and can be understood as *"...a biosphere free from anthropogenic damage. It is thus the goal of maintaining the fundamental requirements for human existence"*, – Barnett (1998, p. 8) states.

The internationally discussed relationship between the environment and security challenges and policy is consequently complex and multi-dimensional, particularly under the specific conditions of countries undergoing economic and political transition. So, the Environment and Security initiative (ENVSEC)[19], using the example of Belarus, Ukraine and Moldova, considers three different aspects of this relationship, which are especially relevant to transition countries (ENVSEC, 2007):

- ➡ ***Security implications of environmental problems***
- ➡ ***Improving security through environmental cooperation***
- ➡ ***Environmental implications of security measures.***

Security implications of environmental problems relate to situations in which scarcity and degradation of natural resources or environmental hazards increase the risk of tensions and exacerbate external and internal security challenges. Existing tensions between and within the states due to non-environmental factors can be exacerbated by environmental degradation, competition over natural resources as well as real and perceived environmental hazards. Environmental factors aggravate such tensions if they contribute to the atmosphere of hostility and distrust between states or communities. Depending on specific local conditions, environmental problems affect not only the probability of conflicts, but also other aspects of security, such as political and social stability, and the running of state and social institutions. Under certain conditions this may disrupt social institutions and even lead to 'state failure'.

---

[19] See: *www.envsec.org*

Improving security through environmental cooperation considers cases in which cooperation might alleviate existing tensions, foster stability and mutual trust. It has also been recognized that the links between environment and security mean that *security can be improved* through environmental cooperation. Whereas environmental problems may aggravate security challenges, protective counter-measures, particularly when they are implemented cooperatively, may help to alleviate them. Undoubtedly, security and stability benefit from effective environmental management and cooperation. As some opportunities for productive environmental cooperation, with potential security benefits in Eastern Europe, ENVSEC named joint management of transboundary water resources (e.g., Dniester River and Danube Delta between Ukraine and Moldova where tensions already exist) or joint operation of cross-border protected areas such as those on the Belarus-Poland-Ukraine and Ukraine-Moldova borders. Concerted development of national-level protected territories ensures that environmental networks or corridors, considered as one of effective measures to conserve biodiversity in the changing climate, are compatible and linked to one another.

Environmental implications of security measures consider circumstances in which security policies and measures have significant environmental implications and require special attention from this perspective, resulting in positive or negative impacts on the environment.

The best example is energy policy – an area where the stakes for both the environment and security are very high. The drive towards energy security and away from acute energy dependence can have positive or negative environmental effects, depending on the choice of resources, solutions and energy technology. Facilitating innovative energy solutions and improving energy efficiency may simultaneously increase energy security and reduce environmental impacts. Conversely, hasty introduction of environmentally unsustainable or hazardous energy technologies may be only a temporary solution to energy security while at the same time imposing numerous new risks on the society. Thus, measures to promote energy security may have diverse and significant environmental impacts. For instance, while increased energy efficiency and some renewable energy technologies result in environmental benefits, the replacement of imported energy with domestic sources is likely to result in adverse impacts on ecosystems.

Table 1.13 Energy consumption in some FSU countries

	Economy energy intensity (million TOE / $ billion)	% of imports in energy balance	Predicted affordability* of basic utilities for poorest population in 2007, %
Belarus	1.61	87%	13-30
Moldova	2.01	97%	7-12
Ukraine	3.19	46%	7-21

Notes: *Affordability is measured as the share of household income required to pay for utilities (electricity, heat and water); services are considered affordable if their cost is below 10% of income for electricity and 10% to 15% for heating, and the total cost of all utilities being under 20%. The data are predicted for 10% of the poorest population. *Source:* Adapted from ENVSEC (2007)

Experience in the transition economies points to wider problems that are well demonstrated by the energy policies in Ukraine. Over the past decades coal has been steadily replaced by cheaper and less polluting imported natural gas, which in principle is an environmentally beneficial change. However, the problems with Russian gas supplies and sharp increase of import prices forced the Ukrainian government to consider a shift back towards coal. Thus, as in this case, the national energy security conflicts with global climate security goals. As a second example, Table 1.13 shows a structure of energy consumption in three FSU countries. Even under such a big share of the import in energy balance, the energy intensity of economy is very far from OECD countries (0.20 on average).

The complex structure of energy-environment-security interaction is shown in Fig. 1.12.

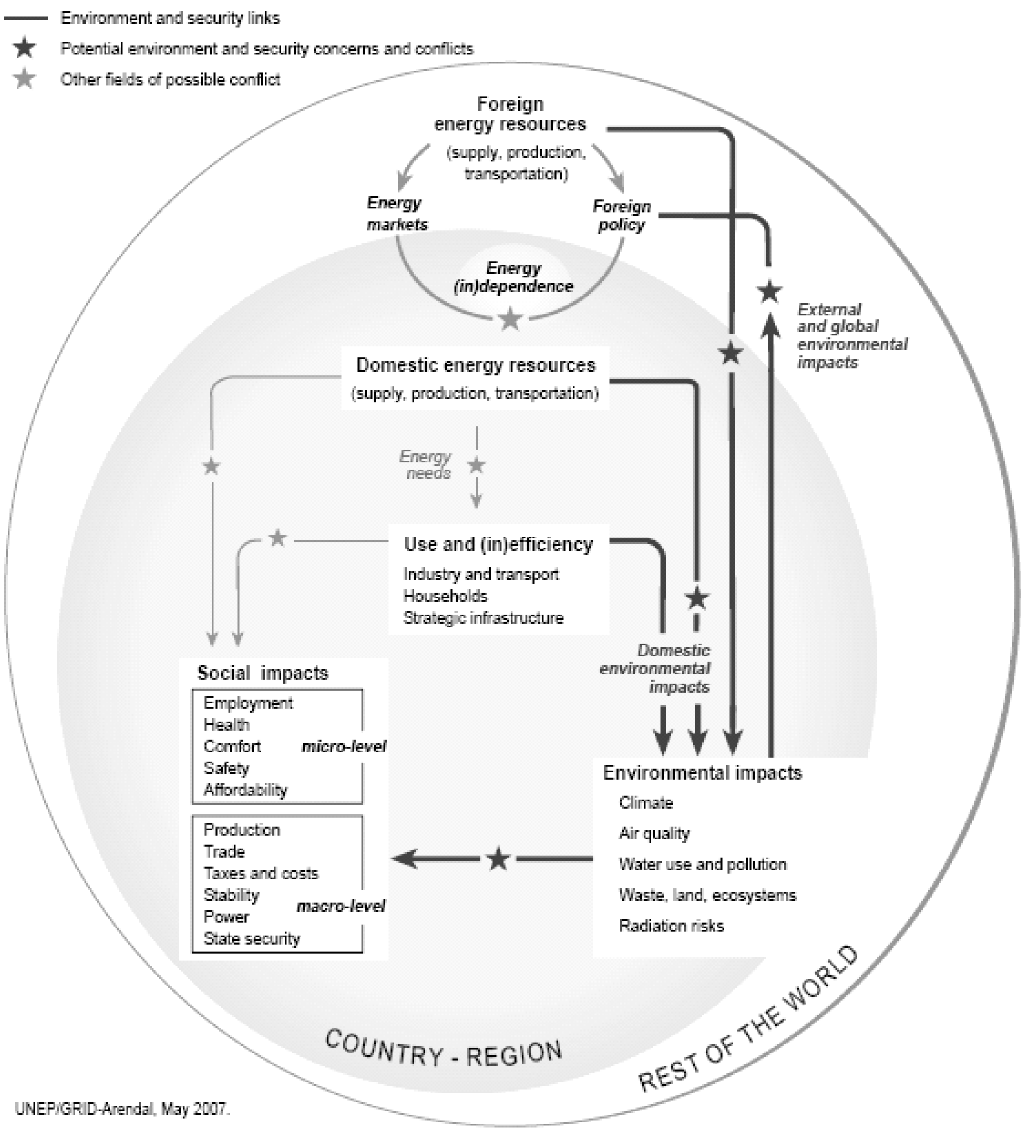


Fig. 1.12 Structure of the interactions between energy, environment and security. *Source:* ENVSEC, 2007

1.3.3.2 Human security

Maltais *et al.* (2003) distinguish two competing approaches that have motivated a significant portion of the contemporary debate over the concept of environmental security. The first aims to create a distinct, useful, analytical approach, and thus many analysts have focused on the linkages between environmental degradation and violent conflict. The second is to engage with the complex ways that social and environmental systems are coupled to one another, and have resulted in broader conceptualizations of environmental security. So, Barnett (2001, p. 18)[20] understands environmental security as "as a social problem, both for the way it impacts upon human welfare, and because the meta-problem of environmental degradation is a product of human behavior".

Violent conflicts and environment are discussed later. As to the second approach, in the 1990s the UNDP (1994) put forward the concept of *human security* to assist in the framing of development and justice issues, seeing it as being concerned with how people live and breathe in a society, how freely they exercise their many choices, how much access they have to market and social opportunities, and whether they live in conflict or peace. Then the concept was developed further in different documents, crowned by the UNDP Human Development Report 2007 (UNDP, 2007a)[21]. Human security, similarly to environmental security, is not concerned with weapons; it is concerned with human life and dignity, highlighting the social dimension of 'three pillars' of sustainable development: environment, economy, and society.

Khagram *et al.* (2003) see four key elements that distinguish human security from the national security:

- → A shift in the focus on what or who is to be secured — from political-administrative units that are territorially bounded to human beings no matter where they may be at any point in time;
- → An expansion of what security means – from a focus solely on survival of states to both survival and dignity of human beings;
- → A claim that the survival and dignity of human beings also requires 'freedom from want', not just the 'freedom from fear' that is associated with the security of states;
- → The protection and promotion of human rights trump state's rights (i.e. territorial sovereignty).

The relationships between the environment and human security are certainly close and complex. A great deal of human security is tied to peoples' access to natural resources and vulnerabilities to environmental change; a great deal of environmental change is directly and indirectly affected by human activities and conflicts.

Being focused on the security of individuals or groups in terms of their well-being, human security is a function of multiple factors affecting well-being. OECD's review of the state of the art of environmental security (Dabelko *et al*., 2000) listed some mechanisms promoting human security/insecurity (Table 1.14). While various forms of

---

[20] Barnett J., 2001: *The Meaning of Environmental Security: Ecological Politics and Policy in the New Security*. Era, London: Zed Books

[21] Shortly, the history of human security concept can be found in Wisher *et al.* (2007)

Table 1.14 Security-promoting mechanisms versus insecurity-promoting mechanisms

System	Promoting Mechanisms	
	Security	*Insecurity*
Economic	Wealth Welfare policies	Poverty Inequity
Political	Law Legitimate Force	Corruption Unlawful use of force
Cultural	Social identity Justice	Discrimination Injustice
Demographic	Low birth rate Urbanization	High birth rate Rapid population flows
Ecological	Life support Raw materials	Scarcity Disease

Source: Dabelko *et al.*, 2000

stress may engender insecurity, other factors promote security for individuals and groups. The review underlines the need to look at the problems and issues that decrease the resilience of groups and societies and make them more vulnerable to threats, including the threat of violent conflicts, although empirically it was difficult to demonstrate that either poverty or environmental factors were strong determinants of conflict.

However, researches (Maltais *et al.,* 2003) show that *loss of livelihoods* is the common denominator for many of the internal conflicts of the last decades. The focus away from national-centered interests highlights multiple stresses that may cause insecurity and the types of resilience that promote security for individuals and groups. These authors justify their approach by the conviction that under certain conditions, such as a war, the distribution and composition of force may be the most important determinant of security and insecurity. But in many other situations, they will be more closely related to poverty, resource scarcity or social discrimination.

1.3.3.3 Environmental insecurity and vulnerability

The environmental security issues are also, in essence, issues about *vulnerability***.** According to Barnett (2001, p. 17)[22], *environmental insecurity* is "the vulnerability of people to the effects of environmental degradation" and thus "is more than the physical processes of environmental degradation." Insecurity, then, is associated with risks, such as those for health or because of resource scarcity, experienced by vulnerable groups or vulnerable regions. For Barnett, namely the persistence of the insecurities induces interest in environmental security, which he defines as "the process of peacefully reducing human vulnerability to human-induced environmental degradation" by addressing its root causes and human insecurity. In turn, the latter is "the impoverishment of people and the degradation of nature largely though political-economic processes" (p. 18).

Maltais *et al.* (2003, p. 9) argue that "vulnerability perspective narrows the approach to overall security by investigating specific answers to these questions: vulnerable to what threat, who or what is more vulnerable, and what processes are at work placing people in harm's way and shaping their abilities to cope with threats". The vulnerability approach is focused on the security of vulnerable groups and high order threats to their well-being as opposed to national security interests and issues such as sovereignty that are central here. The security perspective distinguishes between environmental threats that will result in costs, but ultimately can be eliminated through adaptation process within a society or a

[22] Barnett, J., 2001: *The Meaning of Environmental Security: Ecological Politics and Policy in the New Security*. Era, London: Zed Books

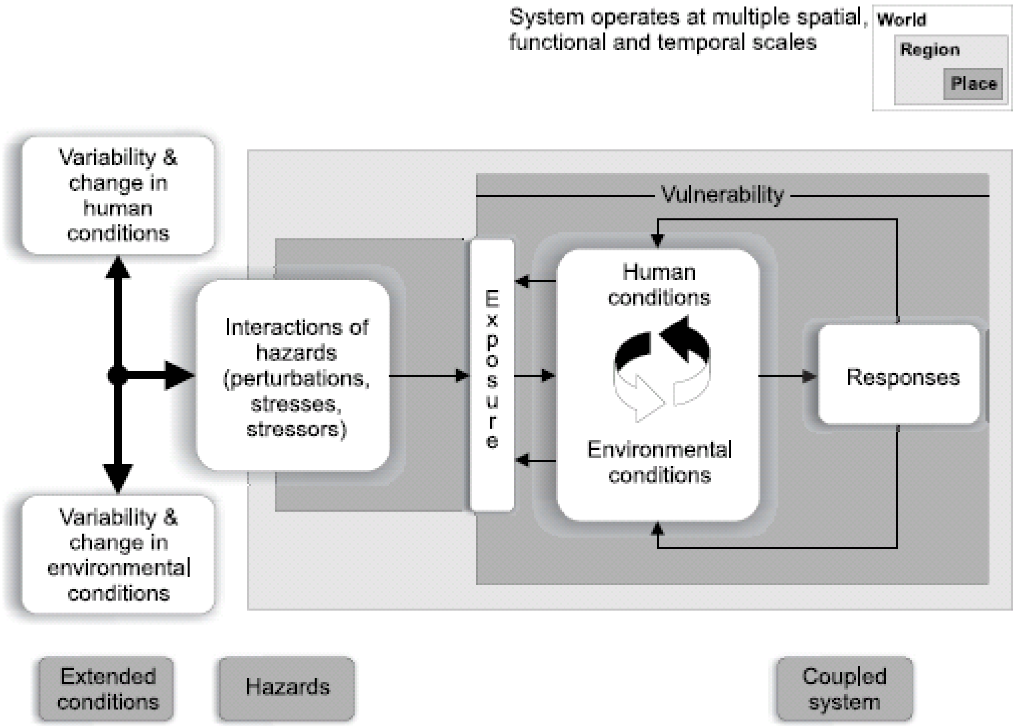


Fig. 1.13 Basic architecture of the sustainable systems vulnerability framework. *Source:* This scheme was developed by the Sustainability Systems Project (SUST): "A framework for vulnerability analysis in sustainability science", which is a multi-institution research program of Clark University, Harvard University, the Stockholm Environment Institute, the Potsdam Institute, and Stanford University. The present version is quoted from Maltais *et al.* (2003)

group, and environmental threats that have the potential to result in serious physical, economic, social, or environmental damages where a society may be unable to adapt.

The assessment of environmental security from a vulnerability perspective allows for systematic investigation of the processes and drivers creating insecurity/security. A vulnerability assessment speaks directly to the multiple drivers that are at play in creating insecurity. The vulnerability framework shown in Fig. 1.13 suggests that an examination of the relationships between human and environmental driving forces will pinpoint both those groups most vulnerable to environmental threats and the interactions of processes working across scales that create this vulnerability. Considering the different discussions, Maltais *et al.* (2003, p. 9) concluded that "Environmental processes are thus not the *centre* of focus, as, for example, a society's institutions, and coping strategies can be equally important in creating or dissipating vulnerability".

Further, these authors showed key issues that can be identified through the vulnerability perspective:

- Multiple socio-economic drivers in combination with environmental change interact over time to create insecurity;

- There are patterns of persistent and predictable differential impacts, and environmental change/degradation tends to create the greatest threats to identifiable vulnerable groups;
- The existence of thresholds or major disjunctions that can lead to abrupt deterioration of security;
- Development policies and programmes informed by a vulnerability analysis will be better able to identify and mitigate the environmental security threats suffered by affected groups.

Vulnerability can be also thought of as the opposite of security, and an asking about vulnerability to a specific outcome of concern provides greater focus to the analysis. *Environmental security and vulnerability analysis* attempts to deal with the complexity of societies' reliance on the environment by focusing on what makes people more or less prone to harm from changes in environmental conditions like global warming. There are also needed indicators of national security taking into account the state of the environment. National security also has an internal dimension in that it is partly a function of state legitimacy. Governments in states where the material well-being of people is highly variable to external forces such as changing terms of trade, or where material well-being is in decline, tend to be relatively more unstable and more prone to internal violent conflict (Maltais *et al.,* 2003).

The Global Environmental Change and Human Security (GECHS) project (*http://www.gechs.org/*) – a core project of the International Human Dimensions Programme – developed the '*Index of Vulnerability',* in which 12 problem-centered environmental, social, and political indicators were chosen to demonstrate the interrelation of social, ecological, economic, and political processes in creating vulnerability of individual countries (Box 1.13)[23]. It was found, for example, that practically all top 25 countries of the refugees' origin showed up at least the mid-level and in most cases were closer towards the high level of the vulnerability index. According to the map based on this classification (Lonergan, 1998) most of EECCC countries are in the zone below of the mid level of vulnerability.

A key point to draw from the GECHS approach is seen in difficulties to clearly quantify the role of environment in creating insecurity. In many contexts, an adequate analysis of insecurity, in general, requires understanding of environmental processes that contribute to its formation.

Box 1.13 Some indicators of national vulnerability

- Food Import Dependency Ratio
- Water Scarcity
- Energy Imports as % of Consumption Access to Safe Water
- Expenditures on Defense vs. Health and Education
- Indicator of Human Freedoms
- Urban Population Growth
- Child Mortality
- Maternal Mortality
- Income per capita
- Degree of Democratization
- Fertility Rates

Source: Lonergan, 1998

[23] Lonergan, S., 1998: *Environmental Degradation in Population Displacement.* Global Environmental Change and Human Security Project, International Human Dimensions Programme on Global Environmental Change, Research Report 1. Victoria, BC: CECHS Project, 75 pp. (Cited by Maltais *et al.*, 2003)

1.3.3.4 Environmental security and conflicts

"Disputes over environmental issues seldom ignite conflicts directly, but they can fan the flames", – is a statement of the Environment and Security Initiative (ENVSEC, 2007, p. 6). Although never the sole causal factor, the contribution of environmental issues, especially resource scarcity, to conflicts is one of the central pillars of the discussion centering on the environment and security.

In the early 1990s the interest in environment and conflicts grew rapidly, and large research programmes were initiated. Efforts to understand the linkages between environmental security and violent conflicts have highlighted specific types of situations where this tragic outcome is more likely. Although the initial hypotheses were different, four common findings that emerged from these research efforts were generalized at the Stockholm Environmental Institute (Maltais *et al.,* 2003):

1. There is an agreement that violent conflicts over *non-renewable* natural resources, such as oil and minerals, are not a new feature of human history. However, the new types of conflicts are emerging over *renewable* resources vital for human survival, such as fertile cropland or freshwater, and are likely to be increasingly important contributing factors to conflicts;
2. There is a general agreement that environmental degradation is not a single or direct cause of conflict;
3. There is some consensus that many environmentally induced conflicts are more likely in developing countries due to their relative dependency on renewable resources, and especially in countries where other tensions already exist;
4. Environmentally related conflicts tend to persist over long periods of time, be spread over large areas, and are more likely to occur at the subnational level or, in other words, are more likely to be intra-state than inter-state. A subnational perspective promotes the identification of different societal groups, defined in economic, ethnic, religious, or regional terms. Even where conflict is or has the potential to become inter-state, many of the underlying drivers are regional in character.

Modern conflicts are complex, unfolding on several levels. In the 1990s the Swiss Environment and Conflicts Project, based at the Swiss Federal Institute of Technology (Zurich) and the Swiss Peace Foundation investigated more than 40 cases of conflicts, about half of which crossed the threshold of violent outcomes. The study concluded that environmentally-induced conflicts result in violence only if and when some of the following five key situations coincide (below and further is quoted from Maltais *et al.,* 2003)*:*

- *Inevitable environmental conditions.* Group survival is dependent on degraded resources for which no substitutes are apparent, and eventually the group faces an inevitable and therefore desperate environmental situation;
- *Lack of regulatory mechanisms and poor state performance***.** When a political system is incapable of producing certain social and political conditions, it becomes impossible to achieve goals such as sustainable use of resources. This shortcoming is either due to a lack of state outputs regarding resource management and livelihood security or to disruption of social institutions designed to regulate access to resources;

- *Instrumentalising the environment.* Dominant players use or manipulate the environment to serve specific group interests, making environmental discrimination an (ideological) issue of group identity;
- *Opportunities to build organizations and find allies***.** Players organize themselves along political lines – often behind a strong leader – and gain allies either from groups affected by similar problems, from certain (fraternizing) factions of the elite, or from foreign groups;
- *Spillover from a historic conflict.* Environmental discrimination occurs within the context of an existing (historic) conflict structure and, as a result, gives new impetus to the conflict.

The Swiss research team also found that violent conflicts that are partly caused by environmental degradation are more likely to occur in marginal vulnerable areas (arid plains, mountain areas with highland-lowland interactions, transnational river basins). Based on this and other research, the joint UNEP, UNDP, OSCE and NATO team have formulated the typical causal pathway leading to conflicts over natural resources (UNEP, 2005):

- ***Dependency*** on natural capital;
- ***Environmental scarcity*** arising either when the quality and quantity of renewable resources decreases *(supply-induced scarcity),* the population increases *(demand-induced scarcity),* and/or when resource access becomes more unequal *(structural scarcity)*. Environmental scarcity, in turn, can produce five types of social effects: *constrained agricultural productivity; constrained economic productivity; migration of affected people; greater segmentation of society* (usually along existing ethnic cleavages) and *disruption of institutions,* especially the state;
- ***Environmental discrimination*** in terms of *unequal access to natural resources,* as a key mechanism since it causes marginalization of a group, which in turn stimulates population movement. Degradation of renewable resources and population growth that cause unequal access to resources may lead to a situation *of resource capture* in which elites gain control over scarce resources. This phenomenon is often related to a modernization and development process with uneven distributive implications;
- ***Ecological marginalization*** when unequal resource access and population growth combine to drive further degradation of renewable resources.

Schematically, this list was supplemented by a diagram (Fig. 1.14).

In its identification of clusters of environmental and security issues in Eastern Europe, ENVSEC (2007) showed that in a number of cases the environmental hazards or disputes over the use of natural resources complicate relations between states or communities, which sometimes already plagued with tensions. These include the potentially conflicting use of transboundary waters such as Pripyat (Belarus & Ukraine), Dniester (Ukraine & Moldova), the Danube Delta (Ukraine, Romania and Moldova), the Azov Sea, Central Asia Rivers (Box 1.14). Environmental issues affect not only external but also internal security. On the other hand, cooperation over the environment, including joint management of water resources and dialogue on transboundary hazards can help reduce international tension (ENVSEC, 2007; UNEP, 2005).

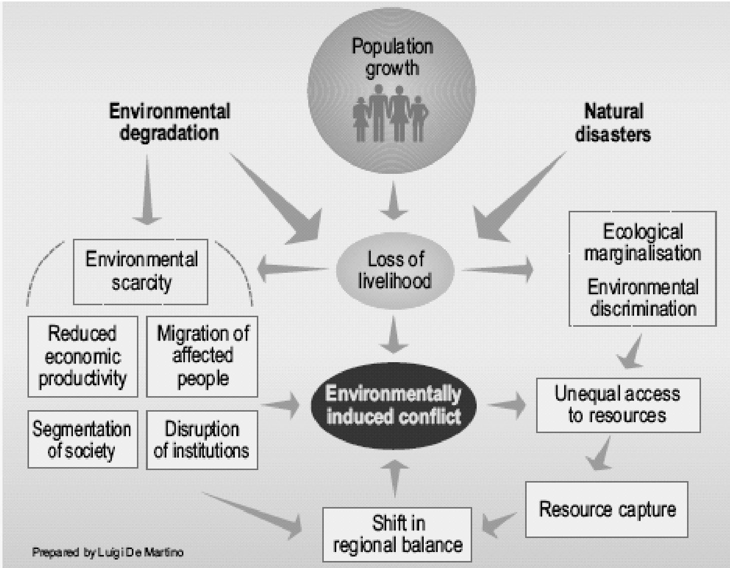


Fig. 1.14 Causal pathways leading to conflicts over natural resources. *Sourse:* ENVSEC, 2007

But conflicts are not unavoidable, a society is not powerless to confront and has ways of dealing with them. Institutions, particularly the political ones, and civil society can work to defuse conflict situations, or they can fuel discontent through poor governance, corruption and inefficiency. Regional and global factors can increase or decrease the possibility of conflict.

It is reasonable to agree with the conclusion of the Stockholm Environmental Institute review (Maltais *et al.,* 2003, p. 23):

> *"Foremost is the question of what is meant by environmental security. Far from being a purely academic debate, the decision to adopt a narrow definition focused on violent conflict is a choice to restrict our search for understanding to a scope that is perhaps more easily managed in research, but does not encompass the concerns for livelihood, health, or future generations envisioned in sustainable development. Nor does this focus lead to attention on the great number of conflicts that are solved through negotiation. While violent conflict is a major concern, it cannot be the only concern in addressing the environmental basis of security".*

And at last, the review of environmental security has raises many important questions for its implications in planning *sustainable development* policies and programmes. Really, "Given far ranging discussions over sustainable development… the term *'environmental security'* can almost sound redundant" because from the inter-generational equity viewpoint "the security of future generations is one way of expressing the ultimate goal of sustainable development" (Maltais *et al.,* 2003:3). Nevertheless, the same authors have suggested that the most productive path to follow in considering environmental security is the one that engages with the overarching goals of sustainable development.

Box 1.14 Water resources as a source of conflicts: *Central Asia case study*

In principle, the Central Asia's mountains are rich in water, however the situation varies greatly between up and downstream countries, and between regions inside individual countries. The annual natural internal renewable water resources per capita are of the order of 700 m^3 in Uzbekistan and 200 m^3 in Turkmenistan. The situation is critical since a country may be considered to be suffering from high water-scarcity when their annual per capita supply is less than 1,000 m^3. In contrast, the figures for other countries are 4,000 m^3 in Kazakhstan, 11,000 m^3 – in Tajikistan, and 10,000 m^3 – in Kyrgyzstan. *Hence, the water crisis in Central Asia is not currently a crisis of its quantity but of its distribution and use.* For example, water withdrawals for Afghanistan, Tajikistan and Kyrgyzstan – the countries furthest upstream in the Aral Sea basin – amount in sum to 17%. On the contrary, the downstream states (Uzbekistan, Turkmenistan and Kazakhstan) withdraw 52%, 20% and 10% of the total, respectively.

Late last century the withdrawal of water for irrigation has caused a social and environmental crisis. By 1991, the Aral Sea's level had fallen by about 15 m, the surface area had been halved and the volume reduced by two-thirds. Drying up of the sea has been accompanied by a wide range of other environmental, economic and social problems, aggravated by the negative consequences of the transition economy.

In particular, the interests of upstream countries collided with those of their downstream neighbors. So, 98% of Turkmenistan and 91% of Uzbekistan water supply originate outside their borders. Consequently, the benefits of cooperation are highly *asymmetrical* and unevenly distributed among water users. In the new situation, created by independence and loss of 'an external enforcer', the individual states could no longer trust the others in water cooperating. Predictably, the states, especially those downstream, while formally adhering to previously reconfirmed agreements, have chosen to adopt bilateral ad-hoc solutions to mitigate the recurrent disputes over water and energy instead of negotiating a new multipartite, multisectoral agreement suited to the new circumstances. In the last years Kyrgyzstan was reputedly blamed for releasing too much water from the Toktogul dam during winter and not enough during summer. As a result, farmers in Uzbekistan and south Kazakhstan faced shortages in irrigation water. Frozen waterways and canals, unable to handle the larger volume of water in winter, either caused flooding of towns, such as Kyzyl-Orda in Kazakhstan, and of arable land or wastefully diverted water into the Arnaysay depression, creating a system of lakes covering 2,000 km^2 and raising the level of groundwater. Kazakhstan and Uzbekistan have managed to hammer out agreements with Kyrgyzstan and Tajikistan to swap fossil fuels for water. However, the terms of trade in water-for-fuel swaps are problematic, prompting recurrent crises over payment. The question of paying for management and maintenance of the water system that benefit more than one republic has also become a major political issue.

Although there is now a growing overall consensus that water scarcity as such will not cause wars between nations, there is a growing conviction that it exacerbates the underlying conditions that fuel livelihood conflicts, particularly while countries are going through the crucial transition period from dependence on agriculture to a modern society with a developed urban economy.

Source: Based on information from UNEP (2005)

1.3.3.5 Climate change and security

Climate change has thus far received little systematic analysis as a security issue, although should be considered as such because it poses many new threats and challenges to national security and international stability as well as to human security at different scales. Proceeding from the above shown understanding of environmental security, the climate change is also a security issue for some countries, communities and individuals. In many different social and ecological contexts this problem is complex in origin, with uncertain impacts and significant risks to livelihoods, culture and health of millions of people. Indeed, in 1988 the first international meeting of scientists and national policymakers aiming to highlight the dangers of climate change (Toronto Conference) was called *"The Changing Atmosphere*: *Implications for Global Security"*. The Conference concluded: "…humanity is conducting an unintended, uncontrolled, globally pervasive experiment whose ultimate consequences could be second only to a global nuclear war" (Quoted by Barnett, 2003, p. 9). Thus, already in the 1990s the potential impacts of climate change have been considered as a security issue. At present, that climate change poses risks to human welfare is relatively indisputable in both climate science and climate policy circles and, in spite of available uncertainties, it is clearly a security problem for some states and people, as well as a problem for certain groups and regions. Correct identification of this reality warrants a policy response commensurate in effort, if not in kind, with other global problems.

Wisner *et al.* (2007) describe at least seven ways of likely climate change affect on security in its narrow and wider meanings, and provide an overview of these complex linkages and interactions arranged on a time scale (Table 1.15). Some effects are already evident and will become very clear in the human and climatic short run (2007-2020). They will increase, and others will manifest themselves in the medium term (2021-2050); in the

Table 1.15 Matrix of Possible Climate Change/Security Interactions over Time

Time horizon	Direct impact	Indirect Consequences					Slow-onset
	Water	*Food*	*Health*	*Megaproject*	*Disasters*	*Biofuel*	*Sea level*
Short term (2007-2020)	Local conflicts over water	Failure to meet Millenium Development Goals		Long history of development-induced displacement	Nation states begin to lose credibility due to inability to prevent disasters	Isolated food/fuel competition & price spikes	Small number of displacements
Medium term (2021-2050)	Increased local & some international conflicts over water	Significant displacement due to famine	Interacts with food production problems	Displacement of rural poor due to CDM & large scale dams & other state based mitigation & adaptation projects	Political unrest due to failure of dividend reinvestment &inadequate recovery in many countries	Food-fuel competition increases & biodiversity erosion	Increasing displacement & national/ international tension
Long term (2051-2100)	Major international conflicts over water	Major displacement & political upheaval	Major displacement due to epidemics	Major urban upheaval and other political fall out from megaproject displacement	Major upheaval with international implications due to unattended weather catastrophes	Major discontent due to food/fuel competition	Major international tensions due to population displacement
All of these processes strongly interact with each other							

Source: Adapted from Wisner *et al.* (2007)

long run (2051-2100) they will be all active, interacting strongly with other major trends. Box 1.15 demonstrates the only aspect of this problem – climate change and food security.

The range of possible connections between climate change and security, discussed in available literature, was also systematized by Barnett (1998, 2003). In our discourse we will follow these two works, being mainly guided by the author's conclusions. Sure, they cannot be considered as the only and, moreover, generally accepted vision of the problem, but as a 'starting point' for further research. Of particular interest are Barnet's views on links between climate change, on the one hand, and national security, violent conflicts, migration, etc. – on the other.

Security communicates a certain gravitas that is arguably necessary in climate change policy. If to agree with Barnet (2003), the security concept encapsulates the UNFCCC reference to 'dangerous' levels of climate change much better than concepts like sustainability, vulnerability or adaptation, offering a framework in which danger can be recast as widespread risks to welfare and sovereignty. Security can serve as an integrative tool, which links local (human security), national (national security) and global (international security) levels of environmental change and response. It also integrates mitigation and adaptation because both are essential to security from climate risks. Understanding of the processes that render insecurity, of which climate change is an important but not isolated factor, brings to the fore issues of justice and the global political economy. Such an integrated vision of climate change and security linkages for Central Asia is shown in Fig. 1.15.

Box 1.15 Climate change and food security in Russia

It is expected that a warmer climate would be beneficial for agriculture in high latitudes. However, this general tendency is not necessarily true for all northern countries as a short growing period is not the only factor limiting agriculture. Modeling for Russia shows that the remarkable increase in potential yield in its central and northern-forested regions would not compensate for a sharp drop in yields due to increasing frequency of extreme climatic events, particularly droughts in the currently most productive regions. The summer of 2010 is the most recent example. It is estimated that under climate normal conditions a 'food production shortfall' (the potential production of the most important crops is below 50% of its 'normal' climate average for a region) occur roughly 1–3 years per decade. However, this frequency will double in many of the main crop growing areas in the 2020s, and triple in the 2070s. Additionally, whereas an increase in average water availability in Russia is expected, a significantly increased frequency of high runoff events in much of central Russia, along with more frequent low runoff events in the already dry crop growing regions in the South, are likely. The increasing frequency of extreme climate events will pose an increasing threat to the security of Russia's food system. The risks are likely to propagate throughout the country because of the higher likelihood of shortfalls occurring in many crop export regions and because of the dependence of most regions on food imports from a relatively few main crop-growing regions with the best soil and climatic conditions. As a result, if currently approximately 50 million people live in regions that experience one or more food shortfalls each decade, then in the 2070s this number may grow to 82–139 million.

If this scenario is indeed realized, the majority of Russian regions will continue to rely on import of agricultural products (again, 2010 year as the most telling evidence). Under these conditions the system of interregional grain trade is critical for national food security. An analysis of the potential impact of basic rules of interregional food market on regional food security showed that if the current market system were still in place in Russia, it would bring the worst results, and that traditionally effective planned adaptation measures would help little in future climate conditions.

Source: Based on Alcamo *et al.*, 2007; Dronin and Kirilenko, 2008; Kirilenko *et al.*, 2004

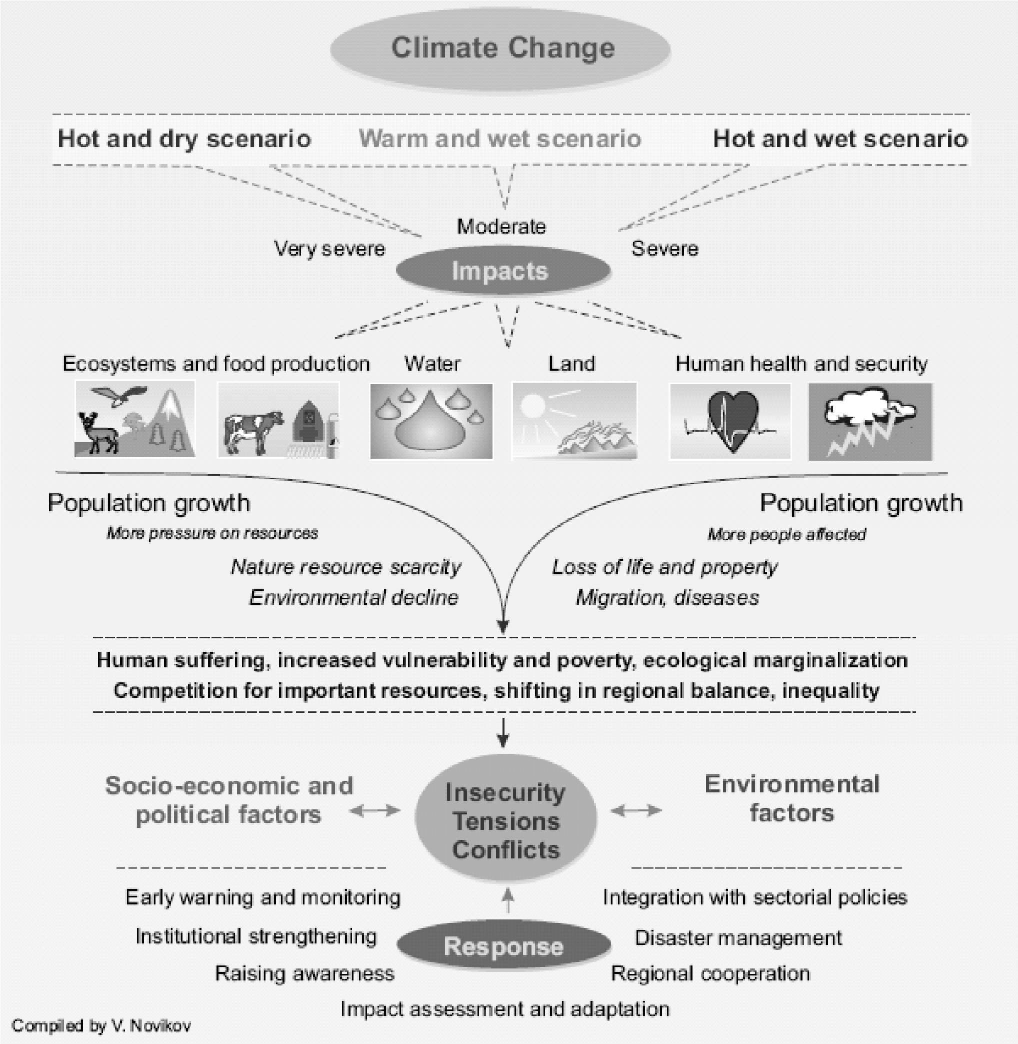


Fig. 1.15 Climate change and security linkages in Central Asia. *Source:* UNEP, 2005

But as to the links between climate change and violent conflict, it is necessary to be cautious. Barnet (2003, p. 14) argues that any identification of climate change as a security issue that "warrants a policy response commensurate in effort if not in kind with war" makes it "a military rather than a foreign policy problem and a sovereignty rather than global commons problem". Although there is a common agreement on some dependence of conflicts on environmental changes, those latter (as it has been shown above) are not the only or even important factors causing a violent conflict. This is also a truth if to agree that conflicts "…in which environmental change appears to be a contributing factor tend to be within rather than between states, and *it is at this sub-state level that a climate change-conflict research agenda would most profitably focus*" (p. 10; italic added). The possible scale of the danger climate change consequences would be far spacious of national borders, plus uncertainties about the extent to which and how environmental factors are driving internal violent conflicts.

Really, physical processes such as sea-level rise evidently pose substantial security risks. However, national security also has an internal dimension. In the states where material well-being is highly variable to external forces or is in decline, the governments tend to be relatively more unstable, and these countries are relatively more prone to internal violent conflicts. Last-decades ‘color revolutions’ in post-soviet countries are good examples. Undoubtedly, new indirect negative effects of climate change can worsen the situation, undermining individual and collective economic livelihood, exacerbating the inequalities between people, exposing to new deceases and so on. These impacts have financial costs and in some cases are sufficiently large to justify an understanding of climate change as a security issue. In addition to focus at the intra-state level, a climate change conflict research agenda would most profitably focus on those transition economies and transition democracies where governance systems are also in transition and social impacts of climate change are ‘modified’ by high levels of inequality. Usually, such countries, especially those where ecological systems are highly sensitive, have a historically large-scale migration.

The possibility of changes in ***human migration*** patterns is among the likely potential impacts of climate change for human societies. Human populations always used migration as an adaptive strategy to adverse environmental conditions; in particular, the so-called environmental refugees are a possible consequence of land degradation. Examples of climatic influences on human migration patterns can be found in recent history. So, the 1930s – a period of particularly unfavorable climate for agriculture that coincided with severe economic recession and rapid mechanization of farming in US – witnessed a migration of approximately 300,000 people out of the US southwest and thousands more displaced within the region (McLeman and Smit, 2006). Moreover, climate-related migration could evolve into a larger, global crisis.

Climate change may devastate large parts of the developing world, driving millions of people out of their homes. Most scenarios agree on a general trend: in this century, global warming may force millions of people, especially in Asia and Africa, to leave their homes and migrate to other places. Although most climate refugees are expected to remain within their home countries (when only parts of the country will be affected by climate change), some studies suggest a potential crossing of international borders. The United Kingdom’s Ministry of Defense foresees large migration flows from sub-Saharan Africa toward the Mediterranean, the Middle East, and Europe between 2007 and 2036[24]. These flows are expected 20 times larger than those currently under UN oversight and equal to half the population of the EU. Scenarios of million-strong stream of climate refugees have conjured up the risk of violent conflicts, both within affected countries and internationally, once refugees try to cross borders. Climate migration could thus turn into a “threat to the peace” and international security (Biermann and Boas, 2008)[25]. One can judge about

---

[24] UK Development, Concepts and Doctrine Centre (DCDC), *The DCDC Global Strategic Trends Programme 2007–2036*, 3rd edition (Swindon, UK: Crown Copyright/ MOD, 2007), *http://www.mod.uk/NR/rdonlyres/94A1F45E-A830-49DB-B319-DF68C28D561D/0/strat_trends_17mar07.pdf*

[25] For example, since the late 1960s, five million people from Burkina Faso and Mali have migrated south to neighboring Côte d’Ivoire. Much of the recent civil strife in Côte d’Ivoire stems from the uneasy

complexity of the problem of climate refugees from the discussion between the quoted authors and M. Hulme (2008b).

Thus, there are historical evidences to suggest a link between climate and human migration, and the notion that human settlement patterns may respond to climate is not new. Migration as a consequence of climate change has attracted the interest of researchers and policy makers in the last decades (Biermann and Boas, 2008; Perch-Nielsen *et al.* 2008; Sokona, 2007; McLeman and Smit, 2006, and other). Sometimes, the topic was examined as a part of a larger discussion on migration caused by environmental factors in general[26] because migration should not be considered as a simple or automatic response to a singular risk, climate-related or otherwise, and is closely interwoven with other societal processes. Many factors combine to influence human spatial behavior, and migration sensitivities and options vary greatly among regions and social groups.

A sensitive understanding of the climate change induced migration requires knowledge in the ways it interacts with other factors, in turn being also influenced by changes in different social and ecological systems under new climatic conditions. Because large migrations in all times have lead to conflicts, the climate-induced conflicts as a result of migration are likely. In the first instance it may result from climatic extremes and increasing climate variability leading to 'danger' climate change. For example, it is very likely, that any further aridization of Central Asia would trigger the mass migration of its population northward, strengthening the process observed everywhere. With the absence of sufficient adaptation potential and resilience to climate change impacts, the migration becomes an attractive, if not the only option, to preserve life. Existing patterns of environmental and social refugees are indicative from the viewpoint from where and to which places 'climate migrants' might emerge.

So, from the Southern Caucasus's total population of 16 millions in 1991 about three-four million have left for other countries in succeeding years, and national conflicts, as it is well seen from Fig. 1.16, are not the only cause (UNEP, 2004). Economies and eco-refuses are among the drivers. This picture is well consistent with one conclusion of the GECHS project, which, according to Maltais *et al.* (2003) citation, found extreme difficulties to identify or isolate precisely how large a role the specific environmental drivers play in causing the displacement of people.

Therefore, for those countries already dealing with large influxes of migrants and for those likely to receive their increasing numbers as a consequence of climate change, the preceding assessments and planning prophylactic measures should be a policy priority. A timed acceptance of immigrants from climate sensitive areas at the earliest stage could facilitate their and host communities 'adaptation'. The world and FSU countries' evidences show that migrants, refugees and Internally Displaced Persons (IDPs) are loosely integrated within state structures and their rights are weekly protected. They are most vulnerable to poverty and suffer from the related consequences to their health and education.

---

relations between these immigrants and local indigenous people. The presence of these immigrants has caused a growing shortage of land in a region where it was formerly considered to be in unlimited supply. In the face of increasing pressure on the land, traditional ways of building resilience to climate stress have confronted new limits (Sokona, 2007)

[26] See, for example, Bates D.C., 2002: Environmental refugees? Classifying human migrations caused by environmental change. *Popul. Environ.* **23**:465–477; Castles S., 2002: *Environmental change and forced migration: making sense of the debate*. UN High Commissioner for Refugees, Geneva, pp. 1–14

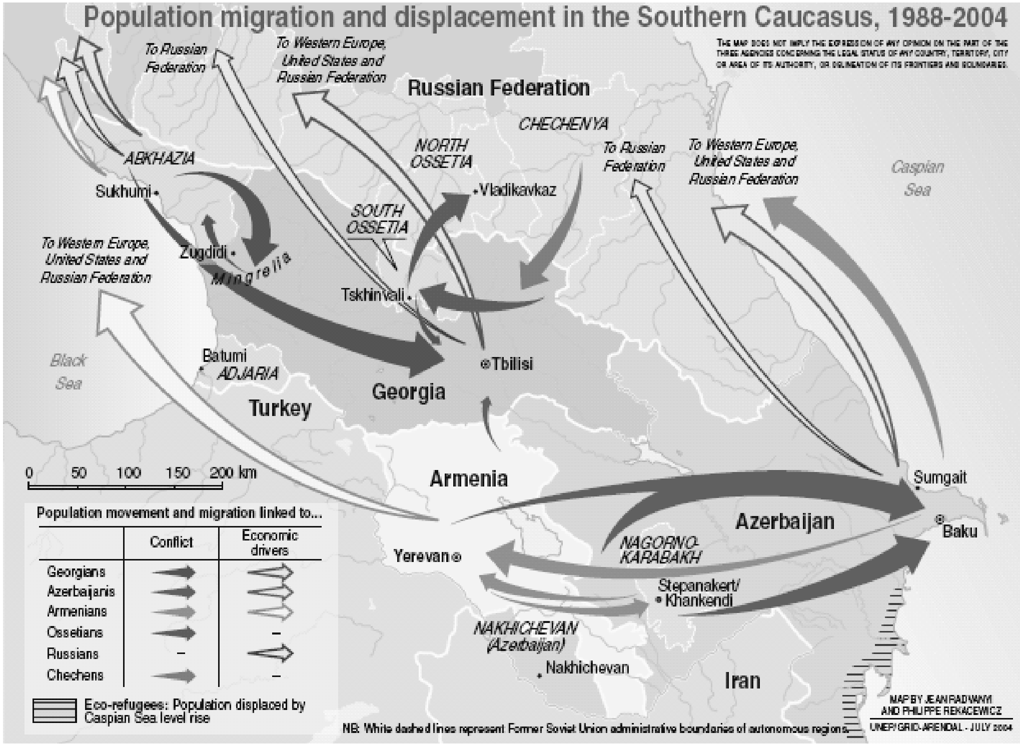


Fig. 1.16 Origins and destinations of population migration and displacement in the Southern Caucasus. *Source:* UNEP, 2004

However, although numerous researches have postulated that climate change will lead to mass migration, the linkages between the two have not been explicitly demonstrated, being rather derived from 'common sense'. Perch-Nielsen *et al.* (2008) investigated and depicted the connection between climate change and migration via two mechanisms – sea level rise and floods. In both cases, the connection could be traced and the linkages were made explicit, however, it was by no means deterministic and depended on numerous factors relating to the vulnerability of the people and the region in question, as well as to their adaption potential (McLeman and Smit, 2006). Further research programs looking to investigate empirically the climate-conflict linkages are required before confident predictions that climate change will induce violence should be made. In greater detail such research would be most effectively targeted at sub-state levels.

1.3.4 A climate policy framework: balancing policy and politics

1.3.4.1 Some issues in practical policy design

Climate change has increasingly become a high politics issue both internationally and in the EU. In particular, in January 2007 the Commission of the European Communities (EU, 2007, p. 3) communicated[27]:

> *"Strong scientific evidence shows that urgent action to tackle climate change is imperative. Recent studies, such as the Stern review, reaffirm the enormous costs of failure to act. These costs are economic, but also social and environmental and will especially fall on the poor, in both developing and developed countries. A failure to act will have serious local and global security implications. Most solutions are readily available, but governments must now adopt policies to implement them. Not only is the economic cost of doing so manageable; tackling climate change also brings considerable benefits in other respects".*

Some consequences of delayed response to climate change have been well demonstrated by M. Parry and colleagues (Box 1.16).

Meanwhile, climate change offers an imposing set of complications for policymaking, which are caused by the above-discussed inherent features of climate change: a global scope, wide regional variations, a potential for irreversible damages or costs, a very long

Box 1.16 The consequences of delayed action on climate change

In their commentary for *Nature,* Parry *et al.* (2008a) assumed that with agreed actions, which lead to global GHG emissions decreasing from a peak in 2015, the 80% cuts in emissions by 2050 are necessary to avoid the most serious global impacts. This assumes, however, not only that very substantial actions should be undertaken, but also that these actions are able to halt completely the increase in global emissions within five years – an extremely tight schedule. Therefore, somewhat later (Parry *et al.,* 2008b), the authors considered the effects of delayed actions with peak emissions in 2025 and 2035. Their results (see the table) show that with a peak date in 2015 to achieve the EU's target of not exceeding 2°C above preindustrial temperatures would require at least 4% annual cuts in emissions (equivalent to a 60% cut by 2050). But this scenario gives little more than a 50% chance of staying below the EU target. To have a significantly greater chance of staying below this target requires a 6% annual cut (equivalent to about 80% by 2050) that gives a 0.3°C margin of safety in the median temperature rise by 2100.

The table also shows that delaying the peak emissions date by just one decade (from 2015 to 2025) increases the median temperature outcome by about 0.5°C by 2100; delaying the peak date by another decade (to 2035) increases it a further 0.5°C. Such twenty-years delaying the peak emissions date approximately doubles the potential impact in 2100 when measured in terms e.g., of millions of people at risk from water stress or coastal flooding. Thus, the window of opportunity for action is very narrow. Moreover, delaying action would likely lead not only to very much more damage and adaptation cost, but to levels of impacts that could well exceed our capacity to adapt, and to conditions that would be difficult to reverse.

Median increases in global mean temperature (°C) by 2100 relative to 1990 levels for different annual reduction rates in emissions and peak emissions years

Peak year	Annual reduction rate after peak emissions					
	1%	*2%*	*3%*	*4%*	*5%*	*6%*
2015	2.6	2.1	1.8	**1.6**	**1.5**	**1.4**
2025	3.0	2.6	2.3	2.1	1.9	1.8
2035	3.4	3.0	2.8	2.6	2.5	2.4

Note: The scenarios that give more than a 50% chance of staying below the EU temperature target (2°C) are shown in bold

Source: Parry *et al.*, 2008a, b

[27] European Commission, 2007: *Limiting Global Climate Change to 2 degrees Celsius. The way ahead for 2020 and beyond.* COM(2007) 2 final

planning horizon, and so on. One way to understand the evolution and shaping of world climate policy is to join it with an understanding of the position of the actors—nations—in the world system (Rosa, 2001). The definition of the problem and the acceptability of solutions strongly depend on consensus or compromise among openly conflicting parties, often between North and South, but most times across more complex divides. Even though much agreement has been achieved, conflicts still emerge and not only on technical issues, but also on fundamental questions of goals and values (Engels, 2005). Being widely accepted as a problem that requires political regulation, the climate change issue has already undergone several phases in the policy cycle that have led to the development of a wide variety of policy responses, many of which are already in the process of implement-tation (SEG, 2007); however, the failure of many of them in delivering an acceptable result (e.g., emission reductions) leads to the development of new policies and politics.

Wide reaching and potentially catastrophic consequences of climate change imply a complex challenge for policymaking in this field because uncertainty and risk are crucial to understand the nature of climate change as a policy problem. In turn, the attempts to reduce these uncertainties contribute to a new understanding of uncertainty in policymaking on the whole (Engels, 2005).

The climate change policy differs in a number of ways from previous forms of international environmental policy and demonstrates the emergence of some new legal aspects of instruments and principles, changing relations between 'hard' and 'soft' law, new economic and political relations between nation-states, new roles for non-state actors in policymaking processes, and so on. In climate change policymaking there is also reflected the process of political modernization, and the policy process here has been multi-level and multi-actor in nature right from the start (Addink *et al.,* 2003). So, the world agenda-setting and policymaking on the climate change issue would definitely have been different and probably weaker without IPCC activity.

Usually, there is almost always a gap between the policy that would be ideal on theoretical grounds, and the policy that, because of practical, political and other considerations, actually gets put in place. Llewellyn (2007) listed three criteria that must be met in designing a 'good policy':

- ***Credibility,*** i.e. people have to believe that the policy will endure and be enforced;
- ***Predictability and transparency,*** i.e. people must be able to predict the circumstances under which the policy will change; and
- ***Flexibility,*** i.e. policy has to be able to be adjusted rapidly in the case of new information or circumstances.

When considering climate change response options, several principles and ideas for policy formulation that are widely used in environmental economics analysis would be useful. As such, Munasinghe (2003) considers, for example, the polluter pays principle, economic valuation, internalization of externalities, and property rights. Into the list of other concepts from contemporary environmental and social analysis, which are relevant for developing climate change response options, he includes the concepts of durability, optimality, safe limits, carrying capacity, irreversibility, non-linear responses, and the precautionary principle. In particular, an important goal under the durability criterion would be to determine the safe limits for climate change within which the resilience of ecological and social systems would not be seriously threatened. Because some bio-geophysical systems may respond to climate change in a non-linear fashion, with the potential for catastrophic collapse, the precautionary principle argues that lack of scientific certainty about climate change effects should not become a basis for inaction, and so on.

Dowlatabadi (2007) maintains that policies can only succeed as intended if they are structured to take advantage of the broader context of improving human welfare and its dynamics, address perceived needs and enjoy public support. Really, climate change was only one of the concerns highlighted at the 1992 Rio Summit (UN, 2002), and many other 'global concerns' such as poverty, famines, equity, etc. have come to command public attention in the last decades. Dowlatabadi also thinks that some of these concerns must be recognized and accommodated in order to deploy successful climate policies, but where climate change is not a primary public concern, policy features addressing it can be incorporated as a secondary aspect to the solutions of the problem of primary concern. "Policy options designed and implemented in the absence of these basic tenants will not realize their goals and may even lead to unintended negative consequences" (p. 652). So, considering the longstanding pre-existing concerns in welfare such as social equity, environmental quality and human health as the primary, this author argues that to focus efforts on climate change first and welfare next means "to put the cart of climate before the horse of welfare". In other words, *climate change should be a new dimension of the context within which these and other concerns are being addressed.*

1.3.4.2 Integration of policies for climate and global changes

Climate change policies and innovations in this field are also structured by a changing context. General processes of globalization, political and environmental modernization, legal innovation, and so on are changing, modifying the context in which national and international environmental policymaking takes place, and vice versa. This changing context is both a medium for and, partially, an outcome of climate change policy: it structures it but is also the result of challenges presented by climate change itself (Addink *et al.,* 2003).

There is a growing awareness that global issues are more likely to be implemented if their shared or overlapping problems, means and goals are better linked. Sustainable development offers considerable scope for synergies, playing the role of a meta-goal tying different regimes together. So, the aim of co-operation between the Rio Conventions is to ensure 'the environmental integrity of the conventions' and to promote 'synergies under the common objective of sustainable development' (UNFCCC, 2004, p. 4).

Linnér (2006), making an analytical distinction between four types of interrelated linkages – natural, socio-economic, institutional and political, refers the *political linkages* to an intended and explicit act of connecting regimes. Synergetic connections as a political choice can be made for normative, functional or strategic reasons when political linkages define the set of problems to be negotiated. They may also be made with regard to common means and goals of regimes facing different problems. Climate change issues are functionally linked through both socioeconomic and environmental (biogeophysical) conditions; this moment is well traced in the structure of the IPCC Assessment Reports.

Let us consider some aspects of the linkage between climate change and other actual world problems.

A. Environmental and ecological aspects. In one of previous sections we already have noted that global climate change is a ‘tragedy of the commons’, in Hardin’s (1968) interpretation of this conception, because climate as a common resource cannot be readily fenced or allocated according to needs. Global climate is at risk since the ‘rules’ of nations’ behavior ineffectively coordinate individual and group interests. Zahran *et al.* (2007), on the example of ratification of the Kyoto Protocol, adapt the *theory of ecological modernization* (EMT) to investigate the strategic and structural factors that explain variations in countries behavior.

Generally, EMT is used to analyze how societies organize economic, political, and cultural institutions to address environmental crises. Ecologically modernized societies incorporate principles of environmentalism in the design of institutions to regulate human interactions with nature. A market economy, democratically elected government, and constitutionally guaranteed rights and freedoms are necessary institutions for ecological modernization, with the potential to soften the human footprint on the planet. As such, ecological modernization is not reducible to GDP or the percentage of urbanized population; it is not also a synonymous with economic growth or the size of an economy. As a prescription for reforms, ecological modernization is about redesigning the institutions of modernity to achieve sustainable development. Such a global institutions change is evident, promoting more sustainable human interaction with the biophysical environment. Because countries vary considerably in the degree to which ecologically modernized institutions are present, to consider EMT is a reasonable framework for organizing the environmental social science on the behavior of nation states. The climate change confronting is no exception. Zahran *et al.* (2007) also believe that EMT is applicable not only to developed countries, being a reasonable framework to empirically assess all countries on a range of attributes associated with ecological development.

Measuring a country’s level of ecological modernization can shed light on the probability it will commit to solving the common problem of global climate change. The quoted authors have demonstrated this assumption in terms of different countries structural and strategic readiness to commit to and comply with the Kyoto Protocol. Their study has attempted to measure an ensemble of institutional dimensions that estimate how far a nation has come in the ecological modernization process.

According to generally accepted approaches, Zahran *et al.* (2007) divided the measurement of ecological modernization into three dimensions – political, economic, and cultural:

- The *political dimension* measures a country’s internal and external political attributes. The variables of internal politics or features estimate the level of political rights, civil liberties and democracy, thus defining a country’s institutional reflexivity and receptivity to environmental reforms. The external politics measure approximates a country’s propensity for strategic cooperation on transboundary environmental problems.
- The *economic dimension* describes two features of a country’s economy that are most sensitive to stabilization of GHG emissions as delineated by the Kyoto Protocol – energy efficiency (with higher scores increasing the odds of ratification) and CO_2 emissions per capita (with higher scores decreasing the odds of ratification).
- The *cultural dimension* measures a country’s level of educational development as a proxy for levels of environmentally aware and concerned public.

Of course, selected variables are not considered as exclusive to EMT.

What is interesting, the demonstrated analysis showed that political and economic dimensions of ecological modernization operate independently – the correlation between the two is weak and statistically insignificant. For example, democratic openness and participation in intergovernmental environmental organizations do not correspond statistically with high economic output per unit or with energy input or CO_2 emissions per capita. The statistical independence of politics and economics in ecological transformation once more shows the complexity of coordinating national interests with global interests to meet emission reduction targets. The common problems are exacerbated by the structural independence of these dimensions, reducing the ability of some countries to align their interests with the interests of the global totality.

Fig. 1.17 shows the world picture of ecological modernization expressed as a two-dimensional scatter plot. The initial data set included 108 countries: 39 Annex I countries and 72 – from the pool of non-Annex I countries. 74 countries from the sample had ratified and 34 – not ratified the Kyoto Protocol by June 8, 2004. Dividing the cluster of countries into four quadrants revealed a structural-strategic logic of the ratification. Countries that are characterized by high political and economic modernization have a higher probability of ratification, evident by the concentration of ratifying countries in the High–High quadrant of the plot (26 of 28 countries). Conversely, non-ratifying countries are concentrated in the Low–Low quadrant where only 7 of the 24 countries ratified the Protocol. The United States and Australia are outliers of this tendency.

More widely, EMT conception shows the importance of institutions in constituting a country's structural readiness for environmentally sustainable development as well as a country's strategic willingness or ability to solve the global environmental problems, in our case – collective resolving the climate change dilemma. From a policy standpoint, EMT dimensions operate as institutional domains to which specific policy mechanisms are attachable. For example, increasing energy efficiency raises significantly the likelihood of formal commitments to the global effort to reduce the anthropogenic causes of climate change. It appears also that an environmentally conscious public is important to steer a course toward climate change commitments. On the whole, a country's level of ecological modernization, indicated by political, economic, and cultural indicators, reflects its structural and strategic readiness to active participation in the international endeavor to confront climate change (Zahran *et al.*, 2007).

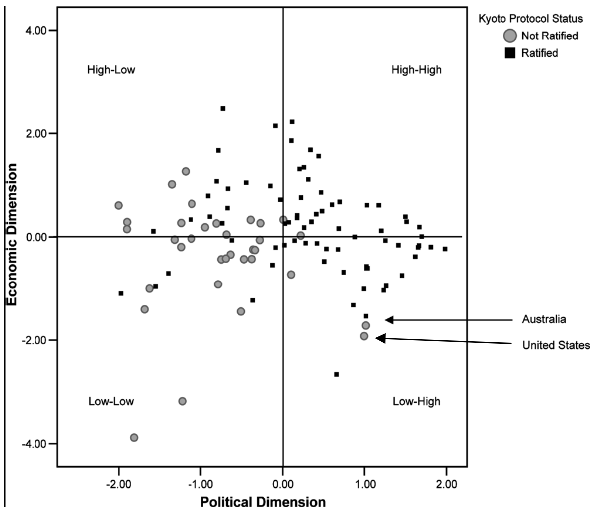


Fig. 1.17 Two-dimensional scatter plot of Kyoto Protocol ratification status, based on economic and political dimensions of ecological modernization. *Source:* Zahran *et al.*, 2007

B. Socio-economic aspects. As to the meaning of UNFCCC Article 2, the political and diplomatic processes through which it had evolved paid much more attention to physical and biological vulnerabilities as the sources of danger, and rather less attention to economic issues. Ethical and cultural considerations have also been nearly absent. This neglect must surely be remedied in order for an adequate response to the danger to emerge (Oppenheimer and Petsonk, 2005). It is no less imposing for the economists to assess how climate-induced changes might affect well-being of citizens for the, sometimes far, distant future.

Earlier, Berkhout and Hertin (2000) stated rather rightly that, generally, the notions of change – what is changing, what causes the change, how quickly change is occurring, and what the outcomes of change will be – are less well defined, more uncertain, and frequently contested in socio-economic science. Many processes of social and economic change are poorly understood as they occur, and some of the most significant variables and relationships cannot easily be quantified. Whereas most natural sciences operate under the assumption that problems can be isolated to well-defined relationships between some quantifiable variables, these conditions are not typical in social and economic systems, especially in the long run. Climate impact studies also face difficulties in dealing with the slippery nature of social and economic change. The uncertainties about future GHG emissions, future development of potentially affected sectors and the adaptation strategies, which they may adopt, narrow the focus and scale of impact assessments.

In principle, only by combining the socio-economic and climate change as two interrelated processes, it is possible to evaluate the exposure of future societies to possible harms. Without taking into account the socio-economic change, the analytical validity and value for policymakers of climate change impact assessments as well as other forms of integrated assessment will remain limited. However, unlike models developed to predict future climates, the tools for generating pictures of future social worlds cannot be fully grounded and often need to bring together tacit knowledge and expectations of broad sets of social actors. There is an important difference in knowledge about the future development of socio-economic systems from predictions about the development of natural systems that Berkhout *et al.* (2002, p. 83) see in that people "…can alter their surroundings having reflected critically on the implications of their behavior and making adjustments in the light of experience". People can apply knowledge from the past in ways that shape its future.

Berkhout and co-authors distinguish four challenges to social and economic forecasting that are shortly summarized in Box 1.17.

The thorough consideration of socio-economic aspects in climate change policies also needs to address the dilemma of improving human welfare under an objective necessity to refuse from the conception of unrestricted economic growth. Global warming poses a serious challenge to the core values that equate material satisfaction and economic growth with happiness and well-being. A threat of climate change to a future basis for improving human welfare is really serious because it poses significant potential risks to the economic well-being of large numbers of humans, simultaneously undermining social welfare and equity. Inequitable distributions are not only ethically unappealing, but also may be unsustainable in the long run (Munasinghe, 2003).

That is why, as alternative politic to basic options in confronting climate change through mitigation and adaptation, Huesemann (2006, p. 567) proposes "transition to a

Box 1.17 Challenges to social and economic forecasting

Danger of reductionism, or problems of indeterminacy – imperfectly understood structures and processes, or the extent to which it is possible to reduce to basic principles the relationships and rationality of agents. While in well-organized systems with clear rules and widely distributed information (such as an economic market) the ability to predict the behavior of agents will be high, many social systems do not exhibit these characteristics. In these more indeterminate systems the reductionist approaches to analysis are less successful in replicating social reality, and social science is therefore hesitant to make predictions about the future development of whole social systems.

Discontinuity, or novelty and surprise in social systems. In general, the natural sciences make well-founded assumptions of continuity because natural phenomena are assumed to behave in the same way, whenever and wherever they occur. Infringement of continuity is considered as 'change' vs. variations that are considered, for example in climatology as deviations from long-term average. This assumption of continuity cannot extend to the social systems where surprise, innovation and discontinuity are normal features of their development.

Reflexivity or the ability of people and organizations to reflect about and adapt their behavior. The society may be ignorant about crucial aspects of the future, but is also aware that the future is fundamentally shaped by the past and by choices exercised by people and organizations. In this sense, the future can be seen as the 'bringing into reality' of preferred futures by dominant or emergent social interests. Examples of widely shared visions, which failed to become established as realities, only demonstrate the fundamental uncertainty that exists about social futures.

Framing or legitimately diverse opinions about the state of the world. It is linked to the previous two points, because a wide diversity of opinions about what the future will hold exists naturally. This is clearly demonstrated in climate change and climate policy debates. Pictures of the future are therefore not neutral, neither is it easy to be dispassionate about them as analysts or decision-makers. Analysts of social and economic futures must therefore account for the variety of ways in which 'the future' is framed.

Source: Berkhout *et al.*, 2002

steady-state economy where the total throughput of matter energy is stabilized at sustainable levels", whereas "the idea of abandoning our belief in unlimited economic growth will appear disagreeable to many, particularly because economic growth is generally seen as a solution to countless problems ranging from poverty to environmental pollution". He argues his idea by the absence of necessity to resort to more global economic growth to satisfy the basic needs of humanity (food, shelter, healthy living conditions, etc.) because "…economic growth, beyond that required meeting basic needs, is not only damaging to the environment but also useless in increasing human happiness" *(Ibid)*. In essence, the sustainable economic growth should be limited to providing 'reasonable human needs'. These basic needs could be met for all by the redistribution of wealth which would involve some modest economic development of developing nations but a significant reduction in material consumption in the "overdeveloped" industrialized countries. It is unlikely that global warming can be successfully averted unless mankind seriously reconsiders its commitment to unlimited economic growth and consumption.

C. Climate change and globalization. Although there are no simple and generic indicators of globalization, there is a widespread agreement that globalization is a defining feature of our times. This problem cannot be 'measured' in general terms. But some initial observations about its basic character and scope help to set the stage for an analysis of the links between globalization and the behavior of socio-ecological systems. Young *et al.*

(2006) believe that drawing a distinction between global social change and global environmental change and then considering the interactions between the two generate a new 'systemic phenomenon'. "Globalization appears to be increasing the mobility of economic and political power, both upwards (toward new global centers) and downwards (toward increasingly specialized nodes in global networks)… Environmental change also needs to be considered as a global phenomenon. Whether changes are systemic (e.g., climate change) or cumulative (e.g., aggregate loss of biological diversity), the biophysical changes occurring today are global in scope. What is more, the large-scale environmental changes that mark the present era are increasingly anthropogenic in origin" (p. 307).

Global social change and global environmental change interact with each other. In many cases, these changes can be expected to amplify or dampen one another through the operation of feedback mechanisms. Climate change impacts on social systems, for instance, may lead to far reaching actions intended to decarbonize industrialized societies, to innovation and diffusion of technological options. However, mitigating GHG emissions may cause new problems in addressing the sustainable development goals.

Addink *et al.* (2003) distinguish three different ways in which the environment, and more specifically climate change, is related to the ongoing processes of globalization:

> ***First,*** environmental interests and considerations enhance and structure the globalization process. Climate change has contributed to the perception of living in one world and the need to coordinate social practices and institutional developments at a supranational level. Thus, it 'triggers' a social transformation at a global level.
>
> ***Second,*** environmental problems are 'structured' by globalization processes, considered as possible solutions to these problems. Climate change as an environmental problem is especially structured by the imbalance between the high dynamics of globalization in economic practices and the much slower development of supranational and global political and legal environmental institutions.
>
> ***Finally,*** the close relation between global environmental change and globalization processes has led to the increasing use of natural resources in global politics and economics. Climate change flexible implementation measures are all examples of the use of environmental resources to secure economic and technological gains as well as national environmental conservation.

Possibly, the most intense form of globalization processes is demonstrated by Europeanization. Here, the political, economic and cultural forms of interconnectedness are articulated higher than on a truly global scale. The wide discussion of challenges and other questions relating to the role of nation states in the context of political, environmental and economic globalization in EU policies can be found in the work of Jänicke (2005).

If one considers the UNFCCC and its Kyoto Protocol at three levels – international, regional and national (Addink *et al*., 2003), the globalization processes have not only affected the international level of environmental law, but also have had a direct effect on regional and (sub)national levels, leading to new questions of competencies among the levels. As a result, the international regulations imposing different obligations on the parties are supported by special institutions with special tasks in relations to the design and implementation of these regulations at lower levels. Thus, the 'three-level approach' involves a multilateral fulfillment agreement, which means that parties in a certain region can enter into an agreement how to meet their obligations and conditions.

D. Linking trade and climate policies. In considering these links, it is important to consider, first, the specific connections made in the various agreements that make up the trade and climate change regimes.

The UNFCCC's Part 3 emphasized that "measures taken to combat climate change, including unilateral ones, should not constitute a means of arbitrary or unjustifiable discrimination or a disguised restriction on international trade". Really, introduction of the 'flexible mechanisms' of the Kyoto Protocol create instruments closely linked to the mandates of the WTO or World Bank, and, implementing the Protocol, the countries seek methods for minimizing its negative effects on international trade because of concerns that the functional synergies between trade and mitigation policies could lead to conflicts (Linnér, 2006). The WTO, already in 1994, created a Committee on Trade and Environment (CTE) to identify and understand the relationship between trade and the environment in order to promote sustainable development and make recommendations for a possible way of 'adjusting' the trading system. Using the specific example of developments within the WTO, Doelle (2004) explored the role of trade in motivating action on climate change, proceeding from the fact that some observers consider, for example, the Kyoto Protocol as much a trade agreement as an environmental agreement.

However, the most discussed and fundamental question is to what extent the rules governing the WTO regime can assist a nation's efforts to address climate change. Some recent EU reforms within the WTO system suggest rising internal awareness of the environmental dimension (Lenschow, 2002). A dispute settlement procedure aims at arbitrating and settling conflicts among members, but it operates on the basis of WTO rules and norms. Tough international standards that may be desirable from an environmental perspective may pose high costs on less developed countries, posing a variety of equity questions.

If we return to the UNFCCC as a starting point, additionally to the above-quoted direct principle to ensure that addressing climate change is not to detriment of international trade, the indirect references to relationships between trade and climate change include the need to consider the economic cost of measures to fight a climate change and the principle of State sovereignty concurrently with a cooperative approach. In turn, the Kyoto Protocol also includes an obligation on parties to minimize adverse effects on international trade when striving to implement climate change measures.

Obviously, the UNFCCC and its Kyoto Protocol anticipate some restrictions to international trade that would result from measures to address climate change and comply with the two documents. The provisions within the climate change regime leave open the question of when measures may be justified, and when they may not be, while the language under the WTO regime is more specific. A crucial question is to determine where the balance can be struck (in terms of environmental protection and trade) between a State's sovereignty to act in the interest of its citizens and the 'treaties obligation'. Specifically, Doelle (2004) raised the following questions relating to *"Can a State take measures to:"*

- *Protect industries that are adversely affected by measures taken to implement e.g., the Kyoto Protocol?*
- *Protect industries that are adversely affected by measures to address climate change independently of the Kyoto Protocol (i.e. what if a state takes steps which are more stringent than those required under Kyoto, whether or not it ratifies the Protocol)?*

- *Influence the climate change impact of imported products?*
- *Prevent a competitive disadvantage resulting from measures to address climate change in the case of exports?*

1.3.4.3 Law and international compliance regime

International law, while many gaps remain (Tol and Verheyend, 2004), provides a basis for responsibility for climate change impacts. This basis lies in widely accepted environmental laws, such as the long been recognized ‘no harm principle’, reinforced by declarations and precedents, as well as by international agreements, such as the UNFCCC. For legal purposes, the obligation to directly prevent damage corresponds with the obligation to compensate for any damage done – rules that base climate change mitigation policies. On the other hand, adaptation can be legally defined as reducing residual damage and the risk of such damage because it occurs when adaptation measures are not possible or are not carried out due to economic or technical constraints.

Gupta (2007) examines the recent academic interest in *litigation* as a tool to address climate change. Stating the surge of legal actions worldwide to bring the problem to the attention of judiciaries, he notes different concurrent trends in the climate change literature that have been developed over last two decades, although each new trend was partially in response to the implications of its predecessors.

The first trend he dates back to 1988, or to adoption of the definition of *‘responsibility’*. The political recognition of climate change as a serious global problem resulted in a number of political declarations focused on the common but differentiated responsibilities for GHG emissions. All countries were responsible for causing the problem, but the initial political declarations and statements phrased this in a ‘neutral factual statement’, rather than with the intention of blaming specific countries. “Climate change was not seen as a case of transboundary harm for which those responsible for the emissions were asked to reduce their emissions and compensate others for the harm caused” (Gupta, 2007, p. 77). Framing the climate change issue as a global commons problem and using ‘neutral language’ when talking about the countries’ responsibilities result in little focusing on the actors responsible for high GHG emissions.

Ten years later, in 1998, the *responsibility concept* had metamorphosed into a *leadership concept* presenting the developed world as leader and not as polluter. While the developing countries were focusing on the no-harm principle with the right to develop, the developed countries – on finding ways to define the climate change issue in terms of the leadership paradigm rather than the pollution paradigm[28]. The framing of climate change as a global commons problem continued, while the costs that effective leadership would pose on developed countries led to the rise of the *cost-effectiveness principle* defined by in Article 3(3) of UNFCCC as “…policies and measures to deal with climate change should be cost-effective so as to ensure global benefits at the lowest possible cost“. Concurrently,

---

[28] As an example, one can name Martin Jänicke (2005, p. 129) who contends that “There is reason to believe that environmental policy convergence resulting from policy diffusion is influenced not only by functional imperatives of the world market, but also by a collective behavior of national governments, where *pioneer countries* function as (intellectual) leaders… Their solutions for general environmental problems are adopted by other countries… This regulatory ‘conformism’ makes pioneer roles of countries highly relevant *(Italic added)*

the political economy and legal literature were also focusing on the use of market mechanisms in the international arena and how these mechanisms could be developed to promote the cost-effectiveness principle. This trend continues today.

However, by 2000, some scientists have realized that the cost-effective leadership process was likely unable to address the major impacts of climate change on developing countries, and that autonomous adaptation and residual impacts were being taken for granted. The leadership paradigm was proving ineffective in the short term, leading to an increased focus on *equity and liability*.

Gupta (2007) outlined new legal trends in climate change discourse as follows:

- There is an active search for legal causes of action to take governments and other social actors to task for not taking their responsibility with respect to global environmental problems (we think that to climate change as well) seriously;
- This phenomenon is not just confined to those countries that have not ratified the Kyoto Protocol, but is also spreading to the countries that have ratified;
- This is not, strictly speaking, a "First World phenomenon only", as the developing country courts are also addressing these issues;
- The potential threat of future litigation might itself give strong incentives to governments to address climate change more seriously.

There is also a growing civil society community that has begun to collaborate to identify the potential for domestic and international litigation as a way to push for climate justice, especially for those countries that have made little or no contribution to the problem. For example, an epistemic and NGO community, based in about 30 countries, joined forces under the Climate Justice Programme[29] whose main goal is to promote global respect for the 'no harm' principle. The rise of transnational communities working together in developing a common science leads to convergent state policies in different parts of the world. These communities influence on policymaking processes not only at the international, but also at the domestic level, promoting the legal principles and concepts simultaneously at the two. Such promotion may lead to similar judgments in national courts in different parts of the world using similar principles, doctrines and often referring to case law in other countries (Gupta, 2007).

At the same time, while the legal cases may try and promote the 'no harm' principle, the litigation may also not be environment friendly or may be against the interests of development. For instance, emission trading, as one of Kyoto mechanisms, is considered by some as 'a payment for emissions'.

Essentially, international law is a regime of coordination, and as such it lacks a centrally regulated enforcement system to identify and react to cases of non-compliance with its obligations. The power of the international organizations authority to enforce decisions depends on the consent of the parties to a treaty, but this consent is often difficult to secure since states are generally unwilling to submit to strong enforcement mechanisms or to transfer too much enforcement power to international institutions. Instead, they want to retain their sovereign powers (van der Lagt, 2003). Thus, compliance control is an inherent

[29] Climate Justice Programme *(Climate Justice: enforcing climate change law)* is a collaboration of lawyers and campaigners around the world encouraging, supporting, and tracking enforcement of the law to combat climate change (See: *www.climatelaw.org/*)

feature of international society. If there is no response to non-compliance with the provisions of a treaty, its overall effectiveness will be limited, and the commitments that have been made under the international legal process will be undermined.

J. van der Lagt (2003, p. 223)) defines *compliance* "…as the extent to which the behavior of a party to a treaty actually meets its obligations as laid down in the treaty". The implementation of the commitments by the state requires actions to be taken at both the national and international levels. "Compliance system includes measures to prevent non-compliance, to determine (non-) compliance, to facilitate compliance and to address cases of non-compliance" (*Ibid*). Increasing costs of compliance with environmental regulations means the greater interest of countries in ensuring that other states subjected to the same international regulations also live up to their obligations, thereby ensuring competition on a level playing field. That is why, compliance control is particularly important in international environmental law. In relation to climate change, the quoted article adds two further reasons: the likely enormous impact on national economies, and the prevention of climate change adverse consequences may particularly affect certain states (firstly, the developing and transitioning).

On the other hand, *enforcement "*... is the set of actions to be taken in response to an identified case of non-compliance in order to bring the violator back to compliance" *(Ibid)*. Thus, enforcement is a component of the compliance regime, which parties to a treaty may adopt, and refers to negative responses, or sanctions. Positive responses to non-compliance are generally referred to as facilitation responses. In relation to the climate change, responses, either facilitating or sanctioning, van der Lagt refers as *consequences*.

UNFCCC defined the commitments of nations in special documents, for example, the Usual Manual on Reporting (UNFCCC, 2003) and Guide (UNFCCC, 2005). In particular, one of the principal objectives of the former is "to ensure that the COP has sufficient information to carry out its responsibility for assessing the implementation of the Convention by Parties" (UNFCCC, 2003, p. 1). Some other commitments of the Parties to the Convention are shown in Box 1.18.

Box 1.18 Commitments of the Parties to UNFCCC

All Parties to the Convention, that is those countries that have ratified, accepted, approved, or acceded to it, are subjected to general commitments to respond to climate change. They agree to compile an inventory of their greenhouse gas emissions, and submit reports – known as National Communications – on actions they are taking to implement the Convention. To focus such actions, they must prepare ***national programmes*** containing:

- *Climate change mitigation measures*
- *Provisions for developing and transferring environmentally friendly technologies*
- *Provisions for sustainable managing carbon 'sinks'*
- *Preparations to adapt to climate change*
- *Plans for climate research, observation of the global climate system and data exchange*
- *Plans to promote education, training and public awareness relating to climate change.*

Source: UNFCCC, 2003, 2005

1.3.4.4 Framing the future policy efforts

In 2004-2005 the Pew Center on Global Climate Change[30] brought together a select group of policymakers and stakeholders from around the world in the Climate Dialogue at

[30] See: *http://www.pewclimate.org*

Pocantico – a series of discussions exploring options for advancing the international climate change efforts (Pew Center, 2005). The report of these meetings can be used for formulating certain international frameworks to effectively advance the climate efforts in transition countries as well.

In particular, participants of the Pocantico dialogue agreed that possible future post-2012 approaches should (with some abridgment):

◆ ***Engage major economies.*** From a strictly environmental perspective, the immediate imperative is successfully engaging the relatively small but diverse set of countries constituting the world's major economies in the international climate efforts. Participation of this core group is clearly critical to the success of any long-term climate strategy, including a political one. The tremendous diversity within this group, which includes developed and developing countries, and economies in transition (e.g., Russia), has significant implications in assessing responsibility for climate change and the capacity to address it. Any approach must be consistent with the principle of "common but differentiated responsibilities" that allow for variation both in the nature of commitments taken by countries and in the timeframes within which commitments must be fulfilled.

◆ ***Provide flexibility.*** Particular national interests and policies vary as widely as do national circumstances, from the nature of a country's economy and governance structure to its natural endowments, level of affluence, development priorities, and vulnerability to climate impacts. Thus, the types of policies vary from country to country in a manner consistent with national interests. A framework for multilateral climate action must therefore be flexible enough to accommodate different types of national strategies by allowing for different types of commitments and enable each country to choose a pathway that best aligns the global interest in climate action with its own evolving national interests.

◆ ***Couple near-term action with a long-term focus.*** An effective climate effort must be aware of multiple timeframes. In particular, the near-term efforts should be guided, whether formally or informally, by a common view of the long-term objectives. Long-term goals, whether defined in environmental, technological or other terms, can help to drive near- and medium-term efforts, and serve as a metric to continually assess the adequacy of commitments and implementation. They also can signal markets to invest in longer-term solutions, reduce the associated investment risk, and help mobilize society more broadly by raising public awareness.

◆ ***Integrate climate and development.*** Strategies advancing the core priorities of economic and social development and poverty eradication can simultaneously serve to confront climate change. Similarly, measures to strengthen critical societal systems and promote sustainable development can help countries adapt to climate impacts. These synergies can turn climate change into a driver for development objectives. In a more flexible framework, some countries could participate by agreeing to undertake national policies that serve their development goals while simultaneously delivering climate benefits.

◆ ***Address adaptation needs.*** Because thus far the international climate effort has focused primarily on reducing GHG gas emissions, all societies must prepare for the unavoidable. Adaptation is a challenge for all countries, and supporting it is a political necessity. Strengthening adaptation at the international level requires new efforts initiated within the climate framework but extending well beyond it.

◆ ***Be viewed as fair.*** A new global bargain on climate change will be possible only if each participating country perceives it to be reasonably fair. Given the wide variances in national circumstances, universal acceptance of any particular equity formula is unlikely, and any assessment is ultimately a political one. Not reaching agreement is, likewise, a judgment with equity implications, as the resulting climate impacts will fall unevenly, and unfairly. Each country will judge fairness in terms that it believes it can defend both its own citizens and the global community.

And, at last, the Pocantico dialogue considered policy-based approaches as one option for strengthening multilateral actions. Countries could agree to undertake national policies that promote confronting climate change with advances in core economic, social, and development objectives through committing to broad policy goals and then pledging specific national policies or measures to achieve them. This combination of broad commitments and specific pledges could encourage countries to better integrate climate concerns into their development planning and allow policies to be tailored to national circumstance.

Chapter 2

Environmental Policies and Management: Integrating Environment in Strategic Decision-making

2.1 Environmental impacts and their assessment

2.1.1 Environmental impact issue

One of the most important questions of our time is whether national and global societies can effectively and fairly address the environmental crises now facing us. Roberts (2008, p. 375) points out that "modern societies, or perhaps life worth living, cannot continue without working out how we collectively address the ways we are endangering the basic support systems upon which we rely". People have always acted in ways that affect their surroundings, but only recently we have become aware of the seriousness of these actions on the global level. As a result, humanity has entered an unprecedented era of environmental protection. It is important to recognize the biophysical forces that exert a powerful influence on humans and their social systems (Kotchen and Young, 2007). Among plenty of reasons why humanity has failed to respond adequately to environmental threats, which now seem about to overwhelm us (see Box 2.1 as one of evidences), there are a lack of vision, few political champions, inadequate financial resources, and the daunting scale of the challenge itself. Compounding these problems, Runnalls (2008) blames our failure to drastically reform national policies and practices, and create an international architecture capable of responding to the challenges of sustainable development.

It is widely acknowledged that an effective environmental policy is fully integrated into mainstream economic, industrial and social policy. The concept of integration is a key to achieving environmentally sustainable development and is now enshrined in a growing number of official documents throughout the developed and developing world. The most important mechanisms available to governments to improve environmental integration are environmental assessments *(EA)* in which the environmental implications of proposals are investigated systematically as an integral part of the decision-making process. *Environmental Assessment* is commonly[1] defined as "a written environmental analysis that is prepared under the United States' National Environmental Policy Act (NEPA)[2] to

---

[1] See, for example, Environmental Glossary of US Army Corps of Engineers. Available at: *http://www.lrb.usace.army.mil/ fusrap/glossary-ef.htm*

[2] National Environmental Policy Act (1969), 42 USC 4321–4347. Available at: *http://www.nrca.org/eias/index.htm*

Box 2.1 The Aral Sea near extinction

One of the striking examples of the environmental mismanagement is the tragedy of the Aral Sea basin and that danger it represents for the regional economy and populations in a changing climate. This former fourth largest lake in the world is now near extinction. Over the last five decades, because humans have being used up almost all of the natural river flow, it has shrunk from 68,000 km^2 to less than 10,000 km^2 (Fig. 1). As a result, population in the arid regions, adjoining the Aral Sea, must endure increasingly inhospitable conditions, facing desertification and worsening of climate conditions. Its water is not safe to drink and the agricultural production is declining. Following the temperature increase and desert expansion, the more powerful dust storms are observed that result in new health problems and ecological stresses (Fig. 2).

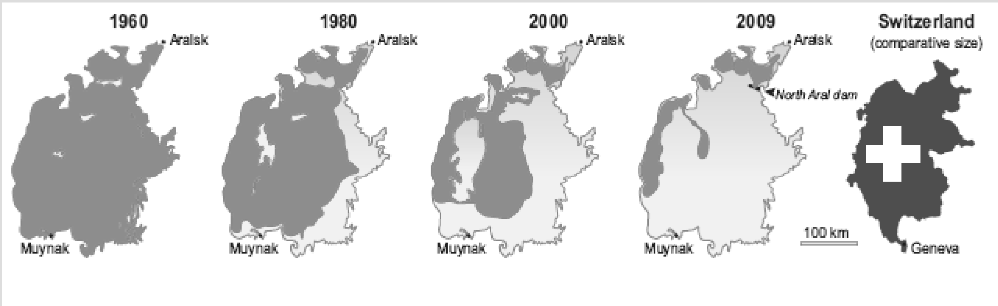


Fig. 1 The dynamic of Aral Sea shrinking

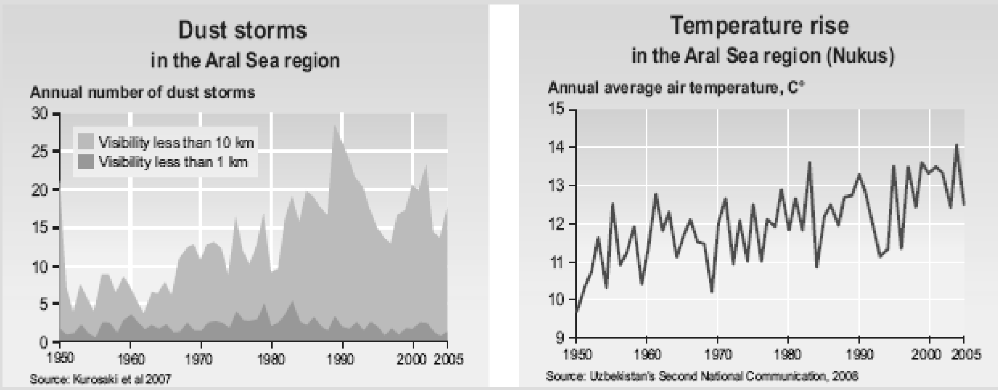


Fig. 2 Temperature rise and dust storms in the Aral Sea region

Source: Adapted from Zoï Environment Network (2009)

determine whether a federal action would significantly affect the environment and thus require preparation of a more detailed environmental impact statement". If following such a preliminary assessment a "finding of no significant impact" is issued, the proposed action is approved (Burdge, 2002).

However, as it was stated by Global Environment Outlook in the end of the last century (UNDP, 1997, p. 14), "Against the background of major changes in the world and the global efforts to address them, environmental assessment is changing too. Monitoring progress towards sustainable development and assessing the state of environment are no longer just static reporting activities. They involve co-operative and frequent interaction of policy-makers and scientists working together to achieve orderly progress towards the implementation of Agenda 21". An assessment that aims to support sustainable development can no longer report on the environment in isolation. Rather, environmental issues have to be seen as a part of larger systems, closely coupled to socio-economic development and strongly influenced by political and institutional structures. The current trends is thus towards integrated analyses, including evaluation of alternative policy options to provide knowledge base for action, political accountability, and public participation (UNDP, 1997).

The increasing pressures on businesses and industries to address environmental issues demand to identify the environmental aspects and environmental impacts, associated with their activities, products and services, to ensure that they are taken into account in setting environmental objectives and associated targets (Johnston *et al.*, 2000). A critical role of EA is to provide the analysis of the significance of potential impacts arising from major development proposals and to communicate this information to a range of stakeholders and broader public. The assessment of impacts and influences of EA on decision-making has been the subject of various studies, both within and outside the assessment community. Correct impact identification is also essential in planning any environmental management system since it determines the establishment of objectives, targets and consequent management programmes (Sánchez and Hacking, 2002; Runhaar and Driessen, 2007; Wood, 2007).

An *environmental aspect* in the ISO 14001 (1995)[3] definition is an element of an organization's activities, products or services that can interact with the environment; a *significant environmental aspect* is an environmental aspect that has or can have a significant environmental impact, and an *environmental impact* is any change in the environment, whether adverse or beneficial, wholly or partially resulting from an organization's activities, products or services. However, regardless of the terminology used, the concept of linking an environmental change (a consequence) to an activity or action (cause) via the causal mechanism should be the gist of correct impact identification and, hence, of successful environmental management. "Management can only be focused if what needs to be managed is understood" (Sánchez and Hacking, 2002, p. 29).

The 'official' guidance for the evaluation of impacts significance is provided by ISO 14004[4] where two broad categories of concerns – business and environmental – are defined. The environmental concerns include the scale of an impact, its severity, probability of occurrence and duration. Jones (1995)[5] lists some more detailed attributes of *a significant impact*:

a) It is controlled by legislation or established codes of practice; any impacts which are covered by legal regulations are considered significant and cannot be ignored;

---

[3] ISO 14001, 1995: *Environmental Management System Conformance Standard*. International Organization for Standardization, Geneva

[4] ISO 14004, 1996: *Environmental Management Systems*. *General Guidelines on Principles*, *Systems and Supporting Techniques*. International Organization for Standardization, Geneva

[5] Jones D (ed.), 1995: *Environmental Standard Certification Kit*: *How To Achieve BS*7750 *Registration*. GEE: London (Quoted by Johnston *et al.*, 2000)

b) It has financial implications, possibly leading to financial or legal liability;
c) It has a potential for environmental harm that is recognized in the company's emergency procedures and contingency planning;
d) It is known to be of concern to customers;
e) It is known to be of concern to bankers, shareholders and insurers;
f) It is known to be of concern to the local community, or a cause of complaint.

Determination of the significance of environmental impacts and their prediction are the most critical element of EA, remaining also one of its most complex, contentious, and least-understood aspects (Wood, 2007; Sánchez and Hacking, 2002). First of all, the complexity of impact significance is exacerbated by its context, comprising issues surrounding spatial scale, temporal change, social and ethical values, ecological sensitivity, economic considerations, institutional arrangements, etc. G. Wood (2007) describes these dimensions as follows:

- The *spatial context* concerns whether the proposal's potential impacts should be considered significant at the local, regional, national, or international scale;
- The *temporal context* concerns the relationship with past, present and potential future development that could cumulatively affect the same environment;
- The *ecological context* plays a further role on a site-specific basis in the sense that a small development proposal in an ecologically sensitive environment may be considered to have a more significant impact than a far larger development located in a more 'robust' setting;
- From an *economic perspective*, a community dominated by high unemployment may be more supportive of controversial development proposals than comparable areas with full employment;
- The *institutional context* defines the formal and informal rules or procedures within which decision-making occurs. The institutional context serves to invest certain rights and responsibilities upon stakeholders, and shapes the degree of power and influence that interest groups exert upon decisions.

A number of techniques have been devised to help practitioners to identify environmental impacts (Sánchez and Hacking, 2002). In particular, Brown (1995)[6] proposed to attribute impacts through 'components of significance', namely:

- *An impact on environmental*, i.e. a resulting 'load' on environment relative to some accepted environmental damage threshold;
- *Significance and extent of receptor*, i.e. whether the damage is of local, national or international significance;
- *Longevity and reversibility of impact*, i.e. the permanence and/or recovery time of the damaged ecosystem component;
- *Sensitivity of the press and public to the impact*, i.e. the extent of local and general public concern, and
- *Business significance*, i.e. the impact on the business of any damage.

[6] Brown D.J.A., 1995: Evaluating environmental effects as part of an environmental management system. *Clean Air* **25**: 108–115 (Cited by Johnston *et al.,* 2000)

Brown also proposed a version to evaluate the significance of a direct environmental impact quantitatively, by its *frequency and severity*. In graphical presentation (Fig. 2.1), an impact is highly significant if both frequency and severity are maximal (the impact is registered in the top right of the graph).

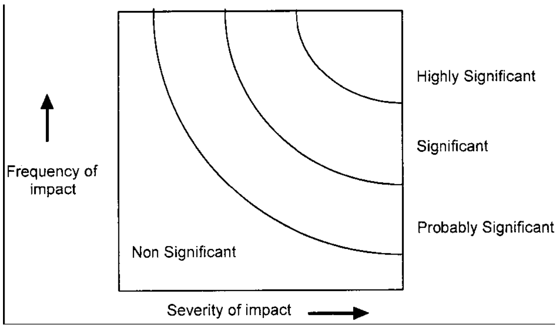


Fig. 2.1 The 'Brown' significance matrix. *Source:* Brown, 1995

2.1.2 Environmental Impact Assessment

Environmental Impact Assessment (EIA)[7] is one of the most critical environmental policy instruments. Its philosophy and principles can be traced back to a rationalist approach to decision making that emerged in the 1960s as a response to the growing need to assert environmental values in decision-making processes and to provide a technical evaluation for basing the objectivity of these processes. In the form of a new analytical approach EIA makes possible to evaluate and interpret, prior to decision-making, any potential for negative impacts. Being first legitimated in the United States under the NEPA in 1969, EIA has become an internationally accepted and established tool for environmental management in many other parts of the world. During this time EIA procedures, widely practiced in more than 100 countries, including many developing and transitional economies, have been strengthened and improved as to their capacity and many different contexts. An initial 'technical–rational' model it has been translated into a whole suite of assessment tools (Jay *et al.*, 2007).

In the European Union the directive on EIA has existed since 1985 (European Commission, 1997).

EIA essence and terminology differs between countries. For example, International Association for Impact Assessment (IAIA, 1999, p. 2)[8] defined EIA as "The process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant effects of development proposals prior to major decisions being taken and commitments made." For practical reasons, Jay *et al.* (2007, pp. 287-278) give a more comprehensive description, namely: "*EIA is the evaluation of the effects likely to arise from a major project (or other action) significantly affecting the environment. It is a systematic process for considering possible impacts prior to a decision being taken on whether or not a proposal should be given approval to proceed. EIA requires, inter alia, the publication of an EIA report describing the likely significant impacts in detail.*

---

[7] Depending on the system in place, the meaning of the word '*environment*' in EIA may range from being exclusively (bio) physical/natural environment to cover also social and economic issues related to the impact of the proposal (Wood, 1995)

[8] International Association for Impact Assessment, 1999: *Principles of Environmental Impact Assessment best practice*, IAIA, IEA, 4 p. Available at: *http://www.iaia.org/modx/assets/files/Principles%20of%20IA _web.pdf*

Consultation and public participation are integral to this evaluation. EIA is thus an anticipatory, participatory environmental management tool".

Thus, the most immediate *purpose* of EIA, arising directly from these functions, is to supply decision-makers with an indication of likely environmental consequences of their actions in order to ensure that development proceeds in an acceptable manner. Additionally, EIA is being increasingly positioned within a broader context of sustainability (Jay *et al*., 2007). In turn, Wood (2007) states that although past research has found that the practice of EIA does not necessarily change the final direction of project authorization decisions, it appears that information generated during this process serves to influence decisions relating to impact mitigation and project design; EIA also highlights the importance of achieving transparency in the evaluation and communication of impact significance during an appraisal process.

However, a project-focused approach in EIA was too limited to fully address the range of policy alternatives and cumulative effects in a development process. The need to upstream EIA into policy and planning levels, the new rationale for dealing with uncertainty, the challenge of emerging strategic decision approaches and sustainability paradigms have leaded to the development of *Strategic Environmental Assessment (SEA).*

2.1.3 SEA in the context of environment assessment

As commonly recognized (see, for example, Eggenberger and Partidário, 2000; Donnelly *et al.,* 2006; Sadler, 2001a, b; Partidário, 2007), SEA is a formal, systematic process that takes impact assessment 'up-stream' in the decision-making process, preventively addressing the impacts of policies, plans and programmes (*PPP)*[9], and identifying the sustainable development opportunities.

In numerous publications SEA has been embraced as a new tool for evaluation of the likely significant environmental effects of implementing the proposals, thus incorporating the environmental concerns, along with social and economic considerations, into the highest levels of decision-making. It is also widely accepted – 'the heart of the SEA' (Hamblin, 1999, p. 3) – that SEA should be applied early in the decision-making process, before decisions have been made and when alternatives and options are still open. Embodying the preventative approach and assessing the impacts at the PPP level, SEA can "influence choices that have to be taken for granted in the case of traditional, project-based EIA" (Runhaar and Driessen, 2007, p. 2), thus contrasting to the 'end of pipe' measures,

---

[9] As Runhaar and Driessen (2007, p. 13) summarize, there is no commonly accepted definition of what ***policies, plans and programmes*** are. Commonly employed definitions resemble those of Sadler and Verheem (Sadler, B. and R. Verheem, 1996: *Strategic Environmental Assessment. Status, Challenges and Future Directions*. The Hague, Ministry of Housing, Spatial Planning and the Environment) who defined policies as broad statements of intent that reflect and focus the political agenda of a government. Plans and programmes give substance and effect to policies, involving identifying options and specifying how, when and where specific actions will be carried out. In the policy analysis literature, however, the term 'policy' is often used in a much broader meaning, encompassing plans and programmes as well. An example is the definition by F. Fischer: policy is "political agreement on a course of action (or inaction) designed to resolve or mitigate problems on the political agenda — economic, social, environmental, and so on" (Fischer, F., 1997: *Evaluating Public Policy*. Chicago, Nelson-Hall Publisher, p. 2). We will employ this definition as well

which were the features of early environmental policy. Recent decades have witnessed this progressive shift in the focus of environmental policy and management that have increasingly turned from end-of-pipe control measures to cleaner production at the process level. The key principle behind environmental product policy is that products are increasingly viewed from a system (or life cycle) perspective where environmental burdens are considered at the various stages in the production chain (Kautto, 2006). As a crucial point in achieving this principle, Hamblin (1999) stated the following hierarchy: *avoid, reduce,* and *mitigate*. Within these markers, the boundaries of SEA are only generally drawn in relation to near-equivalent processes, such as policy appraisal and integrated planning, and to emerging approaches to sustainability appraisal. Also, SEA allows assessing the cumulative impacts of projects and is considered to be a tool to improve the efficiency of EA on the whole by reducing the number and complexity of the project's EIA. For example, Mertensson *et al.* (2005) describe a research project where SEA tools are implemented and evaluated in municipal energy planning. The project aimed to test the SEA process and different analytical and procedural tools as well as to analyze whether such tools would improve the planning process and, subsequently, the energy plan in terms of its ability to direct the development of local energy systems towards less environmental impacts. In the proposed methodology, SEA is an integrated and integrating component of the energy planning process.

The evolution of SEA can be best recounted in relation to the mainstream of EIA history, dating from 1969 when it was first required under NEPA. In light of the evolving nature of environmental assessment, Dalal-Clayton and Sadler (2005), and later Chaker *et al.* (2006), perceived current SEA as a second-generation paradigm moving EIA principles 'up-stream' in the decision-making process. The first two authors divide SEA evolution into three main phases:

- The *formative stage* (1970-1989) when certain legal and policy precedents for SEA were established but had limited application (largely in the USA);
- The *formalization stage* (1990-2001) when different provision and forms of SEA were instituted by a number of countries and international agencies; and
- The *expansion stage* (from 2001 onward) when international legal and policy developments promise to catalyse wider adoption and use of SEA, particularly in Europe, but also elsewhere.

These authors also described *key trends* in SEA process development. In particular, the initial phase has been characterized by diversified arrangements, increasing adoption by countries and international agencies, and a steady extension in the coverage of levels and types of decisions. A second phase is underway, driven by supra-national and multilateral legal instruments. And, at last, a new, third phase is being opened in developing countries through the activities of international assistance and lending agencies.

However, as Dalal-Clayton and Sadler (2005) commented further, whereas the term SEA is widely used by the impact assessment community, there are numerous related terms and institutionalized labels. Moreover, SEA is not necessarily an official title in many countries, particularly those with EIA systems applied to PPPs. By their opinions, "*...the separate designation of SEA at the PPP level reflects the limited coverage of EIA in*

Fig. 2.2 The menagerie of SEA terminology. *Source:* Dalal-Clayton and Sadler (2005, p. 11)

the first two decades of its implementation" (*Ibid,* p. 9). Some examples of commonly used acronyms for SEA-type approaches are expressed figuratively as '*the menagerie of SEA terminology'* (Fig. 2.2). There is wide-spread consensus regarding the lack of a 'blueprint' approach to SEA, and the process will need to be tailored to the particularities of individual countries (Chaker *et al*, 2006).

That is why, the sourcebook and reference guide to international experience in SEA (Dalal-Clayton and Sadler, 2005) does not offer a competing definition of this process, believing that "Any broad definition of the current and growing 'family' of SEA approaches will need to remain generic and flexible" (p. 13). Quoting, but 'leaving overboard' some available definition and understanding evolving experience and practice, they have distinguished only three broad categories:

> *formal SEA procedures* as prescribed in international or supra-national instruments (for example, the below-discussed European SEA Directive and Kiev SEA Protocol), or under legal and policy frameworks established by certain countries and international organizations, such as the World Bank[10];
> other *near-equivalent processes* of environmental appraisal of policies and laws;
> the broader range of SEA-type processes, methods and applications referred to as '*para-SEA'* – a shorthand term for approaches that do not meet formal specifications or strict definitions of SEA but have some of their characteristics or elements and the same overall purpose.

There are two legal documents that specifically set the international regulatory framework for SEA: the so-called European SEA Directive[11] and the Protocol on Strategic Environmental Assessment (the so-called Kiev SEA Protocol)[12]. The first document establishes a basic framework for assessing the effects of certain plans and programs on the environment, thus leading to a greater standardization of SEA approaches that set the

---

[10] World Bank Operational Policy and Procedures OP/BP 4.01. Available at: *http://wbln0018.world bank.org/Institutional/Manuals/OpManual.nsf/toc2/9367A2A9D9DAEED38525672C007D0972?OpenDocument*

[11] Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment. Available at: *http://www.environ.ie/en/Publications/Environment/Miscellaneous/FileDownLoad,1805,en.pdf*

[12] Protocol on Strategic Environmental Assessment to the Convention on Environmental Impact assessment in a Transboundary context (Kiev, 2003). Available at: *http://www.unece.org/env/eia/documents/protocolenglish.pdf*

framework for consent of projects subject to EIA. It was expected that SEA Directive would have Europe-wide as well as international ramifications, and the transitional countries could be expected to introduce SEA arrangements that are aligned directly with the EU framework.

The Kiev SEA Protocol was developed to supplement the Convention on EIA in a Transboundary Context, also known as the 1991 Espoo (EIA) Convention[13]. After a two-year negotiation, the Protocol was formally adopted in May 2003 at the Extraordinary Meeting of the Parties to this Convention in Kiev and seeks to facilitate the implementation both this and the Aarhus Conventions[14]. It also reflects the commitments made at the 1999 London Ministerial Conference on Environment and Health. Once ratified, the Protocol was legally binding on signatories with regard to plans and programmes, and discretionary – with regard to policy and legislation. It requires the Parties to evaluate the environmental and health impacts of their draft plans and programmes; it also addresses policies and legislation proposals. The protocol puts more weight than the European directive on the need for undertaking and defining clear and transparent arrangements for public participation (Cherp, 2001; Dalal-Clayton and Sadler, 2005; Chaker *et al,* 2006).

2.1.4 Surveying the SEA field

2.1.4.1 The essence of discussion

The principal differences between SEA and EIA can be correctly understood based on the context of these processes. Generally, these differences are largely agreed amongst environmental assessment practitioners, but there is much to be discussed. Although SEA definition as 'the application of environmental assessment to PPPs' is now widely used, the rapid development of SEA processes and experience during the last decades, and the corresponding explosion of literature (e.g., Dalal-Clayton and Sadler, 2005; Chaker *et al.*, 2006; Partidário, 2007) have provided new perspectives and background on this evolving process. An opinion has been formed that SEA field should be much broader, encompassing *"…a range of policy tools and strategic approaches as well as formal EIA-based procedures and near-equivalent forms of environmental appraisal"* (Dalal-Clayton and Sadler, 2005, p. 1).

The recent controversy in SEA defining concerns, first of all, its *nature and scope* where Chaker *et al.* (2006) distinguish two schools of thought: the first maintains that the process must largely centre on environmental issues while the other holds that SEA must provide a sustainability focus encompassing social and economic aspects alongside with environmental ones. Earlier, Eggenberger and Partidário (2000) defined these schools as (1) *'bottom-up',* or 'upstream' approach in which EIA principles and methodologies are extended from the project to the strategic level, focusing on the environmental impacts of

---

[13] Convention on Environmental Impact Assessment in a Transboundary Context (Espoo, 1991). Available at: *http://www.unece.org/env/eia/documents/conventiontextenglish.pdf*

[14] Convention on access to information, public participation in decision-making and access to justice in environmental matters. Available at: *http://www.unece.org/env/pp/documents/cep43e.pdf*

proposed PPP, and (2) as *'top-down'* approach, with impact assessment principles tailored *"…in the formulation of policies and plans through the identification of needs and options for development, which are assessed in the context of a vision for sustainable development*" (p. 203). Additionally, they argued that SEA at a policy level requires a different methodological approach than that used in lower tier plans and programmes.

M. Partidário (2007) explains the debate surrounding the SEA context by citing two major reasons. The first reason concerns *the perception of SEA:* is it a methodology to assist strategic decision-making or, alternatively, a methodology to control and validate the environmental component of plans, programmes and policies? Accordingly, in the practice this reason will be addressed as the perception: what professionals want, or expect, SEA to be? The second reason concerns *the conceptualization of SEA* influenced by two different forms of scientific thinking: rational determinism and strategic thinking. As a scientific theory, this reason determines the practice of SEA (its design): how that SEA is, and can be, conceptualized?

Based on available literature, Partidário (2007) sees two ways of ***SEA perception*** (Fig. 2.3):

- ➡ As a *new methodology* to address strategic environmental impacts in a sustainability context that adopts an integrated approach to factors centered on environmental impacts, which may affect the sustainability of strategic decisions.
- ➡ As a *new name* for an existing methodology and practice, based on a standard EIA type methodology, albeit adapted in applications to higher levels of decisions beyond basic project development.

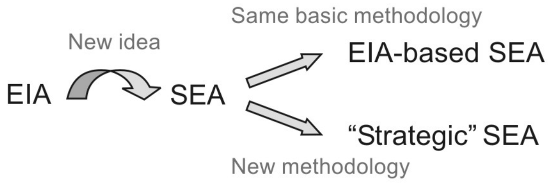


Fig 2.3 Is SEA a new methodology or a new name for an existing methodology? *Source:* Partidário, 2007

As *a new name* for the same methodology, SEA follows standard EIA practices, activities and processes, inherits its basic elements and methodologies, aiming to ensure that environmental issues are considered in decision-making by assessing and validating the environmental quality of proposals in PPP development. *"An assessment is considered to be an SEA if it applies EIA principles to a PPP,"* – noted Nooteboom (2000, p. 152). In fact, despite some improvements and methodological adaptations, in many cases SEA application still follows initial understanding of the SEA concept based firmly on EIA principles and process, although it was recognized that procedure and methodology would need to be adapted (Dalal-Clayton and Sadler, 2005). Hence, *"…it could be argued that a new name is used for basically the same standard practice"* (Partidário 2007, p. 467).

As *a new methodology,* SEA is perceived as a *strategic instrument*: being applied to decisions of a strategic nature, it needs to be used strategically in relation to decision-making. SEA has the potential to be used strategically to enable the environmental integration and sustainability of decisions, and Partidário (2007) calls on the exposure of SEA as a new methodology. This position is supported by many authors. So, Verheem and Tonk (2000, p. 177) summarized, that *"...most SEA practitioners do agree on what the overall concept of SEA is a structured, proactive process to strengthen the role of environmental issues in strategic decision making"*. Cherp (2001) saw the main goals of SEA through (a) overcoming the limitations of the project-level EIA by considering key environmental issues earlier in the planning process and addressing cumulative and synergistic impacts, (b) introducing the environmental and sustainability considerations in the formulation of strategic actions, and (c) contributing the policy appraisal, thus making strategic decision-making more structured and transparent.

Thus, the range of SEA interpretations has grown much wider and now extends beyond its EIA foundations. The growing diversity of more recent definitions reflects the range of types and contexts covered by PPP decision-making and takes a broader, more complex and varied perspective that help to integrate the environmental, social and sometimes economic dimensions during the formulation of policies and development plans and programmes. In other words, SEA is seen now not just as a means to 'upstream' impact assessment, but as "a key tool for sustainable development" (Dalal-Clayton and Sadler, 2005, p. 9).

Conceptual definition of SEA, in the interpretation of Brown and Thérivel (2000, p. 184), is "a process directed at providing the proponent (during policy formulation) and the decision-maker (at the point of policy approval) with a holistic understanding of the environmental and social implications of the policy proposal, expanding the focus well beyond the issues that were the original driving force for new policy… The intention of SEA is moving policy (and PPP generally) towards sustainable outcomes".

In *the scientific conceptualization* of SEA M. Partidário (2007, p. 468) also distinguishes two main schools: the EIA-based and the strategic policy planning-based. The fundamental difference between the two, as has been mentioned above, lies in the nature of the approaches: based more on the rational deterministic-planning approaches against a foundation on the strategic view of planning. Environmental assessment does not just operate within the confines of its narrow rationalist beginnings, *"but has a more complex role within decision-making processes, in which environmental perspectives are being brought to bear in a variety of ways and amongst a range of audiences. Moreover, it is itself subject to some of the dynamics currently being observed within development planning, such as more 'communicative' approaches, in which emphasis is placed upon participation and consensus-building, rather than upon expert-led technical solutions"*, – noted Jay *et al.* (2007, p. 294).

In other words, SEA is structured around key activities that operate throughout the planning process. Before action proposals get formulated, it is advisable not only to identify the sustainable objectives but to get a clear understanding of the strategy that have the highest chances of leading towards sustainable outcomes. In creating a context for the sustainable design of the actions that will implement the strategy, M. Partidário (2004) sees one of the key potential outcomes of SEA, attributing to its three main functions:

- Integration of environment and sustainability issues in strategic processes;
- Assessment of opportunities and risks of strategic options;
- Validation of the assessment of strategic processes and outcomes.

The first two functions demand SEA to be innovative and look for the right methodologies to be applied strategically, and only in the third function SEA can be more comparable to EIA.

Partidário (2007) see also the differences between EIA-based SEA and SEA in a strategic sense in the motivation for SEA, as well as in the rationale and in the methodological approach that assist its application. In the EIA-based methodological approach the *PPP proposals* lie at the centre of the assessment, and the motivation is to assess the consequences of the proposals on the surrounding environment. In the strategic approach to SEA, *the problems* to be resolved lie at the centre of the assessment, and the motivation is to find the policy, plan and programme or alternative appropriate strategic options that have the capacity to resolve the problems, to meet the intended objectives and sustainable outcomes.

Thus, in general, SEA is currently understood to be a process for identifying, understanding and sustainably addressing the environmental (and, increasingly, the associated social and economic) dimensions, effects and consequences of PPPs and other high-level initiatives in strategic decision-making. This approach takes place before decisions are made, when major alternatives are open. Preferably, it should make a contribution to their formulation and development rather than focusing only on the impacts of their implementation (Dalal-Clayton and Sadler, 2005; Partidário, 2007).

However, as Marsden and De Mulder (2005) noted, it seems to be difficult for SEA practitioners to get out of the shadow of the classical EIA traditions. As a flexible tool, which can be applied to a range of different policy areas, SEA is closely related to EIA: SEA builds on and extends the EIA process to more strategic decision-making, influencing the framework for future development (Hamblin, 1999). SEA strengthens EIA both in the object (the evaluation of impacts upon the environment at strategic level against at the project one) and by the time of application (at earlier stage of the decision-making process). Advocating the integration of environmental factors into decision-making, SEA promotes sustainability. Partidário's (2007) vision of the difference between the two processes from the conceptual viewpoint is shown in Table 2.1.

Table 2.1 Difference between EIA and SEA concerns

	EIA	***SEA***
Purpose	To find a solution for a problem	To help to understand, and to appropriately address, a problem
Focus	▪ To help in environmental design of proposals ▪ To give a detail account of the current situation and its future evolution ▪ To support the evaluation of the proposal and its alternative solutions ▪ To validate or reject the proposed project	▪ To delimit and understand the context ▪ To engage different perspectives in clearing the problems through dialogues and communication ▪ To search for the option that will create environmental and sustainable contexts within which the proposals are sought

Source: Partidário, 2007

However, in spite of principal differences, both SEA and EIA are needed, supplementing each other. Nooteboom (2000) demonstrates this on the problem of GHG mitigation. Ideally, the importance, for instance, of GHG emission reducing by some value should be identified through an assessment at country level and then could be laid down in environmental policy. Because sectoral PPPs and project decisions should be coherent with the selected policy, both SEA and EIA would be useful tools in assessing this coherence. Marsden and De Mulder (2005) see one of the reasons to coordinate both processes in the fact that provisions of legal SEA instruments reflect a great similarity with the stages of the EIA process. This discussion continues in greater detail in the next sections.

2.1.4.2 SEA approaches

Some forms of SEA have been in place since EIA was first introduced in 1969 and, arguably, for even longer time in land-use and resource planning practices. However, Partidário (2007, p. 461), who has made a comprehensive review on this issue, argues that *"What may be ironic is to expect SEA to resolve EIA's limitations when still using the same EIA tools, methodological approaches and paradigms"*. SEA needs to be acknowledged as a continuous process, instead of a one-stage reporting exercise.

Current models of SEA application vary widely between countries. In general, Dalal-Clayton and Sadler (2005) have grouped them under three broad approaches:

- Introducing SEA as a relatively separate, distinct process – typically as an extension of EIA;
- Establishing SEA as a two-tier system with formal separate requirement for specific sectoral plans and programmes and an environmental "test" applied to legislation; and
- Incorporating SEA into more integrated forms of environmental policy appraisal and regional and land-use planning. There is also a growing recognition of the importance of its integrating with other policy and planning instruments.

Chaker *et al.* (2006), considering the evolution of these approaches, described in more details two broad perspectives – top-down and bottom-up – that, respectively, exhibit methodological and procedural elements learned either after policy or plan evaluation practices or after project-based practices (Fig. 2.4):

- *Top-down* perspective: the impulse for SEA stems from policy analysis and planning whereby the process is driven by sustainable development concerns. Earlier, Eggenberger and Partidário (2000, p. 203) expressed this principle as "the formulation of policies and plans through the identification of needs and options for development, which are assessed in the context of a vision for sustainable development". In other words, the formulation of policies and plans incorporates principles of environmental assessment, in which the needs and options for development are first identified and then systematically assessed.

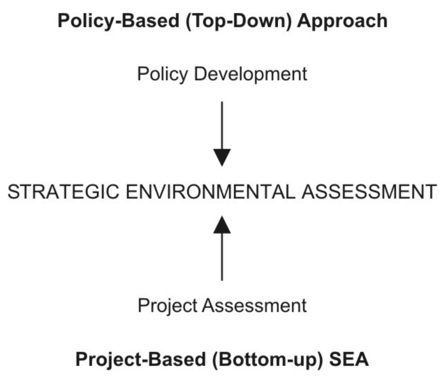


Fig. 2.4 Top-down versus bottom-up perspectives in SEA. *Source:* Chaker *et al.*, 2006

- *Bottom-up*, or *upstream* perspective: SEA is applied to plans and programmes, sometimes using existing EIA procedures and requirements, as an extension of EIA from the project to strategic level. The process is driven by concerns regarding the EIA's limited, project-specific focus and the lack of coverage with respect to higher-level decisions.

Verheem *et al.* (2000) differentiated the approaches by their *openness* (for instance, with or without participation of the general public), *scope* (with or without the mandatory description of alternatives), *intensity* and *duration* (from one day to several years), and so on. Differences stem from the specific contexts in which the SEA processes are meant ('separate requirement' in the above Dalal-Clayton and Sadler grouping) and even from countries' specificity, e.g., either in developed or in developing/transition countries. 'Specific design for specific use' increases SEA effectiveness.

2.1.4.3 SEA principles

Dalal-Clayton and Sadler (2005) infer that a significant increase in the use of SEA might follow a progress in three areas: reaching consensus on its scope and aims; agreeing guiding principles on SEA for potential users; and developing a typology of the different forms that SEA can take.

Scoping determines the impacts and alternatives to be considered, and establishes the Terms of Reference (TORs) for the assessment. Normally, it should be completed in a relatively short period of time, using available information and some consultations (Lee, 2006; Nooteboom, 2000).

As to ***general guiding principles*** for good process design and implementation, the SEA process should (Sadler, 2001a; Dalal-Clayton and Sadler, 2005):

- fit the purpose and be customized for application at the policy level or at the level of plans and programs;
- have integrity, so that it is applied in accordance with the objectives and provisions established for it, and be effective in meeting those objectives;
- be focused on delivering information necessary to the decisions to be made, and address the significant and key issues;
- be driven by sustainable development principles (taking into account environmental, social and economic considerations), and therefore
- be integrated with parallel analyses of economic and social dimensions and issues, and with other planning and assessment instruments and processes;
- relate to project EIA where appropriate, perhaps through tiering mechanisms;
- be transparent and open;
- be practical, easy to implement, oriented to problem-solving, and cost-effective;
- introduce new perspectives and creativity (it should "provide bonuses, not be a burden"), and
- be a learning process (thus it is essential to start 'doing SEA' to gain experience).

Together, these principles offer guidance on the appropriate scope, orientation and content of the SEA process. One more principle, mentioned by Brown and Thérivel (2000), is to see SEA as an overarching concept, rather than as a unitary technique, housing within it a family of tools for PPP planning, development and review, with different members being appropriate for different types and different stage. No one SEA methodology can be applied to all strategic actions and in all socio-political contexts. *"We must begin to think in terms of an array of SEA tools from which the appropriate one(s) can be selected to meet the needs of the particular circumstances"*, – they stated (p. 186). Brown and Thérivel also emphasize the role of SEA as a PPP formulation tool; namely, SEA is most effective just at the stage of PPP formulation, rather than of the appraisal of an already formulated PPP. During the development stage, PPPs go through a complex process of evolution where SEA plays a significant role (Fig. 2.5). SEA should start early in PPP formulation and be integrated, preferably as an active intervention, in the PPP design process.

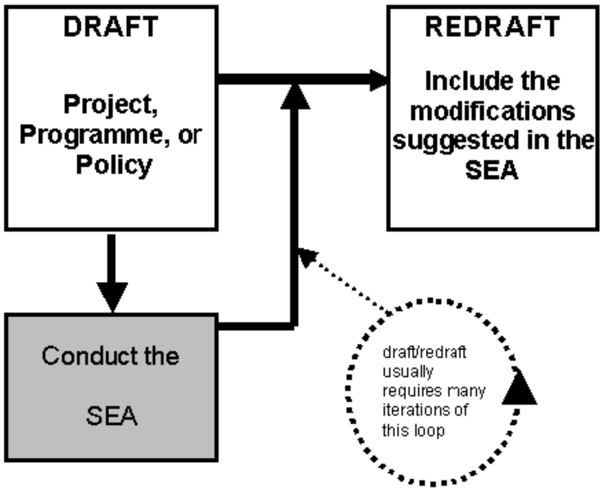


Fig. 2.5 Role of SEA in formulation of policies, plans and programmes. *Source:* Brown and Thérivel, 2000

Every SEA process should achieve certain ***goals***. An attempt to formulate SEA principles in the form of goals, as a starting point for the discussion between SEA and decision-making experts, was made by Verheem and Tonk (2000). It is their opinion (see also Dalal-Clayton and Sadler, 2005) that in the form of successive steps SEA's goals should ensure that:

- *Screening* – an appropriate environmental assessment is carried out for all strategic decisions with potentially significant (positive or negative) environmental consequences by the agencies initiating these decisions;
- *Publication* – it is clear to all parties affected by the decision how the assessment results were taken into account when coming to a decision;
- *Monitoring* – sufficient information on the actual impacts of implementing the decision is gained to judge whether the decision should be amended;
- *Timing* – the results of the assessment are available sufficiently early to be used effectively in the preparation of the strategic decision;
- *Environmental* – scoping all relevant environmental information is included, and all irrelevant information is excluded, to judge whether an initiative should go ahead or whether the objectives of the initiative could be achieved in a more environmentally friendly way;
- *Socio-economic scoping* – sufficient information on other factors, including socio-economic considerations, is available, either parallel to, or integrated in, the assessment;

- *Views of the public* – sufficient information is available on the views of the public affected by the strategic decision early enough to be used effectively in the preparation of the strategic decision;
- *Documentation* – the results of the assessment are identifiable, understandable and available to all parties affected by the decision;
- *Quality review* – the quality of process and information is safeguarded by an effective review mechanism.

The SEA process may be shaped in different ways, and the means to realize its steps may differ. As an example, in Box 2.2 and 2.3 there are given two sets of procedures and methods that may be applied in SEA good practice. It is of great importance to all actors (scientists, planners, experts, etc.) to accept the wide range of different methodologies, all achieving the same goals but fine-tuned to the needs of a specific planning level.

Sadler (2001a) provided also examples of several overlapping types or institutional models of SEA systems that comprise:

- *EIA-based*: SEA carried out under EIA legislation or as separately administered procedure;
- *Regional assessment*: SEA applied to development strategies for a particular geographic area;
- *Environmental appraisal*: SEA addressed by overall process of policy appraisal and review;
- *Dual or two-tier approach*: SEA undertaken on separate levels;
- *Integrated resource management*: SEA-type elements are part of larger process of policy- and plan-making and project decision-making; and
- *Sustainability analysis*: SEA elements are part of integrated, environmental, economic and social assessment and review of resource policy issues.

Lee (2006) presents numerous details to assessment practices, expressed in the form of *a common assessment framework* containing three linked components:

Box 2.2 Procedures for SEA good practice

Proposal – Establish the need for and objectives of the proposed action
Screening – Determine if an SEA is required and at what level of detail
Scoping – Identify the important issues and impacts that need to be examined
Information – Assemble environmental information
Consideration of alternatives – Identify and compare the range of alternatives, including a best practicable environmental option
Impact analysis – Identify, predict and evaluate the effects of the proposal and the main alternatives
Significance – Determine the importance of the residual impacts, and if appropriate, relate these to other benefits and costs
Mitigation – Identify measures to avoid, reduce and offset the main impacts identified
Reporting – Describe the environmental impacts of the proposal and how they are to be addressed
Review of quality – Check the information is adequate for the purposes of decision-making
Decision-making – Approve, reject or modify the proposal, with reasons for decision
Monitoring – Check to see implementation is environmentally-sound and in accordance with approvals.

Source: Sadler, 2001a

- The planning context within which the assessment is to take place;
- The process by which the assessment is to be undertaken; and
- The methods, technical and consultative, by which the impacts are to be assessed.

The following addresses some of Lee's useful recommendations.

First, screening, being applied at the beginning of an assessment process, should determine whether a project or PPP are to be subject to assessment. The screening systems also make a distinction between PPPs, as to requiring only a preliminary assessment with simpler impact assessment, briefer reporting and fewer process requirements, and those needed in a detailed assessment. Scoping and screening stages, taken together, are crucial in ensuring that the resources available for the impact assessment are used most effectively.

Monitoring and *ex post* evaluation are among the least developed stages in many assessment systems, despite being central to their long-term overall effectiveness. Lee (2006) reveals their purposes as follows:

- ✓ To check whether the approved PPP, and its accompanying mitigatory and enhancing measures, have been satisfactorily implemented.
- ✓ To assess whether the type and level of impacts, positive and negative, predicted to occur, have resulted (and whether any unexpected significant impacts have occurred).
- ✓ To recommend, in light of the above, whether the implementation of the PPP needs to be strengthened or where it may need to be amended.

Box 2.3: Methods and their use in SEA

Baseline study
- SOT reports and similar documents
- Environmental stock/setting
- "Points of reference"

Screening/scoping
- Formal/informal checklists
- Survey, case comparison
- Effects networks
- Public or expert consultation

Formulating options
- Environmental policy, standards, strategies
- Prior commitments/ precedents
- Regional/local plans
- Public values and preferences

Impact analysis
- Scenario development
- Risk assessment
- Environmental indicators and criteria
- Policy impact matrix
- Predictive and simulation models
- GIS, capacity/habitat analysis
- Benefit/cost analysis and other economic valuation techniques
- Multi-criteria analysis

Documentation for decision making
- Cross-impact matrices
- Consistency analysis
- Sensitivity analysis
- Decision "trees"

Source: Sadler, 2001a

The set of strategies, used to carry out a particular assessment and to form its overall methodology, should be 'tailor made' to the individual assessment requirements. Within the overall methodology, a number of alternative approaches could be chosen to serve different assessment tasks, and their selection needs to be made in a systematic manner. The tasks–methods analyses highlight the main differences between preliminary and detailed assessments, in their scales, methodologies and data requirements. The main purpose of this *Causal Chain Analysis (CCA)* is to identify the significant sections of the causal chain, which link (a) problems, to be addressed by the PPP, to their root causes and (b) the PPP (and any alternatives to be assessed) to their sustainability impacts.

The presentation of assessment findings may be either in a quantitative or qualitative form. However, at strategic levels of assessment (and particularly in preliminary assessments) a quantitative presentation may be counterproductive, first of all because the high level of precision in impact estimates is rarely needed for strategic-level decision making. Furthermore, quantified estimates, expressed sometimes in a variety of units with which decision-makers and stakeholders are unfamiliar, may be more confusing rather than informing.

Table 2.2 Significance evaluation and uncertainty at key stages in the EIA process

EIA process stage	*Purpose of significance evaluation*	*Minor impacts considered significant*	*Major impacts considered non-significant*	*Sources of uncertainty*
Screening	Identification of development proposals requiring formal EIA	• Competent authority loses credibility • Costs to the developer of initiating an unnecessary EIA	• Controversy and conflict • Legal challenge • EIA occurs at a later phase of project planning	• Project design, technical processes and timing • Environmental and social receptors potentially affected
Scoping	Preliminary identification of impacts and issues requiring assessment	• Assessment resources subsequently wasted • Voluminous and unwieldy EIS	• Bias to focus of the subsequent assessment • Loss of trust, credibility and reduced legitimacy of the EIA	• Knowledge/ understanding of the existing environment • Relevance/availability of environmental information • Future baseline conditions • Detailed project design • Divergence of opinion rekey impacts and valued environmental components • Likelihood of impact occurrence
Impact prediction and EIS production	Feedback to project design for change and/or mitigation. Identification, evaluation and communication of key impacts for the competent authority and the public	• Unnecessary mitigation raises project costs • Causes damage to the public profile of the project and increases opposition • "Overreaction" and possible rejection of feasible projects	• Biased assessment • Loss of credibility for proponent and competent authority • If detected later in the process: –project delays –mitigation "retrofitted" –future legal procedures –project stopped	• Measurement error in assessing baseline conditions • Estimating future baseline changes without the project • Accuracy and/or suitability of predictive methods used • Uncertainty over mitigation performance/ effectiveness • Lexical uncertainty in communication/ interpretation of impact significance
Monitoring/ audit and impact management	Evaluation of impact predictions and mitigation effectiveness. Identification of further mitigation requirements and management resources	• Attempt to mitigate environmental changes that are not related to the project or are costly to correct	• Loss of credibility for proponent and competent authority • Failure to recognize early warning signals • Costly rehabilitation	• Measurement error • Uncertainty in identifying impacts attributable to the project

Source: Wood, 2007

Undoubtedly, one of most sophisticated and subjective processes in environmental statements is evaluating and communicating *impact significance*. First of all, significance evaluation is an inherently dynamic activity, with the nature of significance evolving through the EA process concurrently with the increase of environmental information details and availability. Wood (2007) has demonstrated a model for the evaluation of impact significance and uncertainty at key stages of EIA process (Table 2.2). This model can be used as a case study for 'extrapolation' on the strategic level of assessment.

2.1.5 Problems of scale in Environmental Assessment

2.1.5.1 Scale issues

Real world environmental impacts occur in time and space, and these categories are ubiquitous in all environmental assessments. In essence, the problem of scale refers to the transferability of both empirical generalizations and causal interferences from one level to another in the *space* and *time* dimensions. Natural scientists have long regarded the problem of scale as critical to determining the scope of the validity of propositions about biogeophysical systems and to developing integrated theories about such systems. By contrast, social scientists have devoted comparatively little attention to this problem, although human activities of relevance to global environmental change occur at various levels of social organization (Young, 2005).

Scaling up in space concerns the applicability of findings derived from an analysis of systems on one scale to another. Traditionally, particularly in their environmental and economic manifestations, scientists tend to pursue a *top-down* approach. That is, they try to model the whole world at once, and then derive understandings of impacts and responses in local regions from the global analysis (e.g., climate change modeling). Such an approach is pragmatically sensible because the institutions that construct the policies and treaties for global environmental problems, such as the various conventions of the United Nations, tend to be global bodies. Notwithstanding, there are significant problems with an exclusively top-down approach to the modeling of global environmental problems. The global models cannot capture some phenomena that are important to peoples' lives, such as the expected frequency of extreme events at a specific locality (Cebon and Risbey, 2000).

The problem associated with scale arises from the fact that scaling up and scaling down are relatively straightforward procedures under some conditions; however, this is not the case under other conditions. It is therefore an important challenge both to identify circumstances under which generalizing across scales is hazardous and to develop procedures for adapting propositions and models to allow for scaling in such cases (Young, 2005).

While a regional analysis gains from being more fine-grained and detailed, it loses in one key respect. Unlike global analysis, which is unbounded in space, regions have ***boundaries***. Given that these boundaries are static, while the model is dynamic, the boundaries distort the model inputs. As a result, the difference in outputs may come from a misspecification of the inputs at the boundary. Hence, while the two models (global and regional) are providing the best estimates of particular phenomena, we cannot privilege either. Rather, we must consider them as complements.

The above discussion points to the need for regional analysts to be mindful of the relationship between the region under consideration and its boundaries, and hence the global system in which it is embedded. Cebon and Risbey (2000) showed that different regional specifications of a problem could lead to radically different analytical strategies and insights. So, people trying to understand the limitations of global models are likely to appreciate those limitations better, and therefore act on them. And vice versa, people working with regional models can gain a better appreciation of when they should prefer the regional issues over the global, and when, in contrast, they should privilege drivers from the global system. Different regional conceptualizations of a problem can lead to radically different policy prescriptions.

To facilitate the process of analytical strategies selection, Cebon and Risbey (2000) presented a four-element typology of regional processes (Fig. 2.6). The typology was defined by the nature of the interaction between the regional and global systems across the regional boundaries, concerning with the flows of information that drives these systems.

In particular, in a *convergent* system, behavior at the regional level is driven from the global level, and the regional model is a 'down-scaled' version of the global one. That is, regional parameters are transformations of global inputs. A classical example is the statistical downscaling of global climate models to the regional level, based on the empirical relationships between change in global and regional (local) climatic variables.

In a *divergent* system, behavior at the regional level feeds up to, and provides important influences on, behavior at the global level. There are important feedbacks from the regional level back up to the global level. For example, the well-known regionally located 'kitchens of weather' form global and planetary climates.

In the case of *local regionalism,* behavior at the regional level is essentially independent of behavior at the global level, and the regional system's internal feedbacks are so strong that changes in the global system are not transmitted into the region. Micro-climates, particularly those inside dense forests, provide an excellent example of local regionalism in a climate system. In these systems, some of which have very large extent, local processes create a climate that is essentially independent of that above the tree canopy.

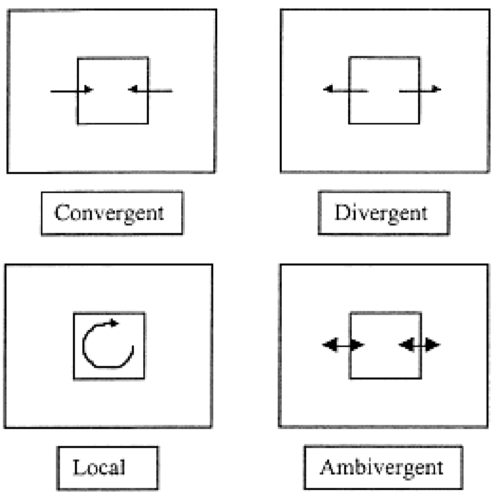


Fig. 2.6 A typology of regional phenomena *Source:* Cebon and Risbey, 2000

Finally, in an *ambivergent* regionalism, the global and regional systems are driving each other simultaneously, and the flow of controlling information in one direction across the system boundary is as important as the flow in another direction. Ambivergence differs from a simple superposition of divergent and convergent regionalism and occurs when both flows of information across the regional boundary (from the local to global and from global to local) are important and are generated by processes that operate in both global and local domains. Such a situation takes place in the case when a system does not offer a useful boundary between two domains, for example, in a multi-disciplinary model for a regional system when the appropriate boundaries for one discipline differ from those for another (e.g., water resources and agriculture). That is why political boundaries are not usually the most useful choices for climate analysis.

Thus, it is clearly that *"…a key analytical trick is to identify cases when that simplification constitutes a legitimate and useful approximation, and when a plurality of regional analyses is called for"* (Cebon and Risbey, 2000, p. 212).

The need to clarify the interdependencies between impacts at different scales and to produce relevant information at scales, appropriate for the actors, presents also major challenges for the ***impact assessment***. The solution of a problem may often be at a scale different from that where the problem was revealed; that is why the issue of scale is part of understanding and defining problem (Karstens *et al.*, 2007; Partidário, 2007). Both of these authors perceive the scale choices as complex phenomena that are best analysed by developing multiple perspectives on them. The multiple scales are to be considered in SEA as well because only all perspectives taken together can provide a comprehensive representation of a complete image. The multiscale contexts determine the need for corresponding data.

Generally, scale is defined by extent and resolution that characterizes two key meanings in scale conception, applicable to both spatial and temporal issues (João 2002, 2007). The first meaning – *extent* – is the overall size or magnitude of the spatial or temporal dimension. As applied to the assessment, extent (also addressed as 'boundary setting') denotes, for example, the size of area under study or the time period considered. The second meaning of scale – *resolution* – is the amount of used details and can be interpreted as the precision of a measurement or assessment. Figuratively speaking, *"the extent determines the size of the 'window' to view the world, while the amount of detail…determines the smallest entities that can be seen in the study"* (João 2007, p. 483). Usually, the scale of any study is the interaction of its extent and resolution affecting each other. In principle, the more extent, the less details. The assessment that is carried out for a very large area or for a very long time period is unlikely to be highly detailed.

In addition to the appropriateness of selected spatial and/or temporal scales to its purpose, SEA decisions may directly affect the results of an assessment. Because of the 'scale effects', SEA outcomes vary according to the choice. Partidário (2007) expressed (Fig. 2.7) the multiplicity of scale context in impact assessment, depending on the nature and timing of decisions (from policies with broad long-term perspectives, through planning and programs, to site-specific short-term project decisions), as well as regarding to spatial dimensions, ranging from the global to site-specific realities. The multiple scales of world trends set the context for the operation of impact assessment in its broad sense, including SEA, EIA, sustainability and integrated assessment, etc. Different purposes for the assessments drive the difference in their relevant spatial and temporal scales.

Sometimes, as an alternative to multiscale analysis, the process of *tiering* is considered. Tiering means that the aspects of SEA carried out at one level (e.g., national or regional) do not necessarily need to be subsequently revisited at 'lower' levels. However, although tiering can potentially save time and resources, João (2007) emphasises its danger. Such a concept of avoiding duplication assumes existence of a single scale where analysis is sufficient to be representative. In reality, in most cases a multiscale analysis is

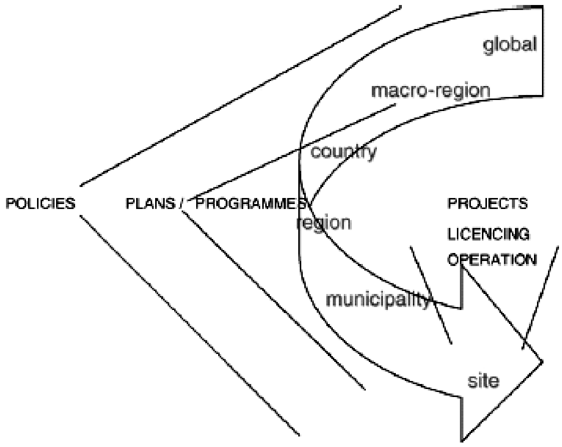


Fig. 2.7 Multiple scales and perspectives in impact assessment. *Source*: Partidário, 2007

needed and the same issue needs to be revisited at different tiers with different scales. Equally, the interaction and 'dialogue' between different tiers are unavoidable.

Partidário (2007) proposed two additional temporal scales that should be considered in SEA. The first is a *generational* time scale (across generations), measured in decades and centuries, that is caused by the fundamental premise of sustainable development. He considers this scale as crucial to ensure that future generations are within the scope of SEA. The generational time scale is relevant to expand the traditional for impact assessment temporal scales, usually associated with a PPP time horizon. The second proposed scale is *decisional* time scale that is relevant for strategic decision-making and is considered as one of the most critical scales to make SEA more effective and efficient in assisting this process. The decisional time scale may be measured in days, weeks, or months.

The selection of spatial and temporal scales, appropriate to the process or phenomenon being examined, is an important and challenging activity at the start of any SEA or policy analysis. The scale bounds "the types of problems to be addressed, the solutions to be found and the impacts to be evaluated" (Karstens *et al.*, 2007, p. 387). Environmental and human processes occur at their characteristic scales, over which the processes have their impacts, but these scales for physical and socio-political processes often do not match. Climate change is a good example of such non-matching processes. For instance, problems of adaptation arise when response process (such as the longevity of some plants) are much slower than driving ones (the changes in air temperature or precipitation regimes). Inter-generational equity problems arise for all processes with time scales greater than that of a human generation, and a large part of the consequences of today's activities will be 'inherited' by future generations (IPCC, 2001a).

Likewise, there are differing political and scientific perspectives on scale. Particular scale choices may be more or less beneficial to different actors and therefore are politically loaded. Karstens *et al.* (2007) give the following interpretation of this thesis. Political discussions are mainly action-oriented and strategic, whereas scientific discussions are knowledge-oriented and 'objective'. SEA and policy analysis studies, often characterized as rational research activities, are typically practiced in conjunction with decision-making processes, which exist on the borderline between politics and science, and therefore need contributions from both spheres. Political actors typically formulate questions, focusing an attention and action on problems. Scientists tend to analyze problems, generating alternatives and investigating their effects. The different orientations imply different perspectives on scale. The political actors involved in a study often influence the spatial boundary setting, and when their interests are different or even conflicting, the spatial boundary setting can become a 'strategic game'. The questions that arise are related to how these differences can be seen in practice.

2.1.5.2 Scale and data

Partidário (2007) explains the exclusion of policy and wider planning issues from EIA in their early days by the difficulties in ensuring sufficient data to satisfy the acceptable limits of uncertainty. *"Scale and data are interdependent—the more detailed the scale, the greater the expectation of more detailed data"*, – he stated (p. 460). Even if modern computers are fast enough to drive, e.g., climatic models with sufficient spatial resolution, we do not have nearly enough data with which to calibrate and initialize models effectively. The period of accurate data collection is relatively short, and the density of measuring stations is very low, especially in the oceans and the less developed world.

This barrier was partially overcome with the acceptance that SEA often needs to deal with higher levels of uncertainty and, consequently, with less data. "One key aspect of data in SEA, which partly sets it apart from project EIA, is the recognition that SEA can be done with missing data" (João (2007, p. 481). Others believe that strategic decision-making can be delayed until all relevant data is collected and the subsequent assessment completed.

Really, in SEA, it is not the data per se that matters, but what you need the data for. *"In the context of SEA what does 'data' mean?—Data means any element that enables you to respond to critical questions and to move on in assisting decision-making by reducing uncertainty"*, – Partidário (2007, p. 475) stated. On the other hand, João (2007, p. 481) argues "that in SEA the purpose is not to provide a detailed account of an existing situation that will enable resolving a problem, but to identify the problem and to understand why, and whether, the problem is a problem". On the whole, João considers the relation of data and scale topics to the SEA process in three ways. From a pragmatic point of view, data are essential as they are needed to carry out the assessment. From a quality perspective, the choice of 'appropriate' data and respective temporal/spatial scales determines different outcomes of SEA processes. In more philosophical terms, data issues are fundamental in terms of what the SEA process is about.

How much data are enough and what type of data is needed for SEA? Data collection needs to achieve the difficult balance between being swamped under too much data and collecting sufficient information necessary for decision-making purposes. Therefore, a sharp initial focus on understanding the problem, identifying driving forces and key issues must precede any massive data gathering. The issue is not only on the data relevance, but also on the decisional time scale for this particular data (João, 2007; Partidário, 2007). A common criterion for evaluating the quality of data (both quantitative and qualitative) is to determine if the data is 'fit for purpose' that means the necessity to determine their suitability in each case. In order to be able to do this, a quality report (so called 'metadata' or 'data about data') is normally required that can provide the basis for a user to decide if the data is good enough for the intended use. Other key data quality issues relate to uncertainty and accuracy, and how to handle them.

A few UK SEAs (Therivel and Ross, 2007) used an effective approach where the so-called "topic papers" related to specific receptors (climate change, biodiversity, etc.) bring together information on:

- PPPs that affect a specific receptor and the indicators, targets and thresholds set for this receptor;
- Baseline data on the topic and on the receptor, including information on trends and data gaps;
- Lists of data sources (useful for updating baseline information);
- Key issues and problems arising from the policy context, baseline review and any early consultations; and
- Possible management approaches that could be taken through the plan in question, and other plans, programmes and activities.

Thus, data and scale are not just technical matters but are fundamental for identifying and understanding the issues that SEA should address, or, in other words, to help define what SEA is about and for what purpose.

2.1.6 Evaluating environmental assessment systems

2.1.6.1 Environmental indicators

To clearly determine the environmental impacts (both positive and negative) of PPP, the objectives, targets and indicators need to be established.

Objectives and targets set aims and thresholds that should be taken into consideration to effectively assess the impact. Usually, an *objective* is a broad overarching theme that specifies the direction of change. A *target* is "…a quantitative value, which usually underpins …a policy objective" (EEA, 2005, p. 7). An *associated target* is more focused to the objective's different aspects and usually has a time deadline that should be met through the design and implementation of measures. It sets mandatory limits and/or thresholds used as a measure (a point or level) against which impacts may be assessed. The thresholds, being approached or exceeded, would trigger remedial actions to alleviate adverse impacts. Development of the objectives and targets promotes the establishment of data requirements to facilitate tracking progress towards their implementation that can be achieved using *indicators* (Donnelly *et al.,* 2006).

The appropriate environmental indicators have become a common assessment tool to allow making the informed judgments regarding PPP proposals. The European Environment Agency (EEA) defines an *indicator* as "a measure, generally quantitative, that can be used to illustrate and communicate complex phenomena simply, including trends and progress over time" (EEA, 2005, p. 7). The EEA also classifies its indicators according to a typology: descriptive (A), performance (B), eco-efficiency (C), policy effectiveness (D), and total welfare (E) indicators. Donnelly *et al.* (2007, p. 162) consider indicators as "measurable aspects of a project/environment/society that can be used to monitor its progress or direction". Consequently, they should be not only measurable, but also scientifically valid and capable to provide information for decision-making.

In particular, indicators are useful to describe the baseline situation, to track the achievements of objectives and targets, as well as to predict and monitor environmental impacts of the proposed plan or program (Donnelly *et al.,* 2006). In SEA they identify the changes in environmental quality resulting from PPP implementation and provide with information to address the SEA objectives and targets, and to demonstrate whether they are being achieved. One of the key functions of an indicator is to illustrate and communicate impacts in a simple and effective manner by reducing the volume and complexity of environmental data and information required by decision-makers and needed for processing. *"It is not necessary for the decision maker to know the detail behind these indices but it is the job of the indicator to relay this complex information in an accurate and understandable manner in order for informed decisions to be taken"*, – concluded Donnelly *et al.* (2007, p. 162).

Thus, indicators are a useful tool for prioritizing which environmental information is most pertinent to a specific plan or environmental receptor and should be selected when the potential environmental impacts have been identified. Predictions about their future behavior, in the case of proposals approving, can then inform decision-makers as well as stakeholders about the future state of the environment (Sánchez and Hacking, 2002). The poorly chosen objectives/indicators would lead to a biased or limited SEA process. The identification of SEA objectives and indicators also depends on the scale of the study (João, 2007).

To address specific environmental issues, numerous sets of indicators have been developed. The most known are the OECD (2004)[15] and EEA (2005) core sets. These and other sets have different selection criteria and may cover different geographical areas (although sometimes with some overlapping) that hampers the use of certain set for another purpose (Donnelly *et al.,* 2007). For example, Box 2.4 presents the sets of criteria that were used to develop climate change indicators for Ireland.

Based on Ireland's experience, Donnelly *et al.* (2007) stated that available indicators (e.g., those of EEA, OECD) do not cover all sectors or all environmental receptors required under the SEA Directive, mainly because their criteria did not fit SEA purposes, and it may not be always feasible for the straightforward transfer of currently available data to SEA. There is a need to develop environmental indicators specifically for the SEA process, which should be accompanied by an associated set of criteria to ensure that indicators are fit for an intended purpose. Table 2.3 presents one list of suitable criteria for SEA indicators selection that was developed by a multidisciplinary team in the special workshop framework. This set is based on criteria widely used both nationally and internationally, while at the same time accommodating SEA needs and requirements. However, much of the work on environmental indicators for SEA remains in a theoretical or discussion stage.

Box 2.4 Criteria for development of climate change indicators in Ireland

Be representative of environmental condition
Be easily interpreted and *show* trends over time
Be responsive to change
Be comparable internationally and based on international standards
Be national in scope or applicable to regional environmental issues
Have a reference value against which comparisons can be made
Be well founded in technical and scientific terms
Be linked to forecasting and information models
Be high quality, well documented and updated regularly
Be readily available at a reasonable cost.

Source: Sweeney J., A. Donnelly, L. McElwain, M. Jones, 2002: *Climate change: indicators for Ireland*. Environmental Protection Agency. Ireland: Wexford, p. 54

[15] OECD, 2004: *OECD key environmental indicators*. OECD Publications, Paris, 38 pp.

Table 2.3 List of criteria for SEA indicator selection

Criteria	*Brief description*
Policy relevant	Consistent with significant legislation already in existence
Cover a range of environmental receptors	The data gathered should provide information that extends beyond that which is being measured
Relevant to the plan	Plan specific environmental impacts should be detectable
Shows trends	Responsive to change, measurable, capable of being updated regularly, demonstrates progress towards a target
Understandable	Ability to communicate information to a level appropriate for making policy decisions and to the general public
Well founded in technical and scientific terms	Data should be supported by sound collection methodologies, clearly defined, easily reproduced, and cost effective
Prioritize key issues and provide early warning	Identifies areas most at risk of damage. Provide early warning of potential problems before it is too late
Adaptable	Emphasis can change at different stages of the plan
Identify conflict	With plan objectives in order that alternatives may be explored

Source: Donnelly *et al.,* 2007

2.1.6.2 Effectiveness and effectivity of environmental assessment

Undoubtedly, any environmental assessment, especially SEA, can play a significant role in enhancing the integration of environmental considerations in policy and planning processes. So, Partidário and Clark (2000) see general benefits of SEA in that it can help decision makers by achieving environmentally sound and sustainable development, by strengthening PPP processes, saving time, efforts and money by avoiding costly mistakes; EA improves also good governance and builds public trust and confidence in decision making. Dusik *et al.* (2001) added to these benefits the promotion to integrated environmental decision-making and public participation in environmental policy making, the account of cumulative effects and global change, etc.

However, all these considerations, being essentially true, are somewhat declarative, and the widespread experience of EA as an anticipatory tool in environmental decision-making has generated a considerable debate over the extent to which it is achieving its purposes. In other words, there are debates about its effectiveness, especially after the discussion has moved away from procedural implementation issues to the more substantive EA goals and its place within broader decision-making contexts. In the comprehensive retrospect of EIA experience, Jay *et al.* (2007, p. 298) state growing dissatisfaction over the fact that EIA influence on development decisions is “relatively limited and it appears to be falling short of its full potential”. Such a relatively weak degree of EIA efficiency Jay and co-authors attributed to its rationalist beginnings and therefore tried to direct the debate towards founding political purposes of EIA as a basis for reforms.

As concerns SEA, proceeding from UK experience, Thérivel and Minas (2002) identified four factors that could contribute to its effectiveness[16]: who carries it out; when it is carried out; the amount of time/resources spent on it; how it is documented. Detailed performance criteria for SEA (Box 2.5) have been developed by IAIA[17]; they were also included in SEA Sourcebook and Reference Guide (Dalal-Clayton and Sadler, 2005). According to these criteria, a good-quality SEA process should inform planner, decision-maker and affected public on the sustainability of strategic decisions, facilitate the search

Box 2.5 Performance Criteria for SEA

A good-quality SEA process is:

integrated:

- ensures an appropriate environmental assessment of all strategic decisions relevant for the achievement of sustainable development;
- addresses the inter-relationships of biophysical, social and economic aspects; and
- is tiered to policies in relevant sectors and (transboundary) regions and, where appropriate, to project EIA and decision-making.

sustainability-led:

- facilitates identification of development options and alternative proposals that are more sustainable, i.e. contributes to the overall sustainable development strategy as laid down in Rio 1992 and defined in the specific policies or value of a country.

focused:

- provides sufficient, reliable and usable information for development planning and decision-making;
- concentrates on key issues of sustainable development;
- is customized to the characteristics of the decision-making process; and
- is cost and time effective.

accountable:

- is the responsibility of the leading agencies for the strategic decision to be taken;
- is carried out with professionalism, rigor, fairness, impartiality and balance;
- is subject to independent checks and verification; and
- documents and justifies how sustainability issues were taken into account in decision-making.

participative:

- informs and involves interested and affected public and government bodies throughout the decision making process;
- explicitly addresses their inputs and concerns in documentation and decision-making; and
- has clear, easily-understood information requirements and ensures sufficient access to all relevant information.

iterative:

- ensures availability of the assessment results early enough to influence the decision-making process and inspire future planning;
- provides sufficient information on the actual impacts of implementing a strategic decision, to judge whether this decision should be amended and to provide a basis for future decisions.

Source: Adapted from IAIA (2002)

[16] Thérivel and Minas (2002) used SEA as an overarching term for all approaches that aim to integrate environmental or sustainability considerations into strategic decision-making, thus encompassing the requirements of Directive 2001/42/EC, environmental appraisal and sustainability appraisal

[17] IAIA, 2002: *Strategic Environmental Assessment: Performance Criteria*. Special Publication Series No. 1, International Association for Impact Assessment (*www.iaia.org/publications*)

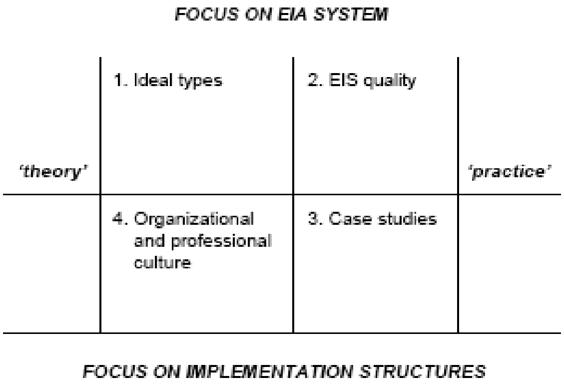


Fig. 2.8 A categorization system for approaches to Environmental Impact Assessment *(EIA)* evaluation. *Source*: Emmelin, 1998

for the best alternative, and ensure a democratic decision-making process.

Emmelin (1998)[18] proposed a concept of EIA evaluation that included four categories formed around two dimensions (Fig. 2.8).

The first dimension is based on a distinction between the structures of EIA systems and the structures of implementation. This idea divides attempts to evaluate EIAs, which are focused on the design of the administrative *process,* from those focused on *outcomes* (evaluating the impact that EIA had on actual environmental performance). The second dimension is based on a distinction between theory and practice. On the whole, this two-dimensional categorization system distinguishes four different types, or categories, of EIA evaluation:

- ***Category 1*** consists of approaches that focus on EIA system design from an administrative process point of view that establish evaluation criteria based on one or more 'ideal types'.
- ***Category 2*** consists of *ex ante* evaluations of EIA documentation against ideal type criteria for 'good' documents, or 'good' practice.
- ***Category 3*** focuses on the practical implementation of EIA when implementation tends to be measured by means of case study surveys, with a specific interest in 'effectiveness'.
- ***Category 4*** includes those that attempt to understand the functioning of EIA, and the quality of processes and documents, in the context of organizational and professional culture.

This scheme suggests that researchers can make choices about the approach to EIA system evaluation. All choices are equally valid, but arguably should be explicit and targeted according to desired outcomes.

Annandale (2001) applied the set of EIA system evaluation criteria to an existing impact assessment administrative process in the Republic of Maldives – a case of a small developing country. The analysis led him to the conclusion that there is perhaps a set of 'core' criteria that must be met for any EIA system to work but also there may be additional criteria that are especially appropriate and important for small developing countries. He suggested to include into the list of required 'core' criteria the following ones:

- the existence of legal and administrative backing for the EIA system;

[18] Emmelin L., 1998: Evaluating environmental impact assessment systems — part 1: Theoretical and methodological considerations", *Scandinavian Housing and Planning Research,* **15**:129–148

- the involvement of regulators in the establishment of 'scoping' guidelines;
- the existence of a transparent government decision-making and approvals stage; and
- adequate administrative support and a viable private consulting sector.

The additional criteria are based on a philosophy of incremental improvement that is most appropriate for countries that tend to be under-resourced. The suggested criteria are:

- the importance of gradual development over time of a formal legal/administrative structure for EIA;
- the *ad hoc* application of EIA requirements working in parallel with the development of a structured legal/administrative system;
- the importance of a strong link between revision and improvement of the EIA systems and other areas of policy development, particularly with those relating to national economic development and the approval of new projects;
- necessity for regular involvement of proponents (public and private) and NGOs in the ongoing revision and strengthening of EIA systems; and
- the importance of maintaining an iterative and 'continuous improvement' philosophy.

Usually, in practice, EA impacts are evaluated against the background of what would happen without EA, but also against their potential scope for improvement. The evaluation intends to determine how much difference the assessment is making – a question that can be addressed with reference to its underlying purposes (Jay *et al.,* 2007). So, Thérivel and Minas (2002) proposed to test whether the post-SEA plan achieves a range of agreed sustainability targets and used changes to the plan resulting from SEA as an indicator of its effectiveness. To get to such changes, several conditions or stages are necessary. The authors have illustrated their proposal by the scheme of an affective appraisal (Fig. 2.9).

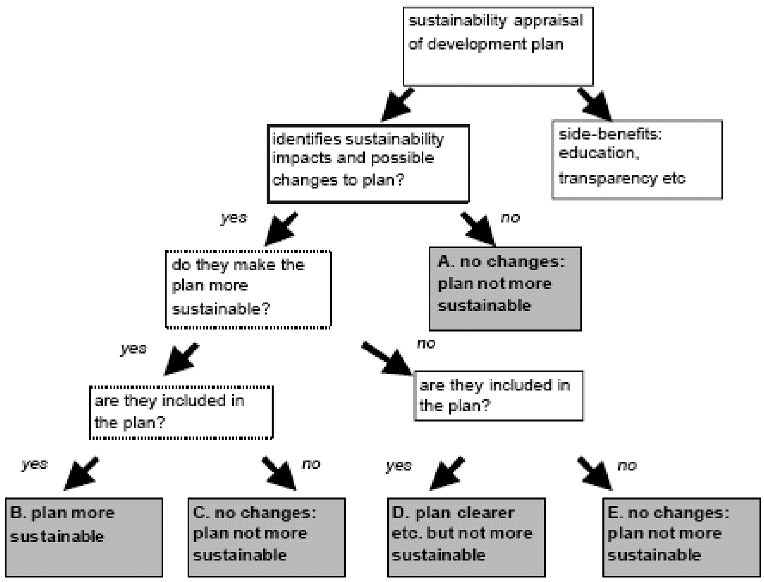


Fig. 2.9 The route of effective appraisal of development plans. *Source:* Thérivel and Minas, 2002

According to this scheme, *first of all* any SEA has to identify the sustainability or environmental ramifications of implementing the strategic action and to suggest possible changes to the action where these ramifications are negative. Such changes could present simple amendments, clarifications or improvements to internal consistency, or else more radical changes requiring a new approach to the strategic action. When the SEA is carried out as an integral part of the development of the strategic action, it may be difficult to distinguish the changes made as a result of the appraisal from those made as a result of the normal plan-making process.

Secondly, the changes have to make the strategic action more sustainable or environmentally benign. Since SEA highlights environmental or sustainability ramifications, subsequent changes to the strategic action could be expected to incorporate these concerns, although it is possible that this assessment may identify changes that improve the plan but do not necessarily improve the sustainability or environmental aspects of the strategic action.

Thirdly, the changes have to be incorporated in the strategic action.

Even when the strategic action remains unchanged after the SEA, the latter may still be useful because it has "indirect outcomes" or "side-benefit" and thus may provide more ideas for the next round of decision-making.

2.1.7 Future directions and ways forward

2.1.7.1 Strengthening and improving environmental assessment

A range of specific measures has been recommended to strengthen environment assessment systems and many of them have been adopted over the years (Jay *et al*. 2007; Dalal-Clayton and Sadler, 2005; Cherp and Antipas, 2003).

As for EIA, Jay *et al*. (2007) emphasize the following moments:

1. The measures on EIA strengthening have generally focused on introducing or bolstering appropriate procedural requirements, underpinned by capacity building measures related to guidance, training and research. The formal mechanisms have also been made, such as linkage with environmental management systems that ensure 'follow-up' of EIA in relation to individual projects.
2. Focusing the attention on the decision-making context itself suggests that EIA should be more closely adapted to the processes that it seeks to influence. Studies on effectiveness also suggest that EIA already relates to decision making in more indirect ways, implying that it is yielding more far-reaching benefits than those simply associated with specific project decisions.
3. The continuing aspiration that EIA should contribute to the wider endeavor of bringing about sustainable development has provided it with the most strategic sense of purpose, although this has not been always translated clearly into EIA frameworks, principles or methodologies. Setting about this task, or ensuring that EIA is linked to clear 'environmentally sustainable development' objectives, would promote re-establishing the EIA founding purposes, giving it a more determinative position in project planning processes.

As to the further development of SEA, Dalal-Clayton and Sadler (2005) see three inter-related avenues that differ in their principal focuses:

→ *environmental focus* – strengthening existing SEA arrangements and approaches as mechanisms for environmental sustainability assessment and assurance;
→ *sustainability focus* – utilizing SEA as a component or means of integrated assessment of the effects of PPP proposals in relation to the environmental, social and economic objectives of sustainable development;
→ *convergence focus* – promoting the convergence of SEA within integrated assessment and planning systems for sustainable development.

These authors also defined three main building blocks for improving SEA quality and effectiveness (Table 2.4):

- Strengthening the institutional arrangements that serve as quality 'controls'. At a minimum, these include procedural requirements and guidance to ensure compliance and consistency of implementation – 'basics' that are lacking even in some well-established SEA systems;
- Undertaking the reviews of SEA effectiveness and performance, using a systematic framework and criteria to evaluate the lessons of practical experience ('learning by doing');
- Promoting the SEA good practice through benchmarking standards and measures for carrying out the process and main activities.

Table 2.4 Elements of review of SEA quality and effectiveness

Main element	*Primary function*	*Components*
Policy or plan monitoring & environmental management	Implementation and intervention	Tracking plan or policy implementation against objectives Monitoring environmental effects and measures Management actions as necessary
Effectiveness & performance review	Learning and process improvement	Evaluating the contribution of SEA in policy or plan preparation Review of quality of SEA information Audit of SEA process and procedure Identifying environmental outcomes of policy and plan implementation
Benchmarking & reporting EIA good practice	Setting and improving standards	Drawing lessons of experience Identifying the elements of good practice SEA principles, performance criteria and step-by-step guidance

Source: Dalal-Clayton and Sadler, 2005

One more conclusion of Dalal-Clayton and Sadler (2005) concerns the future development of SEA principles, nature and scope that can be summarized as follows:

- "The prevailing view of SEA is as a formal instrument instituted through legal or administrative arrangements established by developed countries" (p. 299). Accordingly, many normative definitions are derived from this paradigm and elaborated in terms of procedural features and characteristics.
- The commonly accepted model of SEA also appears to be promoted internationally through SEA capacity-building and training. But often there is no critical perspective on its application in developing countries (*possibly in transition countries as well*[19]) where some elements of this approach may be reflected partially or incompletely in policy- or plan-making.
- The key principle of SEA – "it should be fit-for purpose, adapted to the context and circumstances of countries and their political culture and institutional arrangements" – may need to be reconsidered and possibly replaced in developing (*transition*) countries by a more pragmatic, needs-driven strategy that builds on and improves existing policy and planning processes in these countries.

Based on such preconditions, Dalal-Clayton and Sadler (p. 300-301) represent their re-interpretation of the nature and scope of the SEA field. Because these views are not necessarily widely or fully accepted by the others, they are given here as only one vision of the future of this problem:

- "The development and implementation of SEA systems and elements represents the most striking trend in impact assessment during the past decade, although its dimensions may not be fully appreciated.
- SEA comprises a family of processes and tools that, individually and collectively, are being applied to new aspects and areas, leading to continued extensions of the field that have procedural and methodological implications.
- The emergence of SEA symbolizes and forms part of a more fundamental and potentially far-reaching change in approach – one that integrates the environment into the policy and planning mainstream in support of sustainable development".

2.1.7.2 Integrated Environmental Assessment

Over the past decades *Integrated Environmental Assessment (IEA)* has emerged as an approach to link knowledge and action in a way that is suitable to accommodate uncertainties, complexities and value diversities of global environmental risks (Kloprogge and van Der Sluijs, 2006). As an umbrella concept for multidisciplinary analysis of environmental problems with the explicit objective to support policymaking, IEA accommodates the wide variety of perspectives, represents the diverging and often contradicting interests of the affected stakeholders and can be regarded as the culmination of a multi-decade evolution in environmental sciences and policy (Toth, 2003c). The principle that *'the sum of parts does not equal the whole'* is now widely acknowledged, and the integration creates in fact a new entity where new relationships are established. The individual entities, which have specific characteristics and specific dynamics, act in a different way when combined. *"Integration has become a favored means of increasing the effectiveness of environmental assessment and social and economic appraisal in decision*

[19] In *italics* here and below is added (R.C.)

making in order to promote sustainable development," – Eggenberger and Partidário (2000, p. 204) believe.

SEA, in its various forms, is an important step towards integrated decision-making through promotion sustainable development by assessing the strengths, weaknesses and therefore the potential of environmental resources. Sustainability appraisal will be difficult to implement for many countries where capacities are limited and institutional pre-conditions are missing, and any further progress at this front is also related to the extent to which different levels of integration are in place (Dalal-Clayton and Sadler, 2005).

IEA activities typically draw on a range of scientific disciplines that provide a large array of complex information of different kinds and degrees of uncertainty. Many tools have been developed to tally and consolidate the relevant information, to package it into different analytical frameworks, and to present the results to those responsible for making the decisions. As an example, F. Toth (2003c), analyzing IEA state of the art at that time, listed two different visions of the problems, which we would like to repeat as they cited by the author and without details of his references. In the first case, Tol and Vellinga proposed a wide version encompassing the general scheme of integrated assessment: structuring the problem, its analysis by modeling or participation, and communication of the results. Rotmans's concept of IEA emphasizes the double objective providing with (i) adequate characterization of complex interactions and feedbacks, and (ii) support for public decision making. He also specified two groups of methods: analytical (embracing models, scenarios, and risk analysis), and participatory (including dialogue methods, policy exercises, and mutual learning methods).

Eggenberger and Partidário (2000) identified five different forms of integration when dealing with environmental, social and economic issues in spatial planning that aims to allocate different land-use functions and activities as efficiently and effectively as possible, thus maximizing the 'benefits/profits' at a given location (Box 2.6).

According to the more recent work of Lee (2006), the *integrated assessment* covers three types of integration:

- *Vertical integration of assessments,* i.e. linking together separate impact assessments, which are undertaken at different stages in the policy, planning and project cycle (hereafter, the planning cycle);
- *Horizontal integration of assessments,* i.e. bringing together different types of impacts – economic, environmental and social – into a single, overall assessment at one or more stages in the planning cycle. It may also involve horizontal co-ordination between contemporaneous assessments for separate, but inter-related, planning cycles. Some have called this integration *substantive* (Dalal-Clayton and Sadler, 2005);
- *Integration of assessments into decision-making,* i.e. integrating assessment findings into different decision-making stages in the planning cycle with the main focus on strategic PPP level, sometimes called *process integration* (Dalal-Clayton and Sadler, 2005).

Additionally to these very general statements, integrated assessment as a concept includes a lot of special applications. Some of them that develop IEA as a whole are discussed below; those concerning climate change issues will be highlighted mainly in the following chapters.

Box 2.6 Forms of integration in environmental assessment

Substantive
- integration of physical or biophysical issues with social and economic issues
- integration of emerging issues such as health, risks, bio-diversity, climate change and so on
- appropriate integration of global and local issues

Methodological
- integration of environmental, economic and social impact assessment approaches such as cumulative assessment, risk assessment, technological assessment, cost/benefit analysis, multi-criteria analysis
- integration of the different applications and experiences with the use of particular tools such as geographical information system (GIS)
- integration and clarification of (sector) terminologies (including the element of ‘strategic’)

Procedural
- integration of environmental, social, economic planning/assessment, spatial planning and EIA
- integration of sector approval/licensing processes, spatial planning and EIA
- adoption of co-ordination, co-operation and subsidiarity as guiding principles for (governmental) planning at different levels of decision making
- integration of affected stakeholders (public and private organizations, NGOs) in the decision-making process
- integration of professionals in a truly interdisciplinary team

Institutional
- provision of capacities to cope with the emerging issues and duties
- definition of a governmental organization to ensure integration
- exchange of information and possibilities of interventions between different sectors
- definition of leading and participating agencies and their respective duties and responsibilities

Policy
- integration of ‘sustainable development’ as overall guiding principle in planning and EIA
- integration of sector regulations
- integration of sector strategies
- timing and provisions for political interventions
- accountability of government

Source: Eggenberger and Partidário, 2000

Integrated/sustainability impact assessment

Sustainable development mechanisms are often driven by the need to integrate the environment into decision-making processes. Sheate *et al.* (2003) consider ‘sustainability appraisal’ and ‘integrated impact assessment’ covering social, economic and environmental aspects as just two examples of terms used to describe the strategic assessment that goes beyond SEA.

Lee (2006) also noted growing support for the use of joint integrated assessments and sustainability impact assessments (IAs/SIAs) at different government levels and geographic scales of policy-making and planning, both nationally and internationally. However, to deliver the good quality of IAs/SIAs could be challenging in the near future. The main areas of concern are differences between research and other technical contributions intended to strengthen assessment methodologies and the types of assessment methods that are considered usable by practitioners. To help in addressing this concern, Lee (2006) proposed to develop a common assessment framework, which is based on a shared, practitioner–researcher–stakeholder understanding of what constitutes a satisfactory *integrated/sustainability* impact assessment.

The developed IA/SIA framework contains three inter-related components (Fig. 2.10):

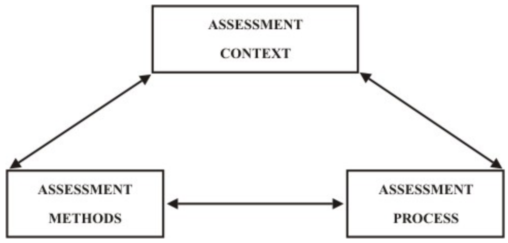


Fig. 2.10 Common *integrated/sustainability impact* assessment framework. *Source:* Lee, 2006

- the planning and assessment context within which the IA/SIA is to be undertaken;
- the technical and consultative methods by which the impacts are to be assessed;
- the process by which the assessment is to be undertaken and used for policy-planning and decision-making purposes.

IAs/SIAs should start, preferably, at or near the beginning of planning, then transforming into an ongoing activity that helps to shape the development of the PPP at each decision point in the planning process. An assessment process commences with a brief, collective attempt to identify the key contextual conditions, which may need to be taken into account in shaping the assessment and the methodology to be used. Some of this basic information may be used again at subsequent stages, serving as a continuing "reality check" during the remainder of the assessment process. The types of information, to be considered, Lee grouped into three categories:

- the regulatory and institutional context within which the assessment is to be undertaken;
- the characteristics of the PPP to be assessed;
- the resources available for the completion of the assessment.

Information provided under the first two bullets can be used to form a first impression of the likely nature, duration, potential scope, level of detail and complexity of the work to be undertaken under the assessment. The third heading of information should indicate the types and scale of resources to be likely available to complete the assessment. A comparison between the two sets of information provides first opportunity for a 'reality check' in developing a shared understanding of how the assessment may be best undertaken.

Participatory Integrated Assessment and public involvement

In its traditional form the integrated assessment involves a group of experts representing all scientific disciplines relevant for a specific policy problem. As such it remains an interdisciplinary effort. Toth (2003c, p. 261) has formulated the following general criteria for success in an interdisciplinary research:

→ there must be a shared research aspiration for the assessment team as a whole;
→ team members should respect each other's disciplinary expertise to ensure an inspiring and effective group dynamics atmosphere;

- → the contribution of each team member should have value for its own disciplinary progress;
- → the more general criteria for IA success include value for society and policy making;
- → it is helpful to locate the IA activity at recognized host institutions or around an acknowledged personality.

As some additional considerations more specific to IAs, F. Toth proposed to consider their ongoing activity or process at least as important as the product. The objective of such approach is to improve understanding rather than pursuing the right decision. He based this conclusion on a few reasons explaining why progress in participatory integrated assessments (PIAs) and in their applications had been slow and lagging noticeably behind IA modeling. The reasons were:

1) *PIAs are needed with a client.* A meaningful PIA is inconceivable and cannot really work without a clearly identified client that is often an 'impediment.' The client must be able to define the content, have confidence in tools to be used to explore the content, and be convinced of the usefulness of the participatory exercise in the sense that tools are suitable to improve the content by participation.
2) *PIAs are time consuming* for some possible redesign and retrofitting thorough preparations, post-processing activities, and so on.
3) *PIAs should be repetitive* because very few complex policy issues requiring participation of the affected stakeholders can be resolved in one round of the assessment process.
4) *PIAs are expensive*. Even if they can incorporate or build upon existing datasets, models, and other information sources, a considerable investment is needed for their preparing.

An integral part of the SEA process is also *public participation* or *public involvement* in decision-making. It should not be seen simply as an additional source of data or as a means of educating impacted communities, but as a mechanism to strengthen inductive reasoning through using the multiple data sources and public debate about conclusions (Lockie, 2001). If the environment is to be considered at the early stage of decision making, it is important that a responsibility for doing this resides in the bodies directly responsible for the decisions that may cause environmental harm. By requiring a public body to consider the potential environmental effects of its decisions, SEA provides a structured mechanism to enable them to do just that. This differs from, and is often more effective than, approaches relying on environmental departments that duty-bound to intervene in the activities of others (Hamblin, 1999).

Lee (2006, p. 73) indicated a number of challenges relating to the effective consultation and participation that public, other stakeholders and technical experts should face in an assessment process:

- ✓ how the general public, as well as a wide range of business, social and environmental interests can be effectively involved in consultation and participation;
- ✓ an appropriate role for a multi-stakeholder assessment group in relation to the specific tasks to be performed at different stages in the assessment process;
- ✓ an effective method of group working and reporting.

Integration of social and environmental impact assessment

The integration of environmental and social aspects of impact assessment is an apparent need. A vacuum still remains at the national level for linking environmental protection to social investment, such as education, better health care, and employment generation for the poor. There are also widespread social trends, intrinsically linked to the environmental trends, notably (UNDP, 1997):

- an increase in inequality within nation in a world that is generally healthier and wealthier; the increasing gap between rich and poor;
- a continuation, at least in the near future, of hunger and poverty;
- greater human health risks resulting from continued resource degradation and chemical pollution.

However, despite the fact that a necessity to address social impacts has been acknowledged since the earliest institutionalization of impact assessment (NEPA, 1969) the social impact assessment (SIA) has remained something of a 'poorer cousin', or 'orphan' in practice (Burdge, 2002), being either straightforward or something that follows the assessment of environmental impacts. Long time the worlds of environmental impact assessment (in its strict sense), social impact assessment as well as economic cost–benefit analysis have operated as separate entities in their separate realms (Slootweg *et al*., 2001). The experience shows that SIA must take a significantly more prominent role in setting the agenda for and in expanding all aspects of impact assessment, "not merely colonizing the space currently occupied by environmental, ecological, economic, or any other form of impacts" (Lockie 2001, p. 278).

The US Interorganizational Committee on Guidelines and Principles for Social Impact Assessment[20] defined *social impacts* as "The consequences to human populations of any public or private actions that alter the ways in which people live, work, play, relate to one another, organize to meet their needs and generally cope as members of society. The term also includes cultural impacts involving changes to the norms, values, and beliefs that guide and rationalize their cognition of themselves and their society". This definition is generally recognized among SIA practitioners (Burdge *et al*., 1995; Slootweg *et al.,* 2001).

By *social impact assessment,* Burdge (2002, p. 5) means *"…the systematic analysis, in advance, of the likely impacts a proposed action will have on the day-to-day life of individuals and communities"*. The Interorganizational Committee (1994, p. 1) extends SIA's meaning to include *"…efforts to assess or estimate, in advance, the social consequences that are likely to follow from specific policy actions…and specific government actions…particularly in the context of the US NEPA"*. So, SIA aims to help individuals and communities, as well as to government and private-sector organizations, to understand and better anticipate the possible social consequences of proposed development projects or policy changes.

---

[20] Interorganizational Committee on Guidelines and Principles for Social Impact Assessment, 1994: *Guidelines and Principles for Social Impact Assessment.* US Dept Commerce, NOAA Tech Memo NMFS-F/SPO-16. Available at: *http://www.st.nmfs.gov/tm/spo/spo16.pdf.* Also: Burdge *et al.* (1995)

A *social assessment* (SA), as it relates to environmental assessment (EA), is a preliminary tool in determining whether a full-scale SIA is needed.

Burdge (2002) listed some reasons why SIA had not been widely adopted as a component of the assessment process for project or policy appraisal and, consequently, in the environmental and natural resource decision-making. Among the reasons he has noted minimal consensus as to the definition and even the label for SIA, and little agreement on the relationships between SIA and EIA. There were also some questions that needed answers: (1) When is SIA required, what are its origins, and why is its importance foremost? (2) Is there a body of research findings that might direct the practitioner managing the SIA of a proposed action? If this body exists, is there a conceptual framework to guide the research and advance the accumulation of findings about social impacts? (3) What should be included when doing a SIA?

Lockie (2001) made a somewhat crude categorization on the question of how successful social impact assessors have been in predicting social impacts. In particular, those authors who believe that SIA has developed adequate tools of prediction tend to be less committed to the notion of prediction for its own sake; those critical of SIA's predictive power tend to be rather more committed to a technocratic vision for impact assessment. In demarcating the SIA approach from the more technocratic ones, the public involvement is particularly important (Box 2.7).

Integrating biophysical and social settings

Human and biophysical systems are coupled: human actions affect biophysical systems; biophysical forces affect human well-being, and humans respond in turn to these forces. Efforts to understand basic properties and processes of natural systems without regard to anthropogenic drivers and, moreover, the management of human systems without regard for the role of underlying biophysical systems cannot succeed in the long run. Because the two sides of coupled systems are highly interactive, one cannot explain, and much less predict, the behavior of these systems without treating both sides as endogenous. Kotchen and Young (2007) characterize this approach as *general equilibrium analysis,* treating the

Box 2.7 Public involvement in social impact assessment

A public dimension should be included in the SIA to ensure that:

- the entire impact assessment process may incorporate local knowledge about social conditions, processes and likely impacts;
- attitudes and perceptions towards proposed change as well as appropriate mechanisms to involve different groups in the decision-making process may be identified;
- subjective and cultural impacts that relate to the ways in which people construct (that is, understand or conceptualize) their social and natural environment, and their own place within them, may be identified;
- the stage of project design the outcomes of the SIA and the views of the public may be incorporated and used to maximize benefits rather than simply to compensate the losers following implementation;
- potential alternatives may be identified and adequately assessed;
- conflicts over projects may be minimized by considering as many interests as possible in decisions and putting in place the appropriate mitigation strategies.

Source: Lockie, 2001

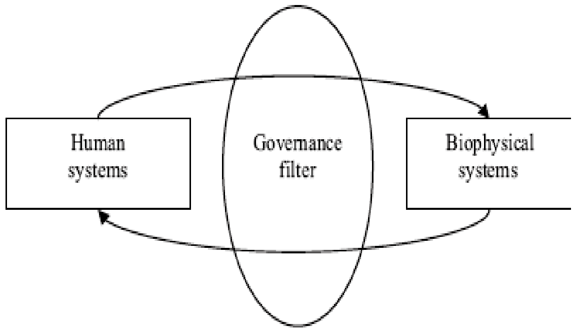


Fig. 2.11 Coupled human-biophysical systems. *Source:* Kotchen and Young, 2007

role of governance systems as institutional filters mediating between human actions and biophysical processses (Fig. 2.11). The governance filter consists of the sets of rights, rules, and decision-making procedures that are created by humans to guide actions, including those that may have disruptive impacts on biophysical systems (e.g., GHG emissions). "The emerging challenge is the demand for governance that can manage both of these relationships simultaneously. Rights and rules can be both part of the problem and part of the solution in managing coupled human–biophysical systems" (*ibid,* p. 150).

The SIA and EIA integration demands the thorough understanding of all biophysical and social changes invoked by a planned intervention. Slootweg *et al.* (2001) presented the conceptual framework that aims to provide insight into the relations between human society and the biophysical environment. The focus of this conceptualization is the characterization and classification of the functions provided by the biophysical environment and the assessment of their value for supporting human activities. The framework is based on the so-called conception of '*function evaluation'* of nature.

The starting point of this approach is the conception of consumption by the society of products and services provided by the biophysical environment. In economic terms this means that the society constitutes the demand side, while the environment is the supply side (Fig. 2.12). Equilibrium in supply and demand maintains sustainability. Perceived imbalances in this equilibrium trigger institutions to act by managing either the supply from nature or the demand from society.

In the proposed 'construction' Slootweg *et al.* (2001) identified three main settings and evaluated their functions.

The natural environment, or ***biophysical setting,*** comprises a combination of living and non-living resources and their interactions with functions to provide goods and services, which are used by human society. Four categories of environmental functions include production, processing and regulation, carrying and signification. *Production functions* refer to the ability of the natural environment to generate useful products; a distinction is made between natural production functions and nature-based human production functions. *Processing and regulation functions* relate to the maintenance of ecosystem support systems; *carrying functions* – to space or a substrate that is suitable for certain activities and for which there may be a demand. *Signification functions* refer to the social values that are ascribed to nature itself and to the features of its landscapes. The difference between the 'classical' approach to describe nature in terms of natural resources (water, soil, forest, and so on) and the function evaluation is that the latter provides much more insight into the multi-functionality of resources.

Human society, or ***social setting,*** encompasses all human activities, knowledge, beliefs and values. As a result of human activities and social values, environmental goods

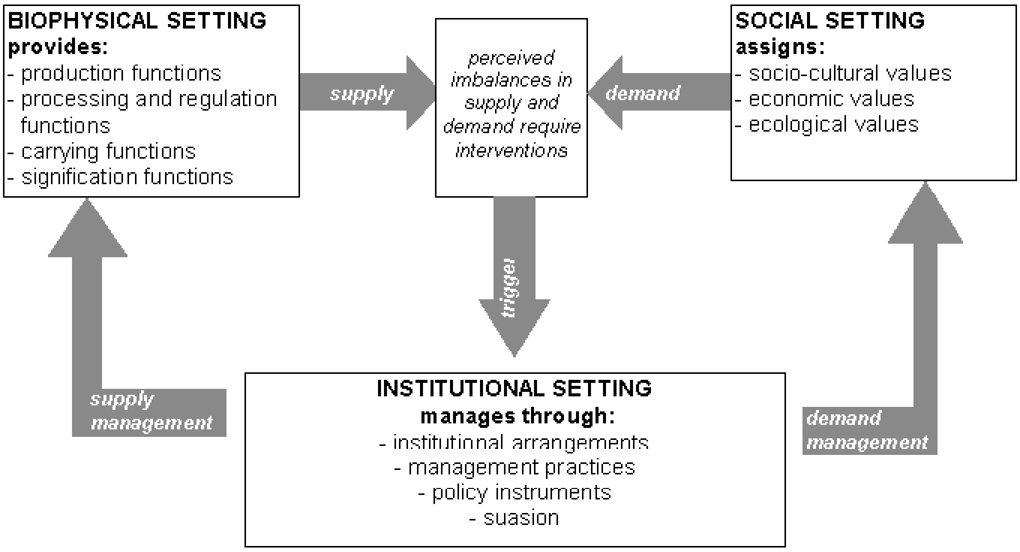


Fig. 2.12 The 'Brown' significance matrix. *Source:* Brown, 1995

and services – the functions of the biophysical environment – are valued in a social context. The social setting creates the demand for environmental goods and services, thus determining their perceived value for humanity. From three broad categories of values the *social values* refer to the quality of life in general, being expressed depending on the social context and cultural background of a society; the *economic value* refers to the monetary value of goods and services that are provided by the environment; the *ecological value* is the value that society places/derives from the maintenance of the earth's life support systems.

The ***institutional setting*** includes the institutional arrangements, management practices, policy instruments and other components that constitute the institutions as a concept.

The need for actions is triggered by a perceived disequilibrium in the relation between supply and demand. So, surpassing the available nature supply by demands for good and service may create current or future problems. The opposite situation when some of the natural environment functions are not in use represents a development opportunity. Both problems and opportunities may trigger corresponding initiatives from policy or decision makers that are realized through institutional setting. Their institutional arrangements, policy instruments and management practices will try to solve the problem or benefit from the development opportunity. This intervention either works via the side of the biophysical setting by managing the supply of environmental goods and services (provision of agriculture, forestry, hydraulic engineering, etc), or via the side of the social setting by managing the demand for goods and services (through tax incentives, setting of quota, trade negotiations, etc.).

Undoubtedly, the biophysical impacts also have social impacts, and social changes can cause changes in the biophysical environment, creating biophysical impacts. Slootweg *et al.* (2001) proposed their interpretation of this process.

First of all, the authors introduced the word *human* instead of *social* to avoid semantic discussions on what should be considered *social impacts*. *Human impacts* are the real and perceived impacts experienced by humans (at individual and higher aggregation levels) as a result of the biophysical and/or social change processes caused by planned interventions. As such, human impacts "encompass all final impact variables that are studied in environmental impact assessments, social impact assessments, health impact assessments, and even biodiversity impacts assessments given that the maintenance of biological diversity (a function of nature) is currently valued by society (as an ecological value) to guarantee the livelihoods of future generations" (p. 24).

The social setting can be influenced by interventions through two pathways: indirect and direct. Indirect human impacts result from changes in the natural resource base and the derived functions, that is, from biophysical impacts. The latter, being expressed in terms of changes in the products and services provided by the environment, can consequently affect the values of these functions for human society. Changes in the functions of nature lead to changes in the values assigned to nature, resulting in the impacts on society that are considered as indirect human impacts. The word 'indirect' in this case refers to the fact that the impact on humans takes place through biophysical changes and impacts, in contrast to the direct impacts where the proposed intervention directly leads to changes and impacts in society.

Direct human impacts originate directly from social interventions (via the social change processes, or changes in the social setting) and are either especially designed to influence the social setting (objectives) or are an unintended consequence of the intervention. Direct human impacts, in contrast to the biophysical, can occur as soon as there are changes in social conditions. In the broadest sense these impacts refer to quantifiable variables such as economic or demographic issues, as well as to changes in people's norms, values, beliefs and perceptions about the society, in which they live, the gendered differentiation of impacts and all other facets of life.

Figge and Hahn (2004) further developed the above discourse and proposed a *value-oriented approach* to impact assessment that assesses and aggregates environmental and social impacts according to their effect on the creation of value rather than according to their relative harmfulness. These authors argue that EIA, as it was conceptualized and used, is incomplete and lopsided for assessing the optimal use of resources because it remains in a burden-oriented logic. 'A paradigmatic shift', or change of perspective, is necessary for a complete and economically sound approach to integrated assessment. Based on the concept of eco-efficiency[21], the economic analysis of optimal use and allocation of environmental and social resources from both a burden-oriented and a value-oriented standpoints showed that value-oriented impact assessment can result in a better allocation of resources and can complement the existing burden-oriented approaches. The value-oriented impact assessment, evaluating and aggregating the environmental and

[21] The term 'eco-efficiency' is often interpreted as a norm or maxim business should follow. When used as a ratio this term describes the relation between an economic activity and related environmental impacts. Eco-efficiency will be enhanced whenever there is more value created for a given amount of environmental impacts, or there is less environmental impact for a given amount of economic value, or there is both more value created and less environmental impact caused. Eco-efficiency can thus be optimized in two ways: either by minimizing environmental impacts per value created or by maximizing value creation per environmental impact (Figge and Hahn, 2004)

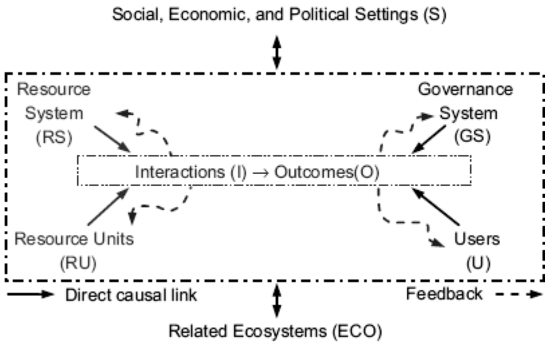


Fig. 2.13 A multitier framework for analyzing a social-ecological system. *Source:* Ostrom, 2008

social impacts with respect to their opportunity cost, shows how much value is foregone when a bundle of resources is used. Thus, it optimizes the use of resources according to the effect on value creation whereas the existing burden-oriented methods solely focus on the relative harmfulness of environmental impacts. Any optimality can only be reached if both perspectives are considered.

And finally, in order to understand sustainability of social–ecological systems (SESs), Ostrom (2008) proposes to build a coherent understanding of how systems are progressively linked to ever larger systems and how upward and downward causation linkages occur within an SES as well as across diverse sectors and scales. Fig. 2.13 includes the highest tier of variables which those, interested in environmental change, include in their theories and empirical SES research. To use this framework, one would first identify which Resource System (and its Resource Units) is relevant for answering a particular question. For instance, in Ostrom's study of deforestation problems in the tropics, the Resource System was forest, the Resource Units were trees, and the social, economic, and political settings were tropics. Numerous interactions among users (international corporations, governments, local private firms, and local users) within institutions, created by national and local Governance Systems, resulted in certain outcomes including both social and ecological performance and externalities. To diagnose the causal patterns that affect outcomes, a set of 'second-tier' variables, which were contained within these four broadest tiers, were needed.

2.1.8 Environmental Assessment in transition countries

2.1.8.1 Background and history

Environmental assessments are an especially relevant tool when looking at environmental impacts in the context of transition countries where numerous strategic choices with significant environmental implications are being made. The changing institutions present unique opportunities for introducing innovative procedures in the environmental decision-making process. EA systems are a potentially effective 'regulatory tool' in that they sequentially transform from appraisals integrated into centrally planned economies to formal procedures aimed at ensuring the interdisciplinary analysis of environmental impacts and linking it to publicly accountable decision-making (Cherp, 2001; Cherp and Antipas, 2003; Dalal-Clayton and Sadler, 2005; Dusik and Sadler, 2004).

The necessity for transition countries to adapt to the world system of environmental assessment follows logically from today's tendencies in environmental management aimed at offering good opportunities to integrate social, economic and environmental considerations in decision-making and to make the latter more transparent, accountable and effective. Success in this transition should result in obvious benefits. In particular, Dalal-Clayton and Sadler (2005), based on a special workshop discussion and the studies carried out as part of the Sofia Initiative[22], showed that SEA can help countries in transition in four general ways:

- ⇨ achieve environmentally sound and sustainable development
- ⇨ strengthen policy, plan and programme making processes
- ⇨ save time and money by avoiding costly mistakes; and
- ⇨ improve good governance and build public trust and confidence in decision-making.

Transition countries present a special opportunity for the wider introduction, further strengthening and continued implementation of EA. While this process is being introduced as a new procedure here, the philosophy behind it is not new. With some exceptions, former socialist countries had traditionally formalized central planning and policy-making processes that required preliminary environmental evaluation of proposed plans and programmes (development proposals) with clear spatial implications. Strong planning traditions have typically incorporated EA elements and provided a sound basis for their further development, including the establishment of a new generation of SEA systems. High level of technical expertise, active nongovernmental organizations and open to procedural and legislative changes transitional economies promote this process (Dalal-Clayton and Sadler, 2005; Dusik *et al.*, 2001).

EA systems in NIS evolved from the assessment procedures inherited from the Soviet Union. A. Cherp (2001), one of leading investigators of the history of SEA formation in transition countries, showed that their prototypes, existed in these countries, already included some SEA elements. However, these procedures were substantially different from those 'classic' assessments used in developed countries at both project and strategic levels. The socialist 'environmental appraisals' were 'internal' government procedures where all participants represented the state. Decisions based on such appraisals relied excessively on technical criteria (i.e. sector- and media-specific norms and standards) rather than on views of affected parties. Interdisciplinary evaluations, as well as the consideration of cumulative, synergistic and indirect impacts, were seldom conducted. Since sectoral planning was far more prominent than spatial planning, very few of the planning procedures were environmentally oriented, especially in that holistic interdisciplinary and participatory way the modern SEA implies. Another obstacle to reaching the full potential of socialist appraisals in form of '*expertizas*' was their narrowness: they seldom affected the existing goals of strategic plans and, as a result, were not capable of challenging the overall economic supremacy of socialist planning.

---

[22] "Sofia Initiatives" was an element of the review of the implementation of the Environmental Action Program for Central and Eastern Europe (EAP) that recommended tackling the priority environmental problems through a mix of policy, institutional and investment measures. The Sofia EIA Initiatives, which were welcomed by the Ministries of Environment at the third *"Environment for Europe"* Ministerial Conference in 1995 in Sofia, gave a high priority to the development and use of SEA in CEE countries. These initiatives were also seen as one step towards the perceived need for these countries to assume a greater ownership of the process. Available at: ***http://www.environmentforeurope.org/efehistory/sofia1995.html***

EA systems were first introduced in the region in the mid-1980s, and now EIA-type frameworks that include SEA elements are in place in nearly all NIS. Although arrangements vary, they have common features based on their "similar origin" (Dalal-Clayton and Sadler, 2005).

It is well known that when the former socialist countries gained independence they did not have national legislation on environmental assessments. In operation there was a 'quasi-EIA' system – the so-called State Environmental Review (SER), also called "ecological expertise", inherited from the USSR[23]. The SER is a procedure, or mechanism, by which state environmental authorities, or independent expert committees appointed by these authorities, verify conformity of virtually all proposed economic activities, including those at the strategic level, to environmental requirements. The conclusions of such reviews are legally binding, i.e. mandatory for implementation for most planned projects. Thus, a SER system is notably different from the EIA, used in developed countries, and represents an internal government procedure, which is not transparent to outside parties and not subjected to independent procedural checks. It is less explicit, more technocratic, sector- and media-oriented and increasingly focused on verifying the compliance of the proposed activities to media-specific environmental norms and technical standards (Table 2.5). Cumulative, synergistic, indirect impacts and alternatives were rarely considered (Bektashi and Cherp, 2002).

Table 2.5 Key similarities and differences between the 'classic' EIA and the SER approaches

'Classic' EIA approach	*SER approach*
Aimed at minimizing negative impacts of planned activities	
Preventive	
Clearly defines roles of developers, experts, affected public, decision-makers and other actors in the procedure	Roles and responsibilities of the actors are less clear, with state bodies dominating the process
Applies to projects, which are likely to have significant environmental impacts	Usually applies to all project-level activities
Requires production of a stand-alone EIA report	EIA findings incorporated into the project documentation
Requires systematic evaluation of all impacts, consideration of alternatives and designing mitigation measures	Focuses on checking the compliance of the proposed activities to the planning rules and standards
Integrative	Sector/media-specific
Provides opportunities for public participation	Limited opportunities for public participation
Linked to publicly accountable decision-making	Used in technocratic decision-making

Source: Bektashi and Cherp, 2002

Dalal-Clayton and Sadler (2005), based on the World Bank study (Klees *et al*., 2002), concluded that it was reasonable to assume that only a small fraction of strategic proposals

[23] *The Network for EA in Countries in Transition.* Accessed 20 March 2007 at: *http://www.ceu.hu/envsci/eianetwork/*

was subjected to formal SER procedures. The failure to implement this provision is a systemic weakness that relates both to the procedural deficiencies and to more fundamental, structural constraints and consequences of legal and regulatory reforms. Cherp (2001) supported the World Bank findings but went further, saying that SER procedures at the project- and strategic-levels were mostly focused on enforcing environmental quality standards and other formal requirements.

At the project level, this situation started to change in the early 1990s when the requirements for developers to undertake the so-called OVOS (Assessment of Environmental Impacts) procedure were consolidated in several pieces of secondary legislation. In 1989, when SER mandatory provisions were adopted, it was extended to the strategic level. The SER/OVOS system was inherited, more or less intact, by all FSU countries, and its key regulations, e.g., the responsibilities of the proponents, were largely unaffected until the disintegration of the Soviet Union. However, since 1991 all NIS have variously retained or reformed the SER/OVOS systems at different speeds and in different ways as well as with important country-specific variations in national legislation and procedures. This 'process of transition' provided a changing context for the reforms that were largely inspired by international experience and promoted by internal and external pressures for environmental responsibility and transparency in decision-making. The general goal of the reform was to reduce the gap between the SER/OVOS system and internationally accepted EIA standards, and now the former represent an interim step toward SEA as it is understood internationally, although some elements can be classified as a para-SEA process. Given its roots in the socialist environmental appraisals used in centrally planned economies, SEA introduction did not initially affected the planning procedures still regulated by the old planning rules (Cherp, 2001; Dalal-Clayton and Sadler, 2005).

The World Bank review (Klees *et al*., 2002) identified important procedural aspects, which differ between SER/OVOS systems and applied internationally EIA/SEA frameworks, as follows:

1. SER/OVOS processes lack appropriate checks and balances. For example, screening is so broad and indiscriminate that it includes nearly all proposed actions, even minor ones. In turn, the sheer volume of activities, reviewed at all levels, leads to problems of avoidance, cost and delay, and also result in superficial examination of environmental aspects. Scoping is an internal procedure rather than a mandatory requirement under both SER and OVOS provisions.
2. Although most NIS ratified the Aarhus and Espoo Conventions, the SER/OVOS frameworks lack transparency and do not fully adhere to the principles of public involvement. Legal provisions do not clearly define the rights of the public with respect to disclosure and examination of documents. As it was reported, only Moldova, and to a lesser extent Georgia and Ukraine, addressed these deficiencies directly.
3. In most NIS, provision is made for the independent organizations of "public environmental expert reviews" of information and the submission of comments. This is a potentially far reaching and internationally significant provision, but usually there are no procedural stipulations relating to the review or consideration of these comments.

Cherp (2001) had analyzed SER applications in different NIS and drawn several conclusions and observations, which were reproduced by Dalal-Clayton and Sadler (2005), and were generally applied to SER of strategic actions:

- strategic actions are subject to SER even in more conservative NIS, although the majority are lower level physical plans or schemes, and applications to policy are relatively rare;
- the main focus of SER is on compliance with formal provisions regarding the content of planning documentation and mandatory approvals, and on meeting environmental protection norms and objectives;
- most SER applications that reach positive conclusions impose environmental conditions, but these refer primarily to subsequent project EIA and there is little evidence that strategic actions are modified other than superficially during their preparation;
- these outcomes reflect the basic features of SER described above, notably the indiscriminate application of the process across a wide range and large number of actions, and the use of relatively simplified, technocratic procedures, which together encourage limited, pro-forma approach;
- SER practitioners must decide the environmental acceptability of a strategic proposal without necessarily having a full understanding of the social and economic effects, or views and information from public consultation;
- SEA elements and principles are built into certain strategic planning procedures, particularly land use and urban plans elaborated using the former Soviet process of territorial integrated schemes for nature protection. Recent reforms in land-use planning did not incorporate a strong SEA dimension because this did not occur in the SER/OVOS systems due to superficial internal resistance to intrusion into policy and planning mandates and a lack of strong incentive to do so;
- where reforms are being made to OVOS regulations, e.g., in Belarus in 2004, the disparity between SER practice at the project and strategic levels becomes even more evident. This might lead to an improved SEA procedure, but much will depend on countries adopting the SEA Protocol and on the capacity-building activities of international agencies.

An example of this situation in the Russian Federation is described in Box 2.8.

2.1.8.2 Difficulties of transitioning to EIA/SEA and their effectiveness in EIT countries

The development of an effective EIA system in a transitional society may be hindered by factors common throughout the world, such as fragmentation of responsibilities between governmental institutions and the lack of awareness, training and guidance. Additional challenges, particularly relevant to transitional countries, include the lack of transparency and accountability of decision-makers as well as the social and economic problems overwhelming the priorities of policy-makers and the public. Also, the pace of changes in environmental policies is being affected by the cost of transition.

For example, the lack of funding for environmental protection was one of the major obstacles for the improvement of Azerbaijan's EIA system, particularly hindering its

Box 2.8 Environmental Assessment in the Russian Federation

The Russian Federation (Russia) is one of the largest emerging democracies, and many NIS still look to it in many matters of environmental policy, including EAs. That is why understanding its EA system is especially important.

The Russian EA system is seen as a 'dynamic policy system', which comprises SER, undertaken by state authorities, and OVOS, undertaken by the developers. SER is centered on the review of the design or planning documentation for proposed projects or other planned activities by state-appointed special expert committees, and issuing a mandatory 'resolution' on whether, and under what conditions, the proposed development can go ahead.

A special World Bank study (von Ritter and Tsirkunov, 2002) identified the following critical deficiencies of the Russian EA system:

- Lack of the integration of OVOS and SER subcomponents. This was especially evident in the limited role that SER authorities played in determining the scope and reviewing the quality and relevance of OVOS;
- Lack of effective screening provisions resulting in 'dispersing' scarce financial resources and wasting time, while analyzing impacts of low-risk projects to comply with complicated assessment procedures;
- A limited impact of EIA on decision making, except of the selected cases of highly visible and internationally financed projects that resulted from an excessive focus on meeting formal requirements to attain a SER approval, which was exacerbated by the declining capacity to monitor and enforce EA conclusions;
- Declining institutional capacity that has been caused by the ongoing restructuring, the lack of or misleading guidance from the centre, and the shrinking of Russia's environmental management system;
- Unclear relationship between federal and regional functions in EA.

To deal with the challenges, related to both regulation and practice facing the Russian EA system, the World Bank proposed four sensible "guiding principles" (von Ritter and Tsirkunov, 2002):

- Assured basic implementation capacity;
- Efficiency and business friendliness;
- Effectiveness, by focusing limited institutional, analytical and financial resources on the most significant environmental impacts;
- Long-term impact by evolving the EA system from a 'do-no-harm' tool to an instrument supporting sustainable development decision-making.

An important lesson from Russia, potentially relevant to large countries with semi-autonomous regional administrations, is that many regulatory and practical developments have proven to be easier to implement at a regional level rather than a national level because in many cases political commitments can be easier to secure and the institutional structures are more flexible. Regional-level policies are also easier to implement since they are often formulated by those directly involved in their implementation. However, a bottom-up approach where pilot EA policies are formulated and tested at the regional level can be successful only if there is a vigorous 'horizontal' dialogue between the regions, supplemented by a 'vertical' dialogue with the central government.

Source: Cherp and Golubeva, 2004

capacity-building efforts (Bektashi and Cherp, 2002). In the early 2010s the country had virtually no developed system of environmental education, training or expert selection as well as no research centers or networks dealing with EIA issues. The increasing interest of environmental NGOs in the EIA process contrasted with the lack of public awareness about environmental issues. Nevertheless, as practical experience was accumulating, the capacity of both governmental agencies and local experts in EIA increased, and more and

Box 2.9 Environmental assessment in Azerbaijan

In the 1990s, the EA system in Azerbaijan has been undergoing a significant transformation. In particular, in 1996 a parallel to SER system, more closely conforming to the 'classic' EIA, was created and applied to dozens of major developments, particularly in the oil sector. At present, the environmental assessment process in the country contains elements of the SER system, inherited from the USSR and similar to other NIS, and elements of a 'classic' EIA system incorporating the best developed countries EIA practice. Such 'dual' EIA system has resulted from a set of domestic and external factors typically affecting EIA policies and practice in transitional countries and has helped to bridge the gap between external pressures for establishing modern EIA and the lack of internal capacity to do so in the face of political and economic challenges. So far it proved to be suitable for the economic and environmental conditions of Azerbaijan.

The case of Azerbaijan provides a clear contrast to some countries in transition where 'advanced' EIA legislation, built according to western models and rushed through Parliaments, were ignored or not even understood by field bureaucrats to say nothing of developers, local authorities and other actors. Azerbaijan's experience demonstrates that although the non-mandatory character of an EA system and associated potential irregularities in the application and utilization of its findings can be considered as a drawback, the introduction of EIA procedures on a non-mandatory basis may bring sufficient practical benefits by subjecting a large number of environmentally significant activities to full EIA and, more importantly, through the building of awareness, trust, and the capacities of domestic actors in the EIA process. The success of the 'Azerbaijan model' will depend on whether the parallel EIA system is capable of continued improvement, integration with existing formal procedures and institutions, and of transforming into a mandatory environmental policy tool.

Source: Bektashi and Cherp, 2002

more Azerbaijani domestic companies and organizations participated in EIA procedures, both as developers and as consultants (Box 2.9).

Dusik and Sadler (2004) reviewed SEA trends, issues and practices in several CEE countries during the period from the collapse of socialism in 1989 to their entry into the European Union and concluded that the basic principles are common for all transition countries. SEA systems in former soci-alist countries were developing within a particular context and political culture, rooted in an existing policy and planning framework with particular institutional arrangements, practices and capacities. SEA reforms also showed that the application of an 'impact asses-sment approach' to planning processes and practices is not automatically or necessarily effective, confirming that 'one size does not fit all' and under-lining the importance of taking a differ-entiated approach using a host of tools.

The effectiveness of EA in EIT countries, according to Cherp and Antipas (2003), is generally focused on two aspects: the quality of EA studies and their application in decision-making. The effectiveness itself is measured by the quality of their scientific advice and the extent to which decision-makers listen to it.

Lessons from other areas of environmental studies indicate that interaction between science and policy- or decision-making is usually far from simple. How science is used in policy systems depends on a variety of factors, including the political and constitutional context of the country, the power and capacity of advocacy coalitions to use science for their political purposes, and whether scientists can effectively play the role of 'policy entrepreneurs' or leaders. Science is often used as a political weapon in the political arena, and scientists, in many cases, face the prospect of losing their legitimacy as independent actors and good-faith arbiters of knowledge, even when they do not intend to be drawn into political controversies. However, environmental assessments are a unique policy tool in that they are deliberately designed to make decision making more 'rational' and more sensitive to environmental concerns by bringing scientific assessment of potential consequences to the attention of decision-makers.

As an example, one can consider the mandate of IPCC whose reports are neutral with respect to policy. Due to its intergovernmental nature, the IPCC provides decision-makers with scientific, technical and socio-economic information in a policy-relevant but policy neutral way, and the governments accepting the IPCC reports acknowledge the legitimacy of their scientific content.

Unlike the tradition of considering an EA process as 'good' when an objective scientific advice is imposed on decision-makers and planners, but 'bad' when scientific expertise is 'co-opted' into justifying economic agendas, a meaningful EA process would be one where both scientific meaning and policy agendas are re-defined and translated to 'change' actors through *learning* from each other. In order to be translatable into policy resources, EA findings must be presented in a language and manner, which policy-makers can understand, similar to the way they analyze their own political world and its distribution of forces and interests. The IPCC provides a second example when it prepares, along with detailed, comprehensive and specious reports, the compact and understandable Summary for Policymakers (e.g., IPCC, 2007c).

A strong region-wide stimulus for the application of SEA in transition countries was driven by the EU accession process, especially within the pre-accession activities (Dusik *et al.,* 2001; Dusik and Sadler, 2004). In addition to the development of legal frameworks, this process has directly influenced SEA practice in EU accession countries, notably through the requirements for comprehensive '*ex ante* evaluation' of national and regional development plans that since 1999 have been prepared to facilitate structural reforms and to set a framework for the future use of EU structural funds. In accordance with EC regulations, the economic, social and environmental impacts of all such plans were subjected to examination.

Peterson (2004) has analyzed the perceptions of SEA experience in Estonia and the effects that EU accession had on the planning process here. On the whole, the accession accelerated the development of national legislation on environmental assessment and transposition of the corresponding EU legislation into Estonian law (Box 2.10).

2.1.8.3 Tasks to be solved

Formulating some recommendations to introduce meaningful SEA provisions in NIS countries, Cherp (2001) first of all names the institutional resistance to SEA that should be overcome and can be only achieved if the concept of SEA is universally redefined as a tool for informing decision-makers, rather than a part of an environmental permitting procedure.

Further, the accentuation of those aspects of SEA that contribute to sustainable development (not just into environmental protection) may increase the chance of its acceptance under difficult social and economic conditions now observed in many NIS. Another challenge in introducing SEA will be to preserve the positive features of existing land-use planning and environmental permitting procedures, neither 'replacing' nor 'duplicating' them with new SEA requirements. Any policy recommendation for

Box 2.10 Stakeholders' perspectives on the role and value of SEA in Estonia

The requirement for mandatory SEA of national plans and programmes has brought about its operative introduction into different sectors and has made public administrations responsible for carrying out and supervising SEA. However, the administration was not prepared for this implementation. The results of special questions are shown in Table below. Respondents were asked about the overall impact of SEA and its effects on specific aspects of the strategic planning process and documents.

Six most significant effects of SEA on the policy document as perceived by different actors in Estonia

Impact of SEA	Significance of SEA impacts as perceived by		
	Public authorities[1]	*SEA experts*[2]	*Stakeholders*[3]
Increased number of stakeholders involved in the policy process	1	1	4
Additional costs on the policy drafting process	2	3	-
Modification of the composition and content of policy documents	3	2	5
Increased length of the drafting process of policy documents	4	5	1
Expanding the scope of policy documents	5	-	3
Modification of the objectives of policy documents	-	4	2

Note:
[1] The public authority (usually sector ministries) responsible for drafting policy documents and assessing their potential environmental effects;
[2] SEA expert(s), contracted by the public authority to conduct SEA (Estonian law stipulates that only licensed environmental experts can conduct EIA and SEA);
[3] Other stakeholders with an interest in the issues potentially affected by the proposed policy and/or discussed in the SEA; in this case – environmental non-governmental organizations.

Only three NGO respondents out of 26 reported that SEA had no overall impact, while 21 regarded it as limited, and two considered it to be significant. According to the majority of answers, the impact of SEA was largely expressed through its ability to modify the content of the policy document. 21 respondents believed that SEA affected the document and drafting process, either to a large (11) or to a more limited extent (10). All groups believed that SEA had expanded the number of stakeholders involved in the policy drafting process, although NGOs ranked this effect lower than authorities and experts. Public authorities had experienced SEA impacts mostly via the increased burden of public communication, such as holding public meetings and correspondence with a large number of stakeholders that often resulted in a budget deficit since these costs were not initially planned.

Difficulties in managing public consultation were the usual reason for delayed planning processes and increased costs. Total costs rose as a result of changes in the initial scope and increased complexity of issues targeted by the policy document, followed by the need for additional public meetings and the extent of amendments required. The perception that SEA adds to the costs was also shared by the experts, but not NGOs. At the same time, all three groups (especially NGOs) believed that SEA increased the length of the planning process.

Regarding the benefits of SEA, the public authorities pointed out the better coverage of environmental issues in policy documents and their own environmental education through contacts with SEA experts. From the experts' view, SEA has mostly contributed to the content rather than to the scope and objectives of the documents. However, the latter role was emphasized by NGOs.

Source: Peterson, 2004

'improving' SEA systems in the NIS should be sensitive to the fact that key societal factors influencing environmental assessment systems vary across the region, thus presenting different opportunities and constraints for SEA development.

It seems that in addition to a detailed understanding of the current SEA practices and institutions, there is a need to generate a policy commitment to SEA strengthening in the NIS. In particular, in the already mentioned review of SEA trends, issues and practice in CEE countries, Dusik and Sadler (2004) emphasized the following:

- SEA reforms cannot be studied and facilitated effectively without detailed knowledge of the planning systems in the country. An initial review of planning frameworks is necessary to identify their main deficiencies and opportunities that can be addressed through SEA application. When designed in this manner, SEA can both respect the logic of the planning process and strengthen its operation with regard to the systematic consideration of environmental issues.
- SEA reforms can also be built on and through the strengthening of previously established systems for the partial environmental evaluation of policy-planning frameworks, through including, for example, the "integration with existing systems" criterion into such evaluation (Cherp and Antypas, 2003). In the context of transitional countries, such incremental improvements of planning processes are likely to be more effective then formally prescribed separate SEA procedures, which may often provide information too late or in a form that is inappropriate for the need of the respective planning, programming or policy-making.
- There is a need for "adaptive policy systems" raised by Cherp and Antypas (2003). SEA reforms cannot be designed and implemented effectively without a sound consultative process among key stakeholders on proposed integration of SEA into planning, programming or policy-making processes. CEE experience suggests that any proposed approaches should be pilot-tested and evaluated before being incorporated into legal frameworks and guidance documents.
- CEE experience with regional capacity building and professional development indicates the value of self-help. East–East exchanges have proven more valuable than the traditional North-South model of training and technical assistance in carrying forward the initial stages of SEA reform in the region.

The most notable directions for possible improvements of EIA systems in NIS are shown in Box 2.11. Despite significant progress over the last decade, in a number of areas these systems still diverge from internationally recognized standards. The main lesson of EIA reforms here is that these systems may evolve quickly in response to changes in their political and economic contexts. Successful EIA reform must not only be guided by international standards, but also be 'in gear' with the changing domestic situation.

Box 2.11 The most notable directions for possible improvements of EIA systems in NIS

➡ Focusing full-scale EIA procedures on developments with potentially significant environmental impacts rather than applying a universal simplistic procedure to thousands of trivial projects;
➡ Clearly defining and enforcing rights and responsibilities of developers and the public rather than operating 'state-dominated' non-transparent and technocratic EIA procedures;
➡ Ensuring that EIA addresses all significant environmental impacts and mitigation measures, not only those regulated by sector- and media-specific standards and design rules;
➡ Linking EIA findings to decision-making in the framework of sustainable development rather than making EIA merely a stage of an *environmental* permitting procedure.

Source: Web-site of the Network for EA in Countries in Transition. Accessed 20 March, 2007 at: *http://www.ceu.hu/envsci/eianetwork/*

2.2 Environmental management

2.2.1 Linking environment with conventional decision making

Environmental management has similarities with other sectors of public planning, especially those managing a common resource. The absence of adequate prices, the multitude of claims to scarce resources and the complexity of environmental problems are similar to the problems encountered in developmental decision-making; the tools of development planning can be suitably adapted to incorporate environmental effects into the decision-making and planning process (Noorbakhsh and Ranjan, 1999).

Toth (2003c, p. 257) defines a *decision* as "the action to induce a change in the behaviour of others by someone who is in the position to influence others' behaviour". From this initial statement it concludes that "*decision analysis* is a special part of the decision preparation activities in the sense that it is trying to bring the insights from the assessment closer to the social and policy context in which the decision will actually be made". Finally, he defined a *decision analytical framework* "as a coherent set of concepts and procedures aimed at synthesizing available information from relevant segments of the given environmental management problem in order to help policymakers assess consequences of various decision options". This framework is used to organize the relevant information in a suitable structure, to apply a decision criterion and thus to identify options that are better than others in given context.

Ideally, decision analysis would consider all interests, constraints, and other intricacies of the decision-making context so that its result can be taken and directly applied in decision making. This is hardly ever the case. At best, results of decision analysis inform participants in the decision-making process and are used by decision makers who need to consider all factors in a whole array of other criteria and considerations not included in the decision analytical frameworks.

Wood and Becker (2005), considering environmental assessment as one example of a planning function governed by a regulatory framework, described EIA not merely as a tool designed to gather environmental information to inform project authorization decision making, but as a *decision process* that involves decisions surrounding, for example, project screening and scoping through the consideration of alternatives, impact prediction, etc. Within this process, *decision-making* activity is increasingly recognized as not simply involving the use of objective 'scientific' information, but rather as being characterized by *value* judgements and subjectivity.

R. Jiliberto (2002, p. 61) suggested the concept of decisional environment values (DEVs), defining it as "…an objective entity that could constitute the basis from which a consistent EA methodology can be developed". Introducing this concept, the author proceeded from examining the role of *value of decisions.* In particular, he used another definition of a decision, namely "…a value-guided choice among available options or alternatives to achieve an end" (*Ibid,* p. 62). In this case, a decision takes place when an individual or a group has to make a choice among several alternatives and uses their individual values as criteria in the selection of one of the possible options. A 'rational' decision attempts to maximise the benefits that can be gained from the choice. The information that society requires to account for a single decision process is related to the interests of third parties that could be intentionally or unintentionally injured/damaged or benefit because they have not been adequately taken into account. The sociological concept that describes those interests is the concept of value; in the case of environmental assessment it is environmental values. *"Environmental values are individual or collective attitudinal relationships with, or preferences for, determined states of ecosystems, natural or artificial (urban), with which human beings interact. Knowledge about ecosystems does not create environmental value; rather it is a preference that leads to social values"* (Jiliberto 2002, p. 62). "Decisional rules and environmental values can be separated," continues Jiliberto, "but in doing so they lose every meaning regarding assessment purposes. Their effective cognitive values come from their combination. This new cognitive entity is a *decisional environment value* (DEV)" (*Ibid,* p. 63). Representing an environmental value of decisional nature, DEV is neither pure environmental value nor pure decisional value; it is both an environmental value expressed in terms of decisional criteria and decisional mandates with an environmental dimension.

Munasinghe (2003) presented an example of the combination of *environmental assessment* with economic analysis (Fig. 2.14). Here, the right-hand side of the diagram indicates the hierarchical nature of conventional decision making. The global and international level consists of sovereign nation states; the next levels are individual countries with multi-sectored macroeconomies and then various economic sectors. Each sector consists of different sub-sectors and projects. On the right side of the figure it is shown the conventional decision making process that relies on techno-engineering, financial and economic analyses of projects and policies, which have been well developed in the past with the use of conventional techniques such as project evaluation/cost-benefit analysis (CBA), sectoral/regional studies, multi-sectoral macroeconomic and international economic analysis, etc. at the various hierarchic levels. However, environmental and social analysis, by the opinion of the author, cannot be carried out readily, using the above process, and on the left side of Fig. 2.14 Munasinghe shows how environmental issues might be incorporated into this framework. Climate change may be considered here as one representative of global/transnational systems, the forests and ecosystems – as representatives of natural habitats, the agricultural zones – of land, and so on. In each case, a holistic environmental analysis would seek to study a physical or ecological system in its entirety.

Since, by definition, environmental degradation originates from human activity, the ecological effects of economic decisions must flow from the right to the left side of the diagram. For example, destruction of a primary forest may be caused by activities in many different sectors of the economy, and disentangling and prioritizing these multiple drivers (right side) and their impacts (left side) involve a complex analysis. EA techniques facilitate this process. A variety of environmental and economic techniques are developed to incorporate environmental issues into traditional decision making. These, particularly, include valuation of environmental impacts (at the local/project level), integrated resource management (at the sector/regional level), environmental macroeconomic analysis and environmental accounting (at the economy-wide level), and global/transnational environmental economic analysis (at the international level). Since there is a considerable overlap among the analytical techniques, this conceptual categorization should not be interpreted too rigidly.

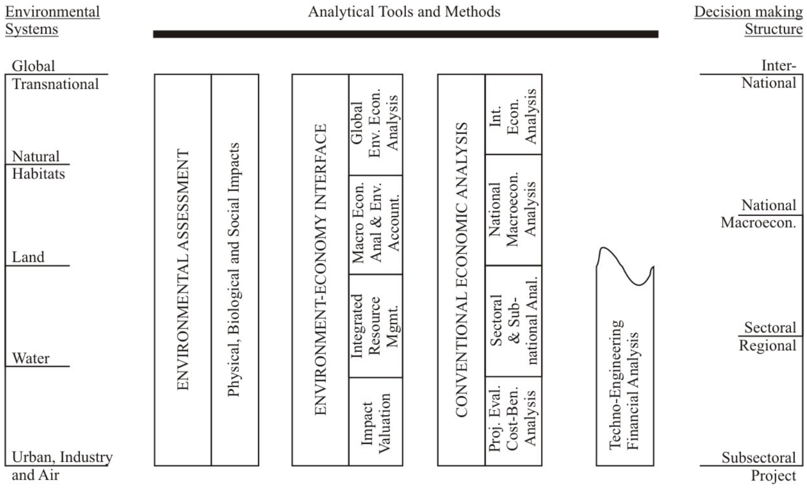


Fig. 2.14 Incorporating environmental concerns into decision-making. *Source:* Munasinghe, 2003

Once the foregoing procedure is completed, projects and policies must be redesigned to reduce their environmental impacts and to shift the development process towards a more sustainable path. In other words, if environmental questions cannot be addressed at the appropriate levels, decision-making systems may be adjusted, and there are indications that in many sectors and countries an experience with environmental assessment has encouraged governments to make such changes (Nooteboom, 2000). Although environmental issues are not the only important factor in decision-making, their strengthening may force the decision-making systems to bring them to the forefront. Similar arguments and logic are applicable with regard to social issues (Munasinghe, 2003).

Tonn *et al.* (2000) presented a framework (Fig. 2.15) for understanding and improving environmental decision making. They theorize that, through using a framework analysis, the structured thinking can be applied to endeavours that are often characterized as random or *ad hoc* and thus may be conflict-ridden, inefficient or ineffective.

By its design, the proposed framework is both descriptive and prescriptive, describing the underlying structure of environmental decision making, but also intending to enlighten decision makers about what they are doing or not doing and how they could improve their decision processes. Being necessarily presented in a linear fashion, the framework is actually quite dynamic, with feedback loops within and among its elements.

The most encompassing elements of this framework are:

- the environmental and social context within which a decision is made
- the planning and appraisal activities that should precede and follow decision making
- typical decision-making modes
- the decision actions themselves.

Briefly, Tonn *et al.* (2000) comment these elements in the following way.

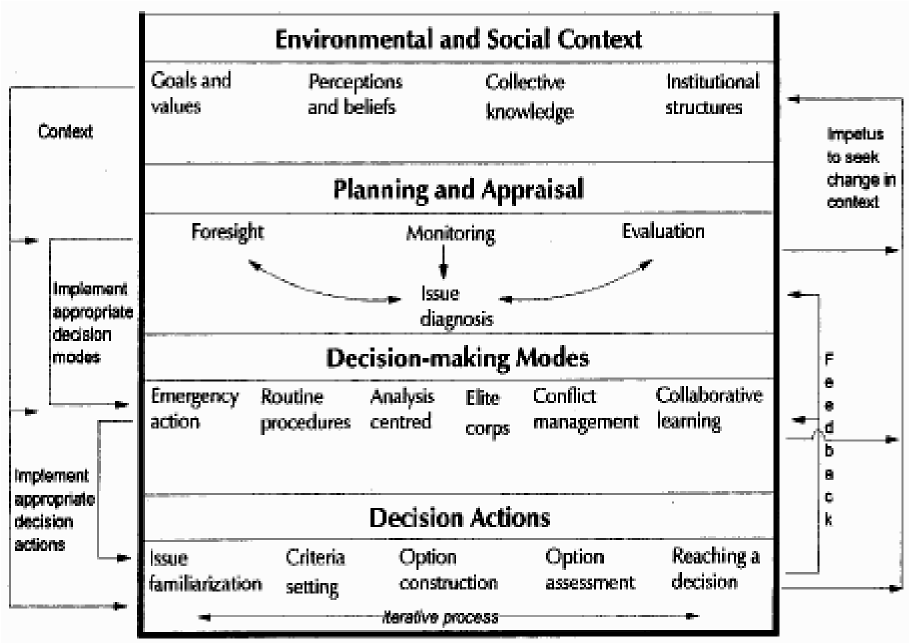


Fig. 2.15 Environmental decision-making: a process framework. *Source:* Tonn *et al.*, 2000

a) Environmental and social context. Environmental decision making takes place within the context of environmental and social realities. The former includes the past, present and expected state of various aspects of the environment. Regarding the latter, the cultures, religions, political institutions and other organizations, economic systems, communities and individuals all may help to shape the social context within which an environmental decision-making process is carried out. Changes in both contexts are inevitable: in the physical world they occur naturally or through human interventions; in the social world they sometimes are deliberate but often occur because of complex, unplanned interactions among people and between people and their physical environments.

Within *environmental* and *social context* the authors identified four *contextual components* that help to shape environmental decision making:

- *Goals and values* referring to preferences for states or things;
- *Perceptions* and beliefs that shape people's conceptions of their environmental and social contexts;
- *Collective knowledge* that includes common as well as scientific knowledge about the environment and society;
- *Institutional structures* including formal and informal political, legal, economic and community institutions that all help to shape the context of environmental decision making.

b) Planning and appraisal element addresses the need for oversight and guidance functions for the entire environmental decision-making enterprise. These functions include foresight, monitoring, evaluation and issue diagnosis and promote sustainability, but should also be responsive to present-day concerns. The first three functions help to articulate the fourth and help also to determine which decision mode is chosen. Eggenberger and Partidário (2000, p. 203) emphasise an evidence of planning traditions where it is customary to integrate environmental issues and concerns into the planning process, noting that as a generic term *planning* "…implies systematically addressing problems and exploring future expectations, by defining goals and new strategies, measures and means to resolve the problems, and identifying actions to follow up".

c) Six typical ***decision-making modes*** (see Fig. 2.15) are 'ideal types' in that, in reality, none is likely to exist in pure form. An environmental decision-making process is likely to incorporate aspects of more than one mode, simultaneously or over time. Nevertheless, each mode has distinctive characteristics that typify different approaches to decision making, and by understanding these six modes the decision makers can make more informed judgments about whether the mode they have adopted is appropriate for the issue at hand. Moreover, decision actions can be implemented in different ways depending upon the mode. It is also suggested, and this may become apparent, that a different decision mode is needed. Changing the mode can radically affect how the decision steps are carried out.

d) Decision actions constitute the actual activities that lead to environmental decisions. Their five steps – *issue familiarization, criteria setting, option construction, option assessment* and *reaching a decision* – are comparable to those usually used in the decision-making practice. These decision actions do not necessarily proceed in a tidy, linear fashion; at times, it may be necessary to backtrack.

The interaction among the four levels of the described framework is not simply top-down; it is also bottom-up. For example, feedback from the decision actions may lead to a change in decision mode. A change in the decision mode may lead to the development of new, hybrid decision modes and improvement in how decision actions are implemented; it may also lead to a change in planning and appraisal activities. There are also no well-recognized methods for choosing the most appropriate decision mode. Decision actions are being implemented roughly in the sequence described in the framework, but in many situations there still appears to be a lack of clarity about how precisely they should be undertaken, particularly given the decision mode that has consciously or unconsciously been chosen. There are also numerous geographic scale issues that complicate environmental decision making.

Further challenges are presented by ***evaluation***. Evaluation of environmental decisions is methodologically quite difficult: environmental decision making is an ongoing process and many decisions are actually composed of numerous sub-decisions, made at different points in time and sometimes revisited. Another problem is decision making's analogy to the uncertainty principle: the more one focuses on certain decisions, the less is known about what could have happened if other decisions had been made.

Overall, Tonn *et al.* (2000) suggest that the proposed framework can improve environmental decision making in several ways.

First, the framework lists comprehensively the elements and activities that either do or should compose an environmental decision-making process, and decision makers can refer to it to make sure that they are not neglecting any important steps. The framework can be also used to better comprehend the decision-making processes for which they are responsible and can be a useful tool to enlighten participants about where, in the overall scheme of things, their process stands. *Second*, the framework can improve a decision maker's understanding of how public participation should be integrated into the decision process. *Third*, environmental decision makers must frequently deal with conflicts concerning not only process values but also outcome values. *Fourth*, the framework ties together process issues with sustainability concerns.

Heugens (2006) distinguishes three core and distinct parts or phases in environmental issues management systems, labelled as *identification, evaluation* and *response*. In combination, these three functionally interrelated and longitudinally overlapping parts of the system enable decision-makers[24] to formulate adequate responses to strategic and environmental issues. Based on numerous sources (that we are omitting here) the author expresses these phases as follows:

- *Identification* of the aims of environmental issue management to enable to register (or even predict) the emergence of strategic issues. When managers seek to identify strategic issues, they must collect issue-relevant information and subsequently disseminate it throughout their organizations to help them to cope with the continuous stream of weak signals and vague stimuli emanating from its environment.
- *Evaluation* of issue management is concerned with interpretation, the purpose of which is a cognitive attempt to bring meaning to an issue – a process that can be described as 'making sense' of carefully monitored events. This is a critical moment because responses cannot come about without interpretation, and no issue is inherently strategic; only the top management's belief in that an issue has implications for organizational performance endows it with strategic characteristics.
- *Response* is concerned with formulating and implementing activities that bestow legitimacy on those that undertake them. Responses can take a variety of different forms and either are relatively weak and generic to accommodate for several contingencies, or they can be highly forceful and specific, aimed at the resolution of crisis issues.

Somewhat earlier, Cain *et al.* (1999) distinguished two steps in a formal approach to developing *environmental management strategies*. Initially, the available management options are identified, and then decisions are made as to whether these options should be implemented. In principle, these steps are identical to the first two of above discussed, but add some details. In particular, the decisions are not only be made at the beginning of a project but throughout its lifetime in response to monitoring and evaluation of its progress and changes in the environment system, basing on its assessment as a whole. The system includes all factors, which interact with the resource to be managed, together with the

[24] The initial object of the cited paper is a company (organization). However, we think that principal statements of the author are applicable to the decision making on the whole

variables characterising these interactions and representing a range of physical, economic, institutional, social, political, cultural, and other factors. Sound management strategies should be based on some understanding of how these variables act and interact as a whole to constrain and provide opportunities for development.

Also, scientific literature distinguishes different ***levels of decision processes.*** So, Kørnøv and Thissen (2000) describe the two levels: an *individual level* where an individual actor or decision-maker develops insight and comes to the choice of a strategy or action, and a *collective level* where individuals interact, resulting in agreement or commitment to a jointly chosen course of action. Situations at the collective level are widely variable from a team or group decision-making to decision-making within an organisation or between independent parties. In particular, Fischer (2003), making a distinction between groups, organisations, and meta-collectives, defines *groups* as a collective with little formal organisation that relies heavily on personal acquaintance and face-to-face contact. *Organisations* differ from groups in that they are formally organised, involve division of labour and fixed roles and tasks for the individual members. *Meta-collectives* are 'collectives of collectives' when groups or organisations co-operate to form a second-order collective that sometimes include also individual actors. The second-order collective can be of a looser type with little formal organisation and little hierarchies (much like the 'group' on the first level) and of the more formally organised type where groups and organisations relate to each other in institutionalised ways. Fischer called this type a "meta-organisation" and, as an example, he named a municipality where different political and administrative bodies may work together to fulfil certain task. Because the collective decisions are always based on a set of decisions of individuals, in the real-world processes both levels of decision-making are intertwined.

When several persons or organisations are involved in decision making, one more dimension becomes important for the process: *mutual dependencies and the distribution of power or authority among the participants.* The spectrum of decision-making can vary widely, from the situations of centralised control, where essentially a powerful individual makes decisions regarding matters that concern the whole organization or even society, to the policy processes in which large numbers of independent actors debate and negotiate. From this viewpoint, the international process on reduction of greenhouse gas emissions and prevention of long-term climatic change is especially indicative. As to SEA, oriented to policy and planning processes, the situations in which power or influence is distributed over several actors are most relevant.

Nooteboom (2000) has extrapolated *the conception of tiers* in EA (see Sect. 2.1.5.1) to decision-making. He is inclined to believe that decision-making may occur in several tiers, any of which may or may not have a formal linkage with an SEA or EIA. From two decisions, the one that is made chronologically first is the first tier and the other – the second. Similarly, a decision which is more 'strategic' is the higher tier, and the other is the lower tier (Fig. 2.16). Moreover, if decision-making about a particular activity takes place in several tiers, an earlier tier is considered, by definition, as the more strategic because it deals with alternatives, which are more strategic than those considered later.

According to this logic, most available cases concern formally tiered decisions, and two environmental assessments are tiered to each other if they are linked to tiered decisions.

The direct interactions between tiers depend on the possibility and willingness to coordinate them or to use lessons learned in the preceding tier. An important factor is a time lag between tiers. If too much time elapses, many of the assumptions that could be made during the first tier may have become outdated.

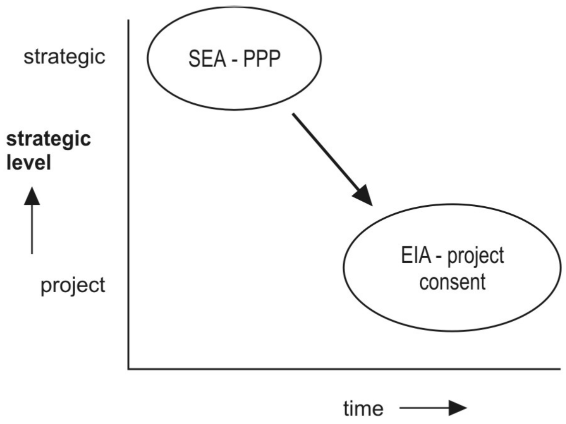


Fig. 2.16 A typical form of tiering: a higher, earlier tier influences a lower, later tier. *Source:* Nooteboom, 2000

Proceeding from these views, Nooteboom (2000, p. 153) proposed his definitions of planning and decision-making systems as *"...formalized systems of tiered planning and decision-making, in several tiers from the most strategic level to the project level. Decision-making is done by a competent body; planning is the preparation of proposals of plans"*. Nevertheless, he admits that they are not generally established in some countries.

2.2.2 Environment and management

2.2.2.1 From strategic environmental management to earth system governance

Integrating the environment into strategic decision-making is an essential pre-requisite for moving towards sustainable development. Furthermore, it moves beyond the traditional idea of environmental policy, which is a separate and discrete area of policy, and follows the *Our Common Future* report (1987, p. 313) that stated: "The ability to choose policy paths that are sustainable requires that the ecological dimensions of policy be considered at the same time as the economic, trade, energy, agricultural, industrial and other dimensions on the same agendas and in the same national and international institutions". Thus, the integration of the environment into strategic decision-making is an attempt to integrate it into all policy sectors and policy-making (Sheate *et al.,* 2003).

A. Cherp (2004) proposed a research agenda based on a holistic approach to the topic rather than separately analyzing individual linkages. He defined the theme of this research as ***Strategic Environmental Management (SEM)*** in a hope to transcend the limitations of traditional tools through expanding their linkages with other tools and, eventually, promoting an integrated system of environmental planning, assessment and management. Cherp symbolically summarised the "promise of SEM" as three-fold:

- Going "*beyond assessment"* to facilitate more effective SEA follow-up integrated with Environmental Management Systems (EMS) in public authorities;
- Going *"beyond management systems"* to facilitate integration of environmental concerns into core organizational policies;

- Going *"beyond corporations"* to facilitate systematic introduction of corporate-type systematic management in public authorities.

Heugens (2006), who also adverts to this problem, thinks that managers, concerned about the continuity and profitability of their organizations, must formulate adequate responses to strategic environmental issues. However, global complexity and dynamism seem to make the task of environmental issue management almost impossible even for the large internationally operating companies. The task's complexity creates situations of information overload, in which the amount of data that needs to be generated and processed by far exceeds the cognitive ability of individual managers or management teams. Therefore, effective decision-making is needed in a method for monitoring a change as long as necessary and to formulate a timely and adequate response. These activities, referred to as *strategic issue management,* Heugens (2006) regards as a crucial managerial task.

To encompass the interplay between ideas and action in processes ranging from problem definition and goal articulation to the design and implementation of policies, Clark *et al.* (2001) used the term ***'global environmental management'***. They consider such a management as an intensely political process (and likely a complex task), being sure that no understanding of its development could be complete that did not take interests and their environmental management politics, both domestic and international, seriously.

In 2001, the scientific communities of four international global change research programmes[25], recognizing that in addition to the threat of significant climate change there is growing concern over the ever-increasing human modification of other aspects of the global environment, in their joint Amsterdam Declaration[26] agreed to intensify cooperation through setting up an overarching Earth System Science Partnership and declared an "urgent need" to develop "strategies for Earth System Management". The research communities represented in this Partnership contend that the earth system now operates 'well outside the normal state exhibited over the past 500,000 years' and that 'human activity is generating change that extends well beyond natural variability—in some cases, alarmingly so— and at rates that continue to accelerate.' To cope with this challenge, the listed programmes have called for 'an ethical framework for global stewardship and strategies for Earth System management' (Biermann, 2007, p. 326). IHDP took up this challenge in March 2007 by mandating an international group of governance experts to develop a science plan for a new international, long-term research project within IHDP – the so-called *Earth System Governance Project*[27]. One can see that the drafting group has opted for the concept of '*governance'* instead of '*management'*.

Biermann (2007, 2008) explains this evolution of terminology as follows.

For social scientists, 'management' is a term more closely related to notions of the hierarchical steering, planning, and controlling of social relations. As a result, 'earth system management' brings connotations of technocratic interference in social processes

[25] The International Geosphere-Biosphere Programme (IGBP), the International Human Dimensions Programme on Global Environmental Change (IHDP), the World Climate Research Programme (WCRP) and the international biodiversity programme (DIVERSITAS)

[26] See: *http://www.sciconf.igbp.kva.se/Amsterdam_Declaration.html*

[27] A project website: *www.earthsystemgovernance.org*

because the term 'manager' implies who controls, plans, and decides. From a social science perspective, 'earth system management' as an analytical or normative concept is both infeasible and – in its connotation of hierarchical planning – undesirable. Global stewardship for the planet is different from centralized management and, instead, must be based on non-hierarchical processes of cooperation, coordination, and consensus building among actors at all levels, including state and non-state actors. It must also "…include complex architectures of interlinked institutions and decision-making procedures, but also different forms of collaboration, such as partnerships and networks". Thus, in a world of diversity and disparity, earth system 'management' is no option. Instead, *"…we hope to observe the emergence of a new, different paradigm: earth system governance"*, Biermann (2008, p. 23) theorizes.

Usually, the term *'governance'* denotes new forms of regulation that differ from traditional hierarchical state activity and implies some form of self-regulation by societal actors, private–public cooperation in the solving of societal problems, and new forms of multilevel policy. Other uses are normative in the sense of 'good governance' and management-oriented – in the sense of 'corporate governance'. *Earth system governance,* in Biermann's (2007, p. 327) understanding, is the interface of two broad strands of academic inquiry: earth system analysis and governance theory. The notion of integrated 'earth system analysis (science)' has emerged from the complexities of global environmental change as a holistic super-discipline that aims to capture all processes in nature and human societies as one interlinked system, thus requiring the involvement of most academic disciplines at multiple spatial and temporal scales. Earth system analysis relates to 'sustainability science' because the challenge of sustainable development is so complex that requires a 'sustainability science' as a new integrative field of study (Kates *et al.*, 2001). The study of earth system governance is thereby part of the larger project of global change research, yet must also remain autonomous in its distinct methodological and theoretical development. The earth system governance theory unites those social sciences that analyze organized human responses to earth system transformation, in particular, the institutions and agents that cause global environmental change and the institutions at all levels that are created to steer human development in a way that secures a 'safe' co-evolution with natural processes.

Earth system governance also relates to the discourse on 'global governance' that is often used as a description of modern world politics, sometimes limited to traditional forms of international relations, but sometimes broader to encompass a variety of social and political problems and interactions at all levels[28]. Biermann (2008, p. 23) defines *earth system governance* as *"…the interrelated and increasingly integrated system of formal and informal rules, rule-making systems, and actor-networks at all levels of human society (from local to global) that are set up to steer societies towards preventing, mitigating and adapting to global and local environmental change and, in particular, earth system transformation, within the normative context of sustainable development"*. As such, it must cope with at least five problems that make this challenge particularly difficult (Box 2.12).

The 'Earth System Governance' project was an attempt to engage social scientists in the study of 'the coupled human and ecological system'. Lövbrand *et al.* (2009) have

[28] As one example, *"Worse worlds are very possible, if we are not successful in addressing the challenge and problem of establishing effective global environmental governance"* (Roberts 2008, p. 378)

Box 2.12 Problems complicating Earth System Governance

(1) The anthropogenic earth system transformation is marked by persistent uncertainty regarding the causes of global environmental change, its impacts, the interlinkage of various causes and response options, and the effects of possible response options.
(2) The anthropogenic transformation of the earth system creates intergenerational dependencies that pose further exceptional governance challenges. Cause and effect of earth system transformations are usually separated by decades, often by generations.
(3) Earth system governance must respond to the functional interdependence of earth system transformation and of potential response options. The former relates to the interdependence of natural subsystems, social systems and policy areas, while response strategies in one problem area or one policy domain are likely to have repercussions in other.
(4) The anthropogenic transformation of the earth system creates new forms and degrees of (global) spatial interdependence. This relates to both natural (direct) and social (indirect) interdependencies.
(5) Earth system governance has to cope with, and gains its particular relevance from, the extraordinary degree of harm that is possible, and that current governance systems might not be fully prepared for.

Source: Bierman, 2007

advanced '*Earth System Governmentality'* as an alternative analytical concept. He identified it "as a mode of analysis that resists the Earth System metaphor as a natural point of departure for global environmental change research and instead focuses on the range of practices that have produced the 'coupled human and ecological system' as a thinkable and governable domain, by drawing attention to the close links between thought and intervention" (p. 12).

Today's ways of ***governing the environment*** also are undergoing a revolution. The most salient feature of this revolution is the evidence that the state – the primary actor responsible for governing the environment for much of the second part of the 20th century – is steadily becoming less important and sometimes completely sidelined in many instances. One general reason for declining the importance of the state is captured well in the notion of the 'shrinking state' that characterizes the rise of neoliberal economic reforms and the associated prescriptions of tax cuts, smaller government, and privatization (Agrawal and Lemos, 2007). The collective effect of these prescriptions has been retrenched bureaucracies and lower state revenues as well as lower budgetary and human resources to implement and enforce environmental policies. In less developed countries, budgetary crises can be particularly costly to environmental protection, increasing the motivation to accelerate the extraction of natural resources to support growth.

The complexities, immediacies, and ubiquities of environmental problems have demanded novel and unusual human responses, and new forms of *environmental governance,* which comprises the rules, practices, policies and institutions that shape how humans interact with the environment (UNEP, 2009). *Good environmental governance* takes into account the role of all actors that impact the environment – from governments to NGOs, the private sector and civil society. Cooperation is critical to achieving effective governance that can help to move towards a more sustainable future (Box 2.13).

Here, as a starting point, Agrawal and Lemos offer four major forms of 'hybrid governance' and regulation across the dividing lines represented by states, markets, and communities (Fig. 2.17), namely: *co-management* (between state agencies and

Box 2.13 UNEP and Environmental Governance

The mandate of UNEP is to be the leading global environmental authority through delivery of expert scientific assessments to providing international platforms for negotiation and decision making. Also, UNEP is undertaking a consultative process on the reform of International Environmental Governance, as one of the pillars of sustainable development (See: *http://www.unep.org/environmentalgovernance/*). The UNEP's Environmental Governance program promotes informed environmental decision-making to enhance global and regional environmental cooperation and governance. Working with the states and all major groups and stakeholders, UNEP helps to bridge the science and policy gaps by keeping the state of the global environment under review, identifying threats at an early stage, developing sound environmental policies, and helping nations successfully implement these policies. The program focuses on strengthening global, regional, national and local environmental governance to address agreed environmental priorities with four key goals:

- *Sound science for decision-making:* to influence the international environmental agenda by reviewing global environmental trends, emerging issues, and bringing these scientific findings to policy forums;
- *International cooperation:* to assist international cooperation in achieving the agreed environmental priorities and to support efforts to develop, implement and enforce new international environmental laws and standards;
- *National development planning*: to promote the integration of environmental sustainability into regional and national development policies, and to help to understand the benefits of this approach;
- *International policy setting and technical assistance:* the work with nations on strengthening their laws and institutions, and helping them to achieve environmental goals, targets and objectives.

Source: Adapted from UNEP (2009)

communities), *public-private partnerships* (between state agencies and businesses), *social-private partnerships* (between businesses, NGOs and/or communities), and *multi-partner governance* incorporating actors from all three arenas. Each form incorporates the joint action of at least two actors from the core triangle and seeks to address the weaknesses of a particular agency or arena by drawing upon the strength of its potential partner. Such reconfiguration of environmental governance, when the state is no longer the only or even the most important actor responsible for add-erssing environmental externalities, has enormous implications.

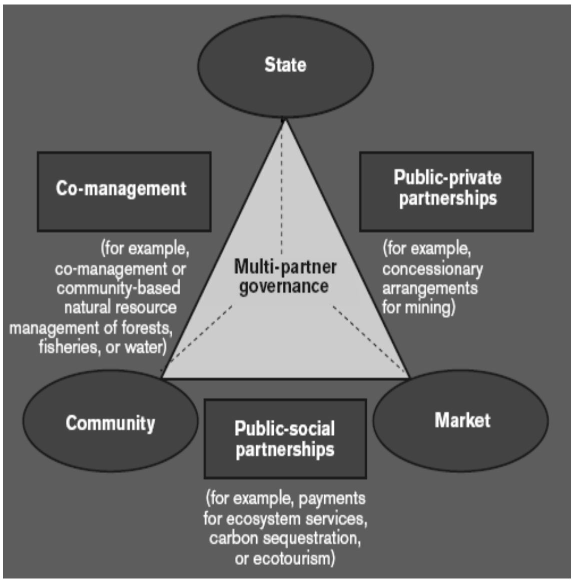


Fig. 2.17 Multi-partner governance. *Source:* Agrawal and Lemos, 2007

As additional reasons for 'multi-partner governance', Agrawal and Lemos (2007) name many new actors, which have come to play incr-easingly important roles in the global environment (e.g., climate or waters), and appearance of entirely new system of ways to regulate the environment. New strategies of regulation are replacing and supplementing older control strategies that were typically based on laws and fines. Today's efforts are pursued by a number of international conservation organizations and represent the convergence of three different insights related to environmental governance: (1) the sustainable environment is a global common good; (2) positive environmental externalities exist at the global scale, and (3) cross-national perspectives on environmental stewardship need to be valued in concrete material terms.

2.2.2.2 Environment and business: corporate environmental management

The revolution in current ways of thinking about environmental governance is most clearly visible in the decline of state agencies and the new attention that market-based approaches have received (Agrawal and Lemos, 2007). The involvement of market actors, mechanisms, and incentives in environmental collaborations adds significantly to the arsenal of ways the environmental problems and crises can be addressed; it also is seen as having the potential to address the inefficiencies of state or community action, often by injecting competitive pressures in the provision of environmental services or through the use of price signals. The basic principle upon which market oriented mechanisms rely—the activation and mobilization of agent incentives—has become increasingly common even in those hybrid strategies of environmental governance that do not explicitly involve market actors. However, the efficient performance of markets requires that a large number of conditions related to property rights, competition, externalities, transactions costs, product characteristics etc. to be satisfied. Although some of these conditions can be met by market organizations, the corporate actors and consumers usually rely on state agencies for their proper definition. For example, it is governments that determine what volume of GHG emissions to permit and whether to allocate the permits freely or to auction them. Thus, a greater role for markets in environmental governance must go together with effective advocacy and safeguarding of the stakeholders, interests, and values that may not be easily priced, and the state and its agencies must play a basic role in such processes. As Agrawal and Lemos concluded, "the state is dead; long live the state", keeping in mind its three essential roles: creating the rules that shape markets and allow them to function, guiding the political processes through which nontraded goods and values are priced, and crafting redistributive policies that guard against the worst effects of efficiency driven market dynamics. Roberts (2008), also clearly recognizing a shift in the character and role of the state, notes that addressing environmental issues requires strengthening the state at all levels: local, regional, national, supra-national and global.

The roles of the state can best be performed by decision makers whose actions are made transparently and through a process that is subject to checks and balances from those influenced by decisions. In particular, environmental issues influence business, and business influences environmental protection (Schaltegger and Figge, 2000). The interaction of business with the environment is of increasing interest within the community. Managers, particularly those in firms that attract attention to their environmental management practices, can no longer ignore the implications of these practices' impact, both physical and financial, upon the environment. Strategic environmental assessment, planning and decision making in public authorities can only be effective along with meaningful sustainability and environmental strategies of private companies or, in other words, with close co-ordination of public and corporation environmental policies.

Cherp (2004) included the following elements into environmental policy, planning and management cycle *in public authorities*: at the planning stage – Sustainable Development Strategies (SDSs), Environmental Policy Integration (EPI) and SEA; at the implementation stage – the SEA follow-up and Environmental Management System (EMS). The analogous cycle in *corporations' policies* includes Corporate Environmental Strategies (CESs) as well as SEA and project-level EIA, conducted by corporations, – at the planning stage, followed by SEA, EIA and EMS – at the implementation stage (Fig. 2.18). These cycles include also *methodological* and *operational* linkages.

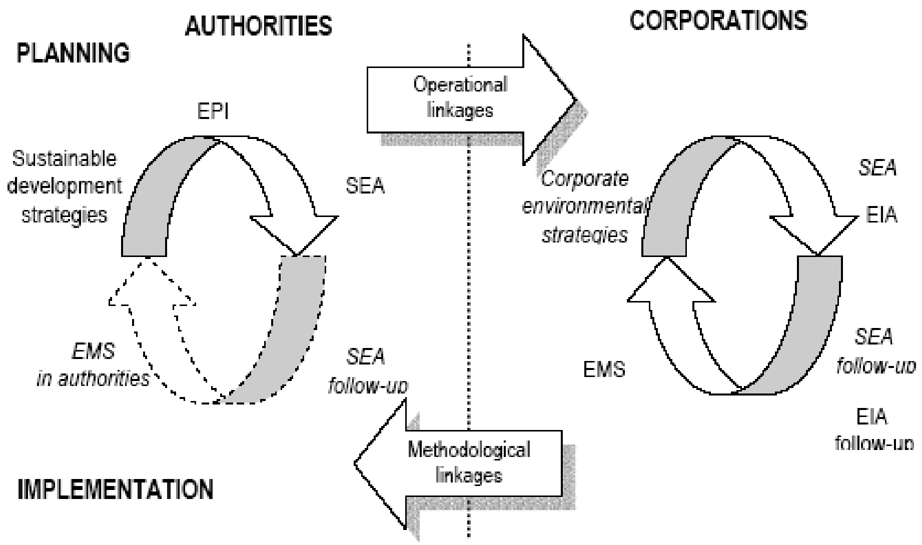


Fig. 2.18 Key elements of environmental planning, assessment and management tools in public authorities and corporations. *Note:* 1. *Italic* designate emerging and less established concepts; 2. Abbreviations – see text. *Source:* Cherp, 2004

Corporate Environmental Management (CEM) has established its place in the boardroom of top management (Schaltegger and Figge, 2000). Cherp (2004) expressed the main rationale for strengthening the linkages between corporate environmental management and strategic decision-making in the governance sector as two-fold. On the one hand, *public authorities* are increasingly facing challenges similar to that of private corporations, namely, to organize their processes and routines in a business-like (market-driven) fashion, managed by goals and objectives, and rapidly respond to changing external circumstances, including environmental demands. On the other hand, *private corporations* are increasingly viewed as being not only major sources of environmental impacts, but also active agents of environmental change and management. Thus, this author (p. 5) considers *Corporate Environmental Strategies* as *"…an approach to overcome limitations of traditional EMS through integrating the environment into core corporate strategies"*.

In particular, the adoption of EMSs was motivated by growing world concern about the impact of industrial activities on the environment companies. Rivera-Camino (2001) listed some reasons why firms consider a necessity to use EMSs. The first reason is a reaction to the worldwide awareness of the importance of environmental protection and conservation, which is supported by international efforts to control pollution. The second reason is the concerns of consumers about the environment that cause the eagerness of producers to convince that their manufacturing processes meet environmental expectations. They hope that operation under EMSs convinces the public of achieving recognized environmental performance levels. There are also political advantages in the incentive for EMS, since most countries directly or indirectly support companies that use environmental standards as well as commercial advantages over competitors if firms respond to consumers' growing concern for environmental correctness.

However, Rivera-Camino (2001) further revealed the reasons why European companies hesitate to incorporate EMSs into their organizations and formulated two main causes of the low level of responses: (1) implementation of EMS is often complicated by technical, personal and organizational impediments, and (2) little theoretical and empirical research materials are available to corporate decision makers about the competitive advantages of using these systems. Simultaneously, he expressed the use of EMSs as the result of a process, in which the main external and internal economic–political forces interact within an organizational system (Fig. 2.19). Rivera-Camino describes the role of each component as follows:

Internal forces are the individual perceptions of top management. This is a critical factor in formulating and implementing successful competitive strategies because managers' own perceptions of environmental accountability influence the relationship between the external setting and group pressures.

External forces are mainly the level of green strategy in a business that, as it was revealed, correlates positively with the managerial perception of regulatory and institutional intensity. It is important to know the top management's opinion about environmental issues and the pressures that motivate them to adopt EMSs.

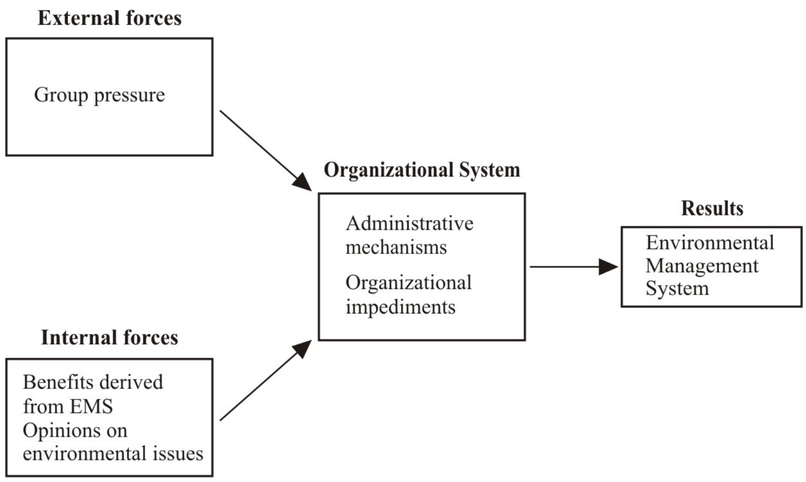


Fig. 2.19 Process of implementing Environmental Management Systems (EMSs). *Source:* Rivera-Camino, 2001

Organizational system. The use of an EMS highlighted the need to manage organizational dynamics, since the incorporation of good environmental practices usually requires changes in organizational structure, the delegation of responsibilities, the training of personnel and the management of communications and control. The organizational dynamics should focus on the variables that firms are unable to control, since these can create serious obstacles in EMSs implementation. Examples include poorly defined objectives and goals, the lack of top-management support, no specification of the individual actions, the lack of required technology, the insufficient allocation of resources, etc. Given the diversity of these variables, it is necessary to determine which of them actually affect EMS implementation, and the organizational actions or routines must be clearly identified before the implementation.

Schaltegger and Figge (2000) analyzed the corporate environmental management from the viewpoint of its links with economic success, or the *shareholder value* of a company. By their opinion, the management often does not pay enough attention to the fact that environmental issues have become an economic reality. At the same time, environmental issues influence the cash inflows/outflows of a company and therefore have a direct influence on its economic value. Thus, only economically oriented, i.e. efficient environmental protection should prevail, and ‘environmentally friendly’ but not economically successful companies can sooner or later disappear from the market. If a company is able to increase its economic success by a progressive environmental management system, it will face fewer internal and external distribution conflicts.

However, not every kind of environmental management increases the value of a company. Schaltegger and Figge noted two schools of thought that had emerged regarding the effect of corporate environmental protection on shareholder value. The one school thinks that the current level of corporate environmental protection conflicts with other business objectives, particularly with increasing the enterprise value for the benefit of shareholders. The other believes that not only the current level of sustainable corporate environmental protection, but also the environmental protection practiced by companies may have a beneficial effect on shareholder value. Both positions highlight the main difficulty in trying to include environmental aspects in company management and valuation. The question is not how much environmental protection is practiced, but rather the combination of what level of protection has been achieved and what kind of environmental protection is practiced by a company. As a conclusion the authors stated that in a general form the equation ‘more corporate environmental protection increases the economic success and the value of the company’ is wrong. Only a pollution prevention strategy that takes into account the effects on the shareholder values’ drivers can secure economic success and improved eco-efficiency. In this context they assume that, in principle, no conflicts between shareholder value and environmental protection exist.

It was also suggested that in successful implementation of the EMS there is a significant role of accounting that could introduce its traditional functions into the environmental management process (Wilmshurst and Frost, 2001).

Usually, in the corporate decision process accountants provide the financial information required to plan for and evaluate the performance of the organization. The financial consequences of an action determine the project’s acceptability, and decisions that are likely to have an environmental impact are also likely to have a financial one. As a result, the corporate accountant is expected to take an interest in evaluating these decisions and hence be involved in the EMS. Wilmshurst and Frost suggested incorporating those accounting mechanisms that deal with the valuation of the environmental impact, environmental performance and flow of financial information, as well as the monitoring of the success of environmentally related action implementations. Linked to other management systems, such an accounting could be expected to enhance the quality of decision making.

2.2.2.3 Environmental management of natural resources

In real world problem settings, a complexity derives from the interactions between the human system, comprising numerous actors and activities, and the natural system (resources) that are mediated by interacting resource regimes (Briassoulis, 2004). It is widely accepted that management of natural resources should aim to benefit all resource users, as equitably as possible, within the constraint of environmental, financial, and institutional sustainability (Cain *et al.*, 1999). However, in practice, natural resource management policies are not working very well, and current patterns and levels of their use are not sustainable. Applying the seemingly 'best practices' too often leads to unintended and unwanted outcomes, and hundreds of diverse social-ecological systems have failed to achieve their goals with resulting social disruption and a decline in the resource base (Walker, 2006; Millennium Assessment, 2005).

Walker explains this situation by the fact that in most cases (even when intentions are good, and different objective local or national factors are neglected) the inappropriate resource use policies and management activities stem from inappropriate 'mental models'. People use and modify nature based upon their notions of how human systems and nature work. These mental models, or paradigms, often either ignore or simplify inappropriately the vital aspects of the ways in which real world systems work actually. The ruling mental models for resource use and development, still based on the deterministic 'command-and-control philosophy' viewing natural systems as highly controllable, mark the early approaches to natural resource management. Prevalence of these models over the world can be explained by four flawed assumptions (Walker, 2006):

- A focus on average conditions, rather than on extreme events, and the fixed and short-time frames and fixed spatial scales, rather than multiple nested scales;
- A belief that problems from different sectors do not interact in the systems, while interacting sectors are a key feature of systems' dynamics;
- An expectation that change will be incremental and linear, when it is frequently non-linear and often lurching;
- An assumption that getting the system into, and then keeping it in, some particular state will maximise yield from the resource base, indefinitely. However, it is an unattainable goal, and there is no sustainable "optimal" state be it an ecosystem, a social system, or the world.

"Partial solutions to problems in complex social-ecological systems do not work for very long", Walker (2006, p. 79) concluded and proposed an alternative approach assuming that social-ecological systems behave as complex adaptive systems with alternate attractors, or alternate system regimes. Three attributes of these systems – *resilience, adaptability and transformability* – determine the topology of the system's stability and, therefore, the likelihood of regime shifts. Governance and management of resilience is therefore concerned with learning how to avoid (or to cross) thresholds between alternate regimes and how to influence the positions of the thresholds. As to climate change problem, this question will be discussed in detail in Chapters 3 and 4.

"Management of natural resources is generally achieved by a combination of experience, intuition, trial, error and effort. This may be successful but is not a basis for effective long term resource management systems which are essential to improved management practice", stated Cain *et al.* (1999, p. 132). Experience has shown that multi-objective management approaches, termed *Integrated Natural Resource Management* (INRM) (Batchelor, 1995)[29], should ideally be comprise of three components: the formulation of management strategies; the implementation of the strategies and monitoring procedures to assess whether the impacts are those intended; and the corresponding adaptation of the strategies.

It is also necessary to keep in mind that resource management operates in the stochastic environment. In the interpretation of Batabyal and Beladi (2006) this means that state of a managed resource at any particular point in time is a function not only of the actions undertaken by a manager, but also of unpredictable environmental factors like droughts, fires, and predators. As a result, even if the manager believes that taken actions ensure that a resource does not hit any of the crisis states, it may still do so.

Institutionally, the use of threatened natural resources can be influenced and managed within a certain *institutional framework* or through *Institutional Resource Regime*. Varone *et al*. (2002, p. 78) understand the latter as *"... a combination of formal property (ownership), disposition and use rights, and the prominent elements of resource-specific protection and exploitation policies, the design of which comprises specific aims with respect to preservation and use, the intervention instruments, institutional actor arrangements, etc."*. The 'disposition rights' are considered as the possibility for the formal owner to freely 'dispose' of the resource or its part, for example, to sell, to give, to rent, etc. Disposition rights refer also to the right to transfer specific use rights or to sell the resource itself versus existent distinguishing "the rights to own and the right to use". Varone *et al*. made also a distinction between the *resource stock* and *resource fruit (or yield).* When one refers to a natural resource management both stock and yield are intended.

According to Briassoulis (2004), *resource regimes* are also historically and socio-culturally determined as a consequence of which they include only a selection of aspects and attributes of a resource with respect to particular activities. In addition to formal ownership and use rights, resource rights may be informally agreed by a local community of resource users and enshrined in community norms and rules of resource use. The spatial and temporal variability and differing degrees of spatial fixity of resources – crucial constraints for the sustainable development of human activities – produce diverse resource regimes at various levels of socio-spatial organization within different time frames.

To address the institutional aspects of natural resource management, Briassoulis (2004) proposed to combine the ideas from the interrelated paradigms of complexity theory with a new institutionalism approach to social and planning analysis. The latter places emphasis on actors (individuals and groups), the diverse relational webs or net-

---

[29] Batchelor, C.H., 1995: *Water Resources Management and Agricultural Production in the Central Asian Republics.* Report on an Agro-Hydrological Consultancy to Sub-Project 7 of the WARMAP Project, June 1995, Institute of Hydrology, Oxford shire

works to which they belong, the stakes they have in local environments and the practices they follow to pursue their interests. It asserts that individual identities are socially constructed within settings structured by powerful forces—socioeconomic and political organization, social dynamics, nature—where power relations shape the opportunity space and value systems of human agents. The actors, as reflective beings, are not passively shaped by and devise actively their social situation, interacting among themselves and with environment and developing relational bonds of various strengths and reach.

Proceeding from these preconditions, Briassoulis (2004) presented the methodological framework for analyzing the interactions between '*problem setting'* and '*institutional setting*' at each of the principal stages of a policy and planning process (problem definition, policy/plan formulation, evaluation and implementation). Fig. 2.20 shows how these interactions produce complexity in identifying sustainable solutions to environmental problems, the effects of this complexity and its implications for planning/policy effectiveness. In this framework the *problem setting* comprises current and potential activities, resources and resource requirements by each activity. The *institutional setting* comprises formal and informal actors and resource regimes. Although the stages in Fig. 2.20 are shown hierarchically and sequentially arranged, in reality they intermingle and interact through continuous feedback.

The proposed framework was developed for the analysis of desertification control in Mediterranean Europe. However, some conceptual comments of the author that we decided to present shortly below are of interest for discussing the overall problem.

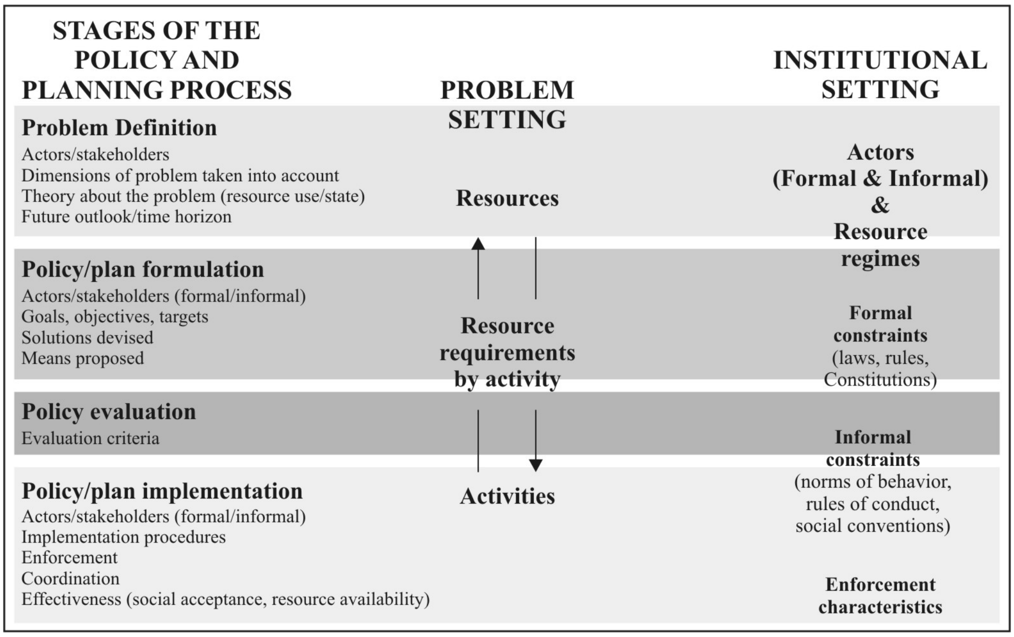


Fig. 2.20 Methodological framework of the interactions at principal stages of a policy and planning process. *Source:* Briassoulis, 2004

Problem definition. An *environmental problem* is typically first defined by those actors who have stakes in particular activities. Consequently, only the resource systems of immediate importance to these activities are emphasized; lesser or no attention is paid to the others that may be directly and importantly related to the first. Several uses of resources may also be excluded from original definition of the problem, and thus are sidelined in a subsequent policy and planning analysis. Activities have different qualitative and quantitative resource requirements that are environmentally and socio-culturally determined. Depending on who defines the problem, the particular physio-chemical attributes as well as functions and dimensions (environmental, economic, or social) of the considered resources are underscored. When several activities compete for the same resource, the pressures and conflicts over resources increase. Generally, *"...problem definitions are activity-led, characterized by particular activity-resource combinations that reflect both the interests of those defining them and the broader historic context and socio-cultural milieu"* (Briassoulis, 2004, p. 120).

The *system of governance* determines who participates in defining the problem. In centralized systems, problems are usually defined 'top-down' and are thus typically more exclusive in who contributes, while in decentralized systems problem definition may be a more participatory process. The perception of the problem of those with the 'right to define the problem' influences their active participation and the emphasis placed on certain attributes of the resources considered. In addition to formal, a host of informal stakeholders also indirectly influence problem definition.

Stakeholders that have different socio-economic profiles, goals, interests, future outlooks and preferences for particular activities occupy different positions in diverse relational networks and possess different powers to promote, or even impose, their favored definition. They espouse different causal theories about the problem and influence the choice of activities, resources and their characteristics, activity-resource relationships and spatio-temporal frames of reference that are considered. Their theories are also influenced by the current state of knowledge and availability of data that can also be incomplete, missing, or even contradictory. Because environmental resources often cross administrative boundaries and spatial levels with different regimes governing and use, and different resource interests, an institutional interplay arises. Interests and resource regimes from various levels influence problem definitions at a certain spatial level.

Multiple, frequently conflicting, problem definitions exist usually when the most powerful interests dominate all others and drive the choice of a problem-solving approach. The problem definition that guides the policy and plan formulation stage is the 'emergent' definition in the sense that it is not the sum of definitions of those experiencing the problem but is the result of their synthesis at some higher level. Resource-wise problems may be ill-defined because uneven emphasis on resources, their attributes and their horizontal and vertical interrelationships, depending on which activities compete for the resources. The present and future causal structure of the problems usually remains vague and unclear, at least at the spatial level(s) at which they are defined. The complexity of the institutional setting results in the spatial and functional compartmentalization of the environmental integrity of resource systems at the problem definition stage. Undoubtedly, this cannot support holistic resource management, and partial, biased, incomplete, competing and exclusionary definitions affect accordingly the solutions proposed and the priorities assigned to policy and planning actions.

Policy/Plan Formulation. At this stage of formulation the additional concerns arise because of the mix of actors involved: the 'old' (those who defined the problem) and the 'new' (those officially charged with policy and plan formulation). The differing traits, competencies, power relations and interests in particular activity-resource combinations determine which goals, objectives and targets are promoted for the problem solution and which theory is adopted. Moreover, because by the time the problem reaches this stage the physical setting may have changed, the problem for which policies and plans are formulated may not coincide with that originally defined.

The devised solutions result from the interactions between, on the one hand, the physical structure and spatial level of the problem setting and, on the other hand, the actors involved, effective resource regimes, technology, available information and scientific knowledge, the presence of uncertainty and the broader policy and non-policy context. The influence of resource regimes is most evident at this stage; resource users promote problem solutions compatible with their ownership and use rights. Well-established resource regimes, such as land property, will produce better defined solutions because the rules of the game are clearer and less uncertain. In contrast, poorly-defined or non-existent regimes at a certain spatial level will generate more uncertain solutions leading to neglecting, overusing or free-riding of certain resources that may cause their damage. Proposed solutions may require the establishment of new resource regimes, where none exists. Extant resource regimes may also influence the types of solutions promoted and whether these are technological or non-technological.

Because of institutional interplay, solutions at one spatial level will bear the influence of regimes at higher levels and also affect lower regimes. For example, local water use, observing the national water laws, must conform to supra-national regulations and respect the water rights of neighboring areas. The spatial fixity of most environmental resources produces keen competition among potential users with incompatible interests and among conflicting uses requiring the same resource simultaneously and contemporaneously. Thus, in achieving desired goals the key challenges facing the design of solutions are the needs for spatial co-ordination and optimal combination of preferred activities. The combination of mitigation and adaptation activities in confronting climate change is a classical example of the latter.

Summarizing the policy/plan formulation stage, Briassoulis (2004) noted that formal and informal actors (usually the most powerful) conceive policies according to their particular interests but not according to the intrinsic characteristics of environmental resources (Hudson, 1999). Design principles are rarely holistic from the viewpoint of resources and serve the needs of activity-related interests. Accordingly, proposed solutions very rarely account for other actors and for the relationships among all resources in a problem setting. The end result is that the use of otherwise indivisible resources is functionally compartmentalized and becomes subject to different regimes and competent organizations. Nevertheless, *"The spatial co-ordination of resource use and of the required means, congruent with environmental carrying capacity limits, is rendered problematic if not infeasible. The solutions advanced inevitably produce unanticipated impacts, generate winners and losers, jeopardize the possibility of integrated resource management and, eventually, of sustainable development"* (Briassoulis, 2004, p. 123).

Policy/Plan Evaluation outcomes hinge crucially on the assumptions, logic and approach to evaluation as well as on the criteria adopted. They all are determined by the 'evaluators' and extant resource regimes. As a result, only selected aspects of activities and resources are evaluated with conflicts arising when pro-conservation and pro-development interests have opposing preferences. The resource regimes may introduce evaluation bias if they do not emphasize all resource aspects and functions; the evaluation may not account holistically for interrelationships among resources and activities. Higher-level resource regimes, in particular, international treaties, may suggest criteria that are too general or irrelevant for lower levels. The obsolete regimes may prove useless, if not irrelevant, for evaluating contemporary policies and plans resulting in the evaluation that reflects the socio-political biases.

Policy/Plan Implementation depends heavily on 'implementers' that include policy makers, formal policy implementers, intermediaries, lobbies and other constituency groups, policy recipients, and mass media, etc. that belong to different organizations and operate at various spatial levels. Moreover, some or most of them may not have participated in the activities at the previous stages. Their participation and effectiveness depend on their official roles, interest in the problem situation and informal rules of conduct. The patterns of interactions among implementers during implementation are not always formally established or clear, frequently evolving into either co-operation or rivalry. Lack of co-ordination among resource regimes and implementing organizations as well as among implementation procedures is common because of the interest-led character of policy/plan formulation. Implementation effectiveness depends critically on the availability of means, optimal combination and co-ordination as well as on the enforcement of policy/plan provisions – requirements that are rarely met in practice. "Enforcement depends crucially on the social acceptance of proposed solutions, the systems of formal and informal sanctions and rewards provided, and the compliance culture of recipients. Implementers who disagree with proposed solutions or with procedures that differ from their customary practices will most probably not observe policy or plan prescriptions, or they will 'bend the official rules' and use available means for other purposes. This is particularly crucial at the level of the actual resource users", Briassoulis (2004, p. 124) concluded. On the whole, ***institutional complexity*** is highest and its implications are most obvious at the policy and plan implementation stage.

Extensive discussions about sustainable development have brought sharply the subject of ***renewable resource management***. Undoubtedly, if the process of development is to be sustainable, then essential renewable resources, including those considered as drivers of climate change, need to be optimally managed. However, despite even the best efforts, these resources may still hit a crisis state.

A key goal of renewable resource managers is to take actions to ensure that the resource being managed stays away from irreversible or crisis states, in which it provides neither consumptive nor non-consumptive services to humans (Batabyal and Beladi, 2006). This statement is especially important for developing countries and some countries in transition that are largely agrarian (for example, Moldova). These countries are significantly dependent on renewable natural resources, and particularly those that are inherent to their local environment (e.g., soil, water, pasture, grasslands, etc.). Given the nature and the extent of this dependence, the optimal management of renewable resources is an extremely important policy objective.

The time taken for a renewal provides information about the character of a resource. If, depending on the existing stock, a resource can renew itself within decision-making periods, it is relevant to humans without targeted human intervention. A renewable resource can exist in a finite number of states, some of which are desirable, others – undesirable, and some of the latter – are likely to be *irreversible*. In these irreversible or *crisis* states the resource is so degraded or transformed that (regardless of efforts to manage it) its return into original or a more favourable state is impossible. Batabyal and Beladi (2006) consider the objective of renewable resource management in *maximizing* the amount of time a resource spends in the desirable set of states, or in *minimizing* the amount it spends in the undesirable—but not the irreversible—set of states.

2.2.3 Environmental assessment and decision making

2.2.3.1 Decision-oriented environmental assessment

In the empirical study of the theory and methods of *decision-oriented environmental assessment,* Pischke and Cashmore (2006, p. 643-644) explained this concept as *"...an expression used to describe theory that seeks to enhance the centrality of sustainability considerations to societal decision-making"*. By their opinion, this ideology is predicated primarily on a critique of the effectiveness and efficiency of conventional environmental assessment, particularly its emphasis on the passive provision of scientific analyses and rationality in decision-making. But although the recognition of potential advantages of decision-oriented theory of environmental assessment is not a new phenomenon, only in recent years it has begun to receive concerted research attention.

Previously, Toth (2003c) formulated key differences between assessment and decision making:

1) Assessment takes place as part of the preparation for decision making, while decision making is the process and act of decision making per se. As such, the assessment is concerned with collecting and organizing data, performing analyses, and searching for the best options according to relevant criteria;
2) The next difference is related to the issue of objectivity, versus values and preferences, and causes some debate in the assessment community regarding whether the assessment can ever be objective and whether it should be as value-neutral as possible. There is no such debate on the decision making side where perceptions, values, and bare interests of different stakeholder groups brutally clash in their efforts to secure a decision favourable to them;
3) Also related but less debated topic is the general principle enunciating that assessments should fulfill demanding criteria of professionalism, incorporate the best available scientific knowledge and use the most appropriate analytical framework. Quite the contrary, the decision making process should be democratic in the sense that there is a fair chance of each affected group to represent and protect their own interests. Professionalism, although a necessary criterion, should not and does not prevent the incorporation of lay or traditional knowledge. It is not to be confused with the decision making process representation where knowledge input and pursuing one's interests are inseparably mingled.

However, the rationale behind the EA, which implies informing decision-makers about the likely impact of their decisions, is not relevant to the environmental aspect only, but to the decisional process as well (Jiliberto, 2002). He justifies this statement through considerations that factors forcing the decision-makers to take into account the likely environmental impact of decisions are not the environment itself or a given environmental value, but the rules of consistent decision-making, which establish *"that a sound decision should take into account all the values at stake"*. The need for public decisions to be consistent with a set of socially accepted decision rules validates EA as a process. The practice also demonstrates that EA goes beyond assessment of the likely environmental consequences of decisions and embrace the broad range of issues, including the consideration of environmental or sustainability objectives, the assessment of environmentally sustainable alternatives, the adequacy of public participation, etc.

Thus, EA as an exogenous process aims to incorporate information on environmental values into decision-making. To depict the role of EA in the decision-making process, Jiliberto (2002, p. 62) even proposed to modify its definition to *"…an environmental decision-making tool the ultimate social objective of which is to incorporate a given set of environmental values into a decision"*. In other words, the way to consider environmental values in a decision is to look at their likely environmental impacts.

For example, Sánchez and Hacking (2002), linking environmental impact assessment and environmental management systems, explained a major shortcoming of the EIA process (the failure to implement adequately mitigation measures or monitor environmental impacts) by disregarding its recommendations and statements when EMSs are implemented. So, they see a considerable, and not accidental, common ground between the planning stage of the EMS and a typical EIA process, since both aim to answer the same questions: "What needs to be managed?" and "How should it be managed?" These significant common tasks and fundamental differences are identified as follows (*ibid*):

- ❖ The initial step common to both tools is impact identification. An important difference is that an environment impact statement (EIS) preparation identifies potential impacts while in an EMS both actual and potential impacts must be considered.
- ❖ Both processes require the ranking of the impacts according to their relative importance. However, in EIA the ranking criteria are submitted for public scrutiny, while in EMS, although a public input is also recommended, the decision whether or not to solicit and how to incorporate these views rests exclusively internally.
- ❖ The environmental consequences of the project – a question that is emphasised in an EIA process for seeking approval for the project – do not feature strongly in an EMS. When an EMS is implemented, the environmental consequences of the activities are usually only considered in sufficient detail for management to be prioritised because, unlike to an EIA where the consequences have to be justified to external parties, an EMS 'audience' is primarily internal. The company's own management can usually be persuaded by less rigorous arguments than would be required to convince external parties.
- ❖ Management measures and action plans are part of both processes, but much more detailed in EMS planning where they should be capable to meet clearly defined objectives and goals. Mitigation and other measures arising from EIA are sometimes stated in vague and imprecise terms, and need to be 'translated' and interpreted to become practical instructions for implementation.

On the whole, project proponents and interested parties benefit in many ways from greater EIA–EMS integration. On the other hand, because they do not aim to achieve the same goal, both are needed.

2.2.3.2 EA and decision-making in the framework of Project Cycle Management

In 1993 the EC promoted a *Project Cycle Management* (PCM) – a set of project design and management tools based on the Logical Framework Approach. In helping to plan, manage and evaluate a project, the PCM was already widely used by many donors, including EU Member States, international organizations and many partner organizations of the EC[30]. According to Project Cycle Management Handbook (EC, 2002) the word "*project"* refers here "… both to a 'project' – a group of activities to produce a Project Purpose in a fixed time frame – and a 'programme' – a series of projects whose objectives together contribute to a common Overall Objective at sector, country or even multi-country level". The way of a project planning and carrying out follows certain sequence beginning with an agreed strategy that leads to an idea for a specific action, oriented towards achieving a set of objectives, which then is formulated, implemented, and evaluated with a view to improving the strategy and further action. Being based around a project cycle, the management ensures that all aspects of projects are considered and all relevant and sufficient information is available, so that informed decisions can be made and any changes that have occurred at key stages in the project life are included in its design. PCM also helps ensuring that stakeholders support the decisions. As a result, projects are more likely to be successful and sustainable.

PCM reflects the decision-making and implementation process through defining the different phases in the project life with well-defined management activities and decision making procedures. The methodology or core tool applied within PCM for project planning, managing and evaluating is the Logical Framework Approach (LFA), known also as a Logframe Approach (LA). The LFA is a technique to identify and analyze a given situation and to define objectives and activities which should be undertaken to improve the situation. After project preparation, the LFA is a key management tool for monitoring its implementation and evaluation. Providing the basis for schedules of activity, the development of a monitoring system and a framework for evaluation, LFA plays a crucial role in each phase of the cycle. Different tools for technical, economic, social and environmental analysis, such as EIA, support LFA effective use. Stakeholders should be involved in the planning as much as possible (EC, 2002).

PCM is used widely in the business sector; it also increasingly used by developmental organizations. Development projects sometimes fail because they are poorly planned and do not take into account these and other important factors (Blackman, 2003).The generic project cycle within EC external aid programmes has six phases (Fig. 2.21). In practice, the duration and importance of each phase may vary for different projects, but within all EC programmes the cycle shares three common themes (EC, 2002):

1. Key decisions, information requirements and responsibilities are defined at each phase.

---

[30] Commission of the European Communities, 1993: *Project Cycle Management, Integrated approach and logical framework manual*. Directorate General for Development, Evaluation Unit, Brussels

2. The phases in the cycle are progressive – each phase needs to be completed for the next to be tackled with success.
3. New programming draws on evaluation to build experience as part of the institutional learning process.

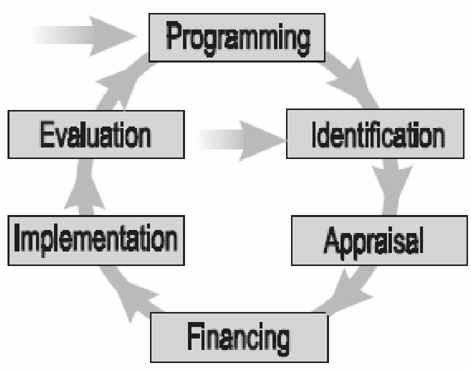


Fig. 2.21 The Project Cycle. *Source:* EC, 2002

Aid co-operation and partnership programs with non-member states involve often complex processes that require active support of many parties.

Thus, PCM can be considered (Ahonen, 1999) as (1) a project planning method including an appraisal, (2) a project management method including a monitoring plan, and (3) a method of *ex post* evaluation. The presence of evaluation in all three dimensions is one of the aspects that strengthen PCM. Ahonen identifies a wide set of evaluation criteria regarding projects, namely: *efficienc*y, which relates means to the results achieved; *effectiveness,* which relates the project purpose to the results; *impact*, which relates the overall objective to the purpose and also in part to the results, with a focus on all planned positive and all unplanned negative effects of the project *relevanc*e, which concerns the adequacy of the objectives of a programme to meet the problems at hand, and finally, *sustainability*, which concerns the permanence of the results and changes accomplished by the project after project funding has ceased.

PCM has a unitary basic format or structure of project documents that follows the core logic of the Logframe Approach and is applied to all documents to be produced during the project cycle (Box 2.14). The next Box 2.15 shows an example of the basic format of documents at the stage of project preparation, proposed by Ahonen for the specific project implemented by a small donor country in a transitional country.

2.2.3.3 SEA and decision-making

The role of SEA in decision-making is widely discussed in the literature on decision-oriented environmental assessment (João, 2007; Kørnøv and Thissen, 2000; Partidário, 2007; Runhaar and Driessen, 2007; Sadler*,* 2001a, b; Sheate *et al.,* 2003; and other).

Much of the earlier work in SEA was based on the assumption that the provision of better information on the environmental impacts of plans or policies will result in more serious perception of environmental aspects by decision-makers than would be the case without SEA, and that this will lead to decisions that will turn out to be better for the environment. Later, the broader approaches were adopted targeting sustainability and pointing out the need for adaptation and integration with a tendency towards participatory approaches (Kørnøv and Thissen, 2000).

At present, SEA is widely recognized as an important tool for integrating the environment into decision-making. This role originates from the one of SEA definitions: *"…a systematic process for evaluating the environmental consequences of proposed PPP initiatives in order to ensure they are fully included and appropriately addressed at the*

Box 2.14 The basic format or structure of project documents

1. ***Summary***
2. ***Background:*** Overall EC and Government policy objectives, and links with the Commission's country programme or strategy, commitment of Government to over-arching policy objectives of the EC such as respect of human rights
3. ***Sectoral and problem analysis,*** including stakeholder analysis and their potentials
4. ***Project/programme description,*** objectives, and the strategy to attain them
   - Including lessons from past experience, and linkage with other donors' activities
   - Description of the intervention (objectives, and strategy to reach them, including Project
5. ***Assumptions, Risks***
6. ***Implementation arrangements***
   - Purpose, Results and Activities (and main Indicators)
   - Physical and non-physical means
   - Organisation and implementation procedures
   - Timetable (work plan)
   - Estimated cost and financing plan
   - Special conditions and accompanying measures by Government / partners
   - Monitoring and Evaluation
7. ***Quality factors***
   - Participation and ownership by beneficiaries
   - Policy support
   - Appropriate technology
   - Socio-cultural aspects
   - Gender equality
   - Environmental protection
   - Institutional and management capacities
   - Financial and economic viability

Annex: Logframe (completed or outline, depending on the phase).

Source: EC, 2002

Box 2.15 Basic format of documents for Project Cycle Management (PCM) preparation

1. ***Summary***
2. ***Background***
   2.1. Government/sector policy
   2.2. Features of the sector
   2.3. Beneficiaries and parties involved
   2.4. Problems to be addressed
   2.5. Other interventions
   2.6. Documentation available
3. ***Intervention***
   3.1. Overall objectives
   3.2. Project purpose
   3.3. Results
   3.4. Activities
4. ***Assumptions***
   4.1. Assumptions at different levels
   4.2. Risks and flexibility
5. ***Implementation***
   5.1. Physical and non-physical means
   5.2. Organisation and implementation procedures
   5.3. Timetable
   5.4. Cost and financing plan
   5.5. Special conditions/accompanying measures taken by the government
6. ***Factors ensuring sustainability***
   6.1. Policy support
   6.2. Appropriate technology
   6.3. Environmental protection measures
   6.4. Socio-cultural aspects/women in development
   6.5. Institutional and management capacity (public and private)
   6.6. Economic and financial aspects
7. ***Monitoring and evaluation***
   7.1. Definitions of indicators
   7.2. Reviews/evaluations
8. ***Conclusions and proposals.***

Source: Ahonen, 1999

earliest appropriate stage of decision-making on par with economic and social considerations" (Sadler, 2001a, p. 11). Thus, SEA is recognized as an important decision support tool for integrating environmental considerations, along with the social and economic ones, into proposed PPPs, representing, in essence, *"...a key instrument for integrating environmental considerations into the highest levels of development decision-making in support of sustainable development"* (Sadler 2001b, p. 27).

Specifically, this definition of SEA process delineates its role and the relationship to decision-making in terms of three key interrelated functions (Sadler 2001a, b):

- To analyze and document the environmental effects of proposed strategic actions;
- To identify alternatives and measures to mitigate significant adverse effects;
- To ensure that relevant findings are considered and fully integrated in the decision-making process, consistent with policy objectives for environmental protection and sustainable development.

These functions can be divided into three categories, corresponding to:

→ *substantive goals*, achieving environmental protection and promoting sustainable development (the so-called "top-down" strategy);
→ *instrumental goals*, responding to and overcoming the limitations of project-level EIA (the so-called "bottom-up" strategy); and
→ *institutional goals*, integrating environment into the decision-making process (the so-called "mainstreaming" strategy).

SEA applies to all types of proposed strategic actions and decisions that are likely to have potentially important adverse environmental effects, both direct and indirect, including through setting direction and initiating or giving authorisation to other subsequent decisions and actions that may affect the environment. Where a proposed action forms a part of a hierarchy or a series of contingent decisions, the assessment shall be appropriate to the particular stage and context of a proposed action, taking into account any requirements for consideration of effects at the subsequent level of decision-making (Sadler, 2001b).

Thus, SEA is a tool that intends to inform decision-making processes related to PPP proposals with an ultimate aim not to carry out the SEA per se but to use it in achieving the best possible strategic decision. The established best-practice way to achieve this is through integrated models that assume that strategic actions are subject to multiple stages of decision-making and attempts to integrate SEA into each of those decisions (João, 2007). Furthermore, SEA seeks to inform the decision-maker of the degree of uncertainty over impacts, as well as the level of consistency in objectives and the sensitivity of the baseline. It also provides a process in which a wider group of people can be involved in decision-making (Sheate *et al.,* 2003).

The SEA sourcebook and reference guide (Dalal-Clayton and Sadler, 2005) qualifies SEA as a *decision-aiding* tool rather than a decision-making process that needs to be flexibly applied to policy and planning cycles. However, the Guide admits other comments that have argued that SEA needs to be more sensitive to the real characteristics of decision-making (e.g., Nilsson&Dalkmann, 2001). From such a perspective, SEA encompasses assessments of both broad policy initiatives and more concrete programmes and plans that have physical and spatial dimensions. The important interrelationship of policies, plans and programmes is frequently idealised as a hierarchical or tiered process of decision making, although the reality is often quite different. This is particularly the case of the policy-making level, which does not necessarily follow a logical sequence of discrete, technical steps, being often a more complex, iterative process. As a 'compromise', the Guide explains that, logically, the scope and form of SEA should correspond broadly with the level of generality of decision-making and the type of environmental effects that are identified. Typically, direct effects can be correlated with

Box 2.16 Factors that contribute to SEA impact on decision-making

- flexibility that fits into the decision-making context
- stakeholder participation
- transparency and binding character of SEA process
- quality of the assessment
- values in SEA should reflect values in policy context
- ‘openness’ of decision-makers to environment/sustainability
- SEA ‘tiering’ with other assessments
- adequate resources and effective communication
- assessment and mitigation of redistributional effects.

Source: Runhaar and Driessen, 2007

projects, plans and programmes that initiate and locate specific activities. Indirect effects are associated more with policies, strategies and legislation – particularly those that are not easily separable into discrete actions but have an environmental dimension (Dalal-Clayton and Sadler, 2005).

Based on the mentioning in literature, Runhaar and Driessen (2007) identified some factors that contribute to the impact of SEA on decision-making (Box 2.16). However, they consider this list mainly as indicative, partly because of the lack of unanimity on how SEA impact is defined. Besides, a large part of the used literature was based on experiences and analyses that have been made in a selected number of countries (mainly the Netherlands and the UK), and the validity for other countries can be questioned. Partidário (2007) also adheres to the opinion that in the SEA decision-centred models there is a framework of key functions and activities, but no established standard and streamlined process. Each case has its particularities and, once objectives are set, the specific SEA process is designed to fit the decision-making process, which is its object. SEA is intended to affect policy processes and their outcomes, and if so the approach should be guided by insights into the nature of decision processes and the ways to influence these processes (Kørnøv and Thissen, 2000).

Runhaar and Driessen (2007) formulated also main lessons that can be learned from the discussion on the analysis of SEA impact on decision-making. They think that impact, as well as factors contributing to this impact, will depend on three contextual determinants: (a) degree of consensus about norms and values regarding the policy issue; (b) certainty about the knowledge base; (c) characteristics of the decision-making process, in particular the ‘openness’ of decision-makers to outsiders or other norms and values. One may expect that ‘lists’ of factors that are favourable for SEA impact on decision-making will vary along these dimensions.

Finally, to evaluate the effectiveness of an EA system, its direct and indirect impacts should be compared to the potential impact. The latter depends on the environmental or sustainability performance of the assessed policy, plan or programme, as well as on the often-mentioned ‘openness’ of decision-makers to environmental values. Fig. 2.22 expresses certain ‘summary’ of the discussion about (S)EA impacts on decision-making.

There is an opinion (Pischke and Cashmore, 2006) that contemporary interest in decision-oriented theory has arisen as a consequence of the proliferation of SEA. As one seemingly innovative product of this interest they named development of a new conceptual and methodological framework for SEA – the so called *Analytical SEA* (ANSEA). ANSEA is founded on the hypothesis that a thorough understanding of a decision process can be used to identify critical moments (‘decision windows’) when environmental input

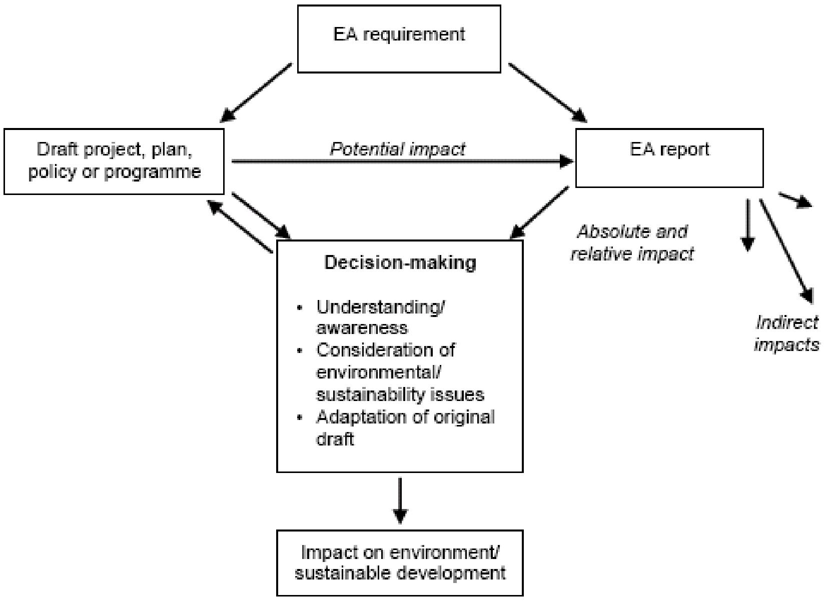


Fig. 2.22 Impacts of EA on decision-making: types and magnitudes. *Source:* Runhaar and Driessen, 2007

can potentially influence the sustainability of outcomes. At these critical moments, through the application of principles of good decision-making, ANSEA proposes introduction of environmental values, rather than information per se. Thus, it moves environmental assessment away from analyzing the environmental consequences of decisions to the analysis of decision processes themselves.

Such a shift in the main SEA paradigm, expressed as ANSEA methodology, is summarized in Table 2.6. The focus on broad principles of good decision-making (such as timeliness, comprehensiveness and participation), is partially caused by conventional impact prediction practices that are not necessarily realistic at strategic levels (Dalkmann *et al.*, 2004; Glasson *et al.*, 2005). At the project level of decision-making, where the assessment context differs considerably, Pischke and Cashmore have considered feasible ways to define precise interpretations of the good decision-making principles in the form of generic procedural criteria (Table 2.7). Nonetheless, the overriding aim of these criteria also remains the integration of environmental values and the analysis of decision processes, but not the consequences of decisions, although the principles are more prescriptive and rationalistic than in the analysis focused on strategic decisions.

Thus, some aspects of decision-oriented theory offer considerable potential for environmental assessment process management, and should be employed routinely, although uncertainty remains about whether certain core concepts, notably the detailed a priori description of decision processes, can be achieved in practice. The significance and importance of decision-oriented theory lies *"...in the contribution it makes to redirecting attention away from the debilitating preoccupation with procedures, towards a more balanced research agenda, focused on the substantive intent of the US NEPA, and environmental assessment more generally"* (Pischke and Cashmore, 2006, p. 659).

Table 2.6 Outline of the analytical SEA (ANSEA) methodology

Stage	*Description*
Screening	A decision is made concerning whether ANSEA is an appropriate approach to use and its relation to the relevant legislative framework
Scoping and identification of procedural criteria	Identification of: (a) legal and institutional characteristics of the decision process, and their interrelations; (b) development of a set of generic procedural criteria for good decision-making, against which decision windows can be assessed
Functional description of the decision process	The development of a description of the decision process in terms of the inputs, analysis and outputs at each stage
Identification of decision windows	The key decision moments within a decision process, where the consideration of environmental issues is important and/or influential, are identified. These are referred to as decision windows
Assessment of decision windows	Specific criteria for the analysis of individual decision windows are developed from the generic procedural criteria and applied
The ANSEA report	Documented summary of the findings of the ANSEA process
Review	An on-going process of monitoring and evaluation that may be conducted for a variety of purposes, depending on the nature and aims of the case under consideration

Source: Pischke and Cashmore, 2006

Table 2.7 Generic procedural criteria of good decision-making principles

Criteria	*Definition*	*Input*	*Analysis*	*Outcome*	*Context*
Comprehensiveness	Relevant sustainability criteria considered throughout the decision-making process	Sources of information available and sources of information used in practice	Type of analytic tools considered for use; Appropriate set of alternatives considered	Environmental considerations form part of the decision-making process	Demonstrable consideration of alternatives
Timeliness	Critical information inputs received and outputs produced on time. Sufficient time allocated for specific tasks and decisions	Information available in a timely manner	Time-efficiency of analytical tools employed; Adequate time available for analysis	Outcome of decision(s) incorporated into decision-making process	Process perceived as time-efficient
Transparency	Opportunities exist for scrutiny by both internal and external parties to ensure environmental values are incorporated	Transparent information sources	Explicit account of assumptions and results obtained; Accessibility of process	Reports are publicly available	Feedback given to stakeholders

Table 2.7 (continued)

Criteria	*Definition*	*Input*	*Analysis*	*Outcome*	*Context*
Participation	Adequate scope provided for stakeholder engagement. Their input is used in a balanced and constructive manner	Involvement of affected stakeholders at an appropriate stage in decision-making	Appropriate stakeholders involved	Stakeholders engaged in stages leading to the final decision	Participation prior to, and following, final conclusions of the environmenttal assessment
Credibility	Robustness and consistency of inputs, analysis and outputs guaranteed in order to reduce potential bias	Consideration of mitigation	Specific provisions available to guide decision and employed in practice	Peer review of analysis and outcomes	Linked to earlier stages of EIA

Source: Pischke and Cashmore, 2006

2.3 Environmental policies and low

2.3.1 Integration of the environment in policy-making

It is widely accepted that integrating the environment into policy-making is a key principle of moving towards sustainable development. McCormick (2001, p. 21)[31] defined *environmental policy* as "…any (course of) action deliberately taken (or not taken) to manage human activities with a view to prevent, reduce or mitigate harmful effects on nature and natural resources, and ensuring that man-made changes to the environment do not have harmful effects on humans".

Environmental planning and policy problems concern mostly the negative environmental externalities of human activities. Because of their complexity, the human/environment systems create inherently complex societal problems that require actors to set goals, to design future courses of actions and to use various means to implement the solutions chosen. The effective achievement of sustainable socio-spatial developments depends critically on availability and particular combinations of environmental and human resources, the readiness of resource owners – individuals or groups belonging to various spatial/organizational levels and subjected to diverse and not always mutually congruent resource regimes – to agree with proposed solutions and to dispose their resources as prescribed. A social acceptance and a broad social and political consensus are seen as equally important. Due to these and other factors the complex societal problems are often ill-defined or, on the contrary, have many definitions, their

[31] McCormick, J., 2001: *Environmental Policy in the European Union. The European Series*. Palgrave, 347 p.

causes and structures are vaguely understood and future evolution is unclear and unpredictable. If to add that knowledge and data are often missing or contradictory, the environmental planning and policy problems are hard to analyze and handle with ready-made solutions (Briassoulis, 2004).

The worldwide wave of concerns regarding the environment "…has resulted in a movement away from a piecemeal and *ad hoc* approach to environmental policy-making to a more proactive cross-sectoral approach, where environmental considerations are integrated into all policy areas" (Sheate *et al.,* 2003, p. 5).

Wilkinson (1998) identifies three forms of the environmental integration strategy:

(i) *top-down integration*, binding frameworks constraining the actions of sectoral departments, often led by a strong environment ministry reviewing and regulating the environmental performance of other departments;
(ii) *bottom-up integration*, where integration occurs independently within sectoral departments through a gradual process and where the environment ministry can only persuade or influence;
(iii) *intermediate steps*, where sectoral departments face increasing constraint as they are required to apply 'integrative mechanisms' such as SEA or environmental auditing and reporting.

On the other hand, Bailey and Rupp (2004) divided the literature on environmental politics into three *main schools of thought:*

1. With a focus on the role of environmental policy in maximizing the public interest through the application of environmentally effective and economically efficient policy instruments (Baumol and Oates, 1988);
2. A *public-choice* theory that holds that environmental policy is determined less by the public interest of environmental protection and more by the efforts of policy actors, both private and public, to maximize their self-interest (Dryzek, 1997);
3. *Institutionalism* theories that regard the historical–institutional contexts in which decisions are made as pivotal to understanding the resilience of national policy-making styles. Although these are not impervious to change, they usually evolve incrementally and respond only slowly to policy innovations (Wurzel *et al*., 2003).

2.3.2 Instruments of environmental policy

Concerning the history of the environmental policy, Bailey and Rupp (2004) noted that throughout the 1970s – early 1980s it was driven almost wholly by *command-and-control regulations.* Increasing dissatisfaction with "…legislation's track record in resolving complex environmental problems…" resulted in "…a somewhat paradoxical development that the institutionalization of environmental policies in most European countries had taken" (Lahusen, 2000, p. 253). Although the struggle against environmental degradation and pollution was established as the state's regulatory task, thus underlining its responsibility in this sphere, the state's regulatory actions in the environmental policies were criticized and considered as a field where the state expands and deepens its powers and controls. The state was *"…being perceived less as a problem-solver and more as part* *of the problem itself, in that its regulations increase costs and expand bureaucratic interventions, which are slow and badly targeted, and therefore often inefficient and ineffective"* (*Ibid*).

These general debates has prompted a significant shift towards the use of New Environmental Policy Instruments (NEPIs) and resulted in the recognition of a necessity to re-orient regulatory actions. State regulation (legislation), even when referring to its 'tougher' command and control instruments, has been grounded on a wide cooperation between state agencies and social groups on the international, national and local levels. A cooperative orientation is becoming a 'leitmotiv' of environmental regulation as such. The European institutions introduced a number of documents dealing with cooperative instruments (e.g., tradable permits and environmental agreements between state and industry, eco-taxes and eco-audit) that aim to institutionalize cooperative relationships between the regulators and the regulated. Bailey and Rupp (2004) argue that the key distinction between NEPIs and state regulation is that they rely less on the assumption, e.g., that polluters will automatically comply with given standards and, instead, create incentives for firms to reduce their environmental impact. Whilst many NEPIs include elements of regulation, they pay closer attention to the methods required for successful policy implementation.

Usually, *cooperation* is understood "…as any structured working relationship between the state and society, be it informal or formal, which aims to prepare, produce and implement commonly supported measures of environmental pollution abatement or prevention informal working relationships" (Lahusen 2000, p. 255). Cooperation fulfils different functions within the regulatory process allowing categorizing the different instruments and procedures. In short, C. Lahusen summarized these functions as follows:

1. The *cooperation* and *consultation* process is widely used and accepted with regard to the definition of goals to be pursued in environmental regulation because it allows mobilization of diverse concerns and expertise and thus formulation of enforceable and practicable laws.

2. State and industry cooperate by 'dividing' duties and responsibilities, and most market-based instruments fulfill the function of relieving the state from regulatory action and/or preventing it from taking undesired measures. The state may threaten to be engaged in a legislative process in order to move industry into voluntary agreements on environmental pollution abatement, or it may negotiate goals and terms in the form of a binding contract. The state can also define the general goals to be reached, leaving their achievement to the market or industry through giving them a mandate to decide by which measures and where the objectives can be attained efficiently and effectively. For instance, the marketable permit systems and joint implementation procedures allow 'clean' industries or plants to trade their remaining GHG emission permits and/or to balance the emissions of diverse sites. The state also can be involved in formulating, monitoring and sanctioning market-based instruments such as eco-audit or eco-labeling, where the respective assessment procedures are authorized or sanctioned by the state or semi-public agencies.

3. The drafting of regulations, guidelines and guidance notes is supported and shaped by an intense cooperation between regulators and the regulated where practitioners, on the one hand, and scientists and technicians, on the other, are crucial participants of this process. The implementation process, particularly with regard to the permitting procedures, also involves heavy consultations.

Bailey and Rupp (2004), in their assessment of the impact of NEPI on the politics of regulating industrial GHG emissions, name two principal policy instruments that are favoured by *environmental economists*: eco-taxes and tradable pollution permits. A chief appeal of eco-taxes is that they leave polluters with the discretion to determine how to respond and which technologies to adopt. Naturally, the companies select the least expensive option to reduce pollution or to pay higher taxes and, thus, eco-taxes help to minimize the cost of raising environmental quality. Residual pollution charges also provide firms with a continuous incentive for further abatement, whereas there is no reason to go beyond the standards set by legislation. A principal objection to eco-taxation is that it restricts competitiveness by imposing additional costs on firms. However, all environmental policies impose costs, but they are simply more transparent with eco-taxes.

Whilst environmental economics presents a normative analysis of causes of and solutions to environmental problems, the so-called *administrative rationalism* deals more explicitly with the bureaucratic organization of environmental policy. Recognizing the increasing complexity of the resolution of environmental issues by isolated individuals, it acknowledges the need to engage expert groups who possess privileged information needed to define pollution standards and polluter groups in the problem-solving process. Correspondingly, decision-making tends to be hierarchical, with leanings towards top-down solutions. *"Whilst administrative rationalism is an apparently efficient way of tackling environmental issues, it assumes that problem-solving capacity resides exclusively within the expert group when, in reality, such knowledge is dispersed and fragmented"*, – Bailey and Rupp (2004, p. 237) argue.

Democratic pragmatism responds to such concerns by emphasizing the need to uphold the democratic accountability of public administration. In place of expert groups, it emphasizes pluralism, networks between the public and private spheres, and open, fluid communication. As a result, *"…many decisions are settled during informal discussions between stakeholders rather than in grand political acts or technocratic committees. Typical problem-solving techniques used by democratic pragmatism include public consultations, dialogue with stakeholders and right-to-know legislation"* (*ibid*).

Bailey and Rupp also refer to democratic pragmatism the *environmental agreements* that promote a problem-solving dialogue between government and industry during the definition of environmental standards and implementation timeframes. The benefits from this approach include, for example, the more willing of firms to share technical information and expertise that leads to more appropriate and achievable standards. However, environmental agreements also have some drawbacks, for example, when industry representatives seek to weaken agreements by withholding or misrepresenting, rather than sharing, information.

Thus, environmental politics involves complex interplay between rival ideologies and interests where three theories are distinguished. Bailey and Rupp (2004) summarized them as follows:

- *Public-choice theory* explains political behavior as a struggle between the competing self-interests of actors involved in policy networks, wherein policies become deflected from best serving the public interest;
- *Capture theory* suggests that politicians are vulnerable to pressures from powerful economic elites. Politicians may often intend to uphold the public interest but

frequently lack essential technical information and become reliant on industry guidance, leading to regulatory capture and the extraction of concessions in exchange for cooperation;

- *Bootleggers and Baptists theory* suggests that industry may frequently portray a shared concern for environmental protection that belies a covert agenda to protect market share by diluting policies or strategically supporting measures that provide competitive advantages.

Concluding their review, Bailey and Rupp (p. 239) stated that *"…environmental politics, like environmental issues, is inherently complex and defies neat categorization. Disputes surround not only the motivations behind environmental policy, but also its design and polluter responses to different instruments. In reality, no single theory fully captures the intricacy and fluidity of environmental politics … What is clear, however, is that the shift from standards-based regulation to more flexible and incentive-based NEPIs has the capacity to profoundly alter relations between government and industry in the environmental sphere, particularly during policy implementation"*. Based on the implementation of climate policy in UK and German they showed that some states are adapting to NEPIs more skillfully than others. Whilst the overall pattern is convergence towards economic rationalism, the states with traditions of informal, market-based and cost-conscious environmental policy (like the UK) seem to be integrating NEPIs into policy more readily than those such as Germany, where strong regulatory traditions have led to rather fitful and incremental experimentation and somewhat disjointed policies.

As some continuation of above discourses, let us consider the ***impact of policy analysis on decision-making***, which was discussed by Runhaar and Driessen (2007). They identified various reasons why classical 'rationalization' of decision-making, that is, its improving by means of scientific information, is not self-evident and the outcomes of policy analysis studies often are not accepted by stakeholders or used strategically.

First of all, they think that policy-making has increasingly become a multi-actor activity, implying that decision-making often encompasses negotiation between public decision-makers and stakeholders. This also relates to activities that form partially the policy-making processes, such as analysis. If certain values or interests of stakeholders are not (or not enough) reflected in analysis, opposition may be provoked from a stakeholders particular group. The authority of policy analysis has become also less self-evident because of the many uncertainties dominating some policy areas that cannot be addressed adequately by science alone. In particular, this is an integral feature of complex issues, such as environmental effects of human activity causing an anthropogenic greenhouse effect and climate change.

Therefore, 'rationalization' of decision-making requires knowledge not only scientifically valid but also acceptable to stakeholders (see Sect. 6.1.3.2).

Many issues in global change involve temporal, spatial and socio-political scales that are significantly broader than those encountered in most traditional policy analyses. In principle, an environmental policy exists at all levels, from the international to the local. As a result, the uncritical application of conventional tools can violate the assumptions on which they are based, produce insignificant or misleading findings, and lead to occasional controversy.

Morgan *et al.* (1999) have seen the source of such difficulties in the multidimensional space of global changes. They have chosen three axes that for any particular policy problem indicate: the amount of resources required or at stake; the time-scale, both to implement and to reverse the effects of the choices available; and the degree of political and cultural homogeneity of the people involved (Fig. 2.23). However, despite the fact that past three decades have witnessed an explosive growth in the development and use of tools for quantitative policy analysis, most such tools were developed to address problems that lie near the origin of this space. As one moves outward from the origin, more and more of the underlying assumptions upon which conventional tools are based break down. At the same time, on all three dimensions, many global change problems lie usually far from the origin and may involve very large costs; they are often characterized by long temporal scales and associated intergenerational equity, and may involve a large political and cultural distance between different parties. Thus, one can expect that the straightforward application of standard ideas and methods will often fail.

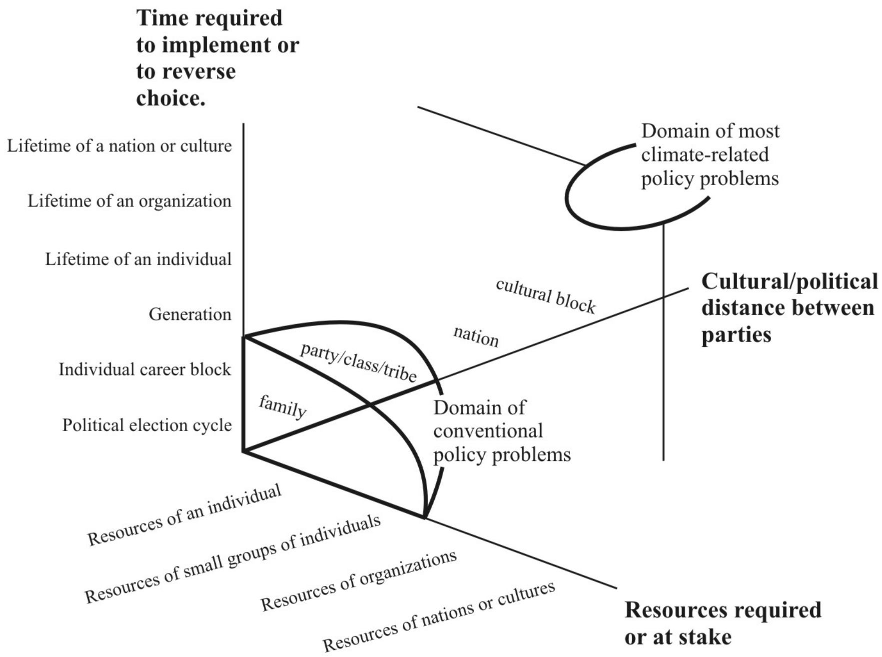


Fig. 2.23 Placing of policy problems in three-dimensional space. *Source:* Adapted from Morgan *et al.* (1999)

To understand those limitations, Morgan *et al.* (1999) identified six basic assumptions on which most conventional policy analysis tools were based, namely:

(1) there is a single public-sector decision maker who faces a single problem in the context of a single polity;
(2) the impacts involved are of manageable size and can be valued at the margin;

(3) the values are known, static and exogenously determined, and that the decision maker should select a policy by maximizing expected utility;
(4) the time preference is accurately described by conventional exponential discounting of future costs and benefits;
(5) the uncertainty is modest and manageable; and
(6) for most questions of interest, the system under study can reasonably be treated as linear.

These authors also proposed several assumptions, which seem as useful up to date:

◆ To avoid above mentioned failures, analysts must think much more carefully about the assumptions on which their ideas and tools are based before applying them to problems that lie far from their ones.
◆ Integrated assessment, at either a local or a global scale, does not automatically address or resolve these problems. The process of trying to perform integration can help to make the limitations of tools more apparent, but the simple fact of integration does not make the problems go away.
◆ Some problems, such as predicting future human values, future technological capabilities, or the structure of future socio-economic systems, are probably insoluble. In such cases, one must find strategies to work around the limitations and be able to gain an understanding of the general character of responses that can be expected under various circumstances, even if prediction of specific responses is beyond the abilities.
◆ Even the best analyses cannot offer magic solutions to the difficult global policy problems such as climate change, but thoughtful one, both qualitative and quantitative, is really the only approach to improve the quality of our understanding.

Presently there are a large number of environmental policy instruments, which overlap with each other as much as they share policy targets. In most cases the steering effects of a policy instrument are affected by other instruments, creating co-effects. The co-effects occur not only within the same policy field, but also between instruments of the different fields. For example, development of renewable electricity generation is counteracted by the restrictions of hydropower for water conservation purposes. This is a task of policy makers to take efforts to integrate such overlapping policy goals. However, not only public authorities – from the supra-national level to national organizations – have responsibilities in policy disarticulation; different private lobby groups actively seek to influence political outcomes. On a practical level, Simóes *et al.* (2005), basing on the assessment of environmental and energy policy instruments overlap, consider the lack of awareness to the issue and lack of knowledge on its impacts as two causes for the occurrence of antagonistic co-effects. This is also due to the very rapid pace of development and implementation of policies that does not include systematic policy evaluation practices. The relevance in overlaps of two or more policy instruments may increase to the extent that they will share the same target stakeholder and that their steering effects occur within related policy goals. For example, two policy instruments that steer the behavior of totally different stakeholders and whose steering effects are not at all related are of course not overlapping. However, if the stakeholders are different, but the steering effects are closely related, there is a relevant overlap. The overlap is even more relevant if different instruments steer the behavior of the same target stakeholder. On the whole, Simóes *et al.* (2005) divide co-effects on complementary, synergetic and antagonistic.

2.3.3 Institutional complexity of environmental policy and low

Providing different goods and services, natural resources give rise to three different forms of their use by humans (Varone *et al*., 2002): direct use (e.g., as input factors in production processes or the direct consumption option); indirect use (e.g., absorption sink for pollutants), and immaterial use (landscape, amenity, aesthetic and cultural values). The resource situation is inevitably characterized by a number of beneficiary groups and uses where distinction is made between the *formal owner* (ownership rights), the *appropriator* (disposition rights) and the final *consumer* (use rights). Existence of numerous uses, property, use rights and beneficiary groups is significant from *institutional perspectives;* the disposal and use of the resource stock, the sustained yield as well as goods and services based on the resource are subjected to different regulations with respect to *law* on property and use. All institutional regulations that influence the behavior of the different beneficiary groups and owners, and their rights can be defined as elements of institutional regime. A broader view of institutions as regimes – sets of rules and procedures that structure relations among relevant actors – is more consistent with the interest in the long-term development of society's efforts to manage their interactions with the environment (Clark *et al.,* 2001). Whereas owners have actual ownership and enjoy the rights associated with this ownership, the appropriators have clearly restricted use rights relating to specific resource goods and services. Final users are those beneficiaries who actually consume the acquired goods (e.g., consumers of electricity or drinking water).

As to property and use rights, four classical types of regimes are distinguished: no property, common property, state property and private property. A classical case of resources is *no property* where access to resources is not formally regulated. *Common property,* or open access, intend collective ownership where a resource is controlled and managed by an identifiable group establishing governing rules of the resources use to avoid their degradation. If to consider climate as the common resource, all efforts to mitigate greenhouse emission can be considered as an example of such activities.

The viability of coordinated resource use depends on whether the rights of resource owners and appropriators are violated and their interests are promoted. To design sound solutions that can be implemented, the rights on all required resources must be compatible. Otherwise, the set of feasible solutions is constrained and either development cannot occur or it may have to adapt to extant combinations of use rights. Ill-defined resource rights or their absence result in the resource overuse and degradation – the well-known *'tragedy of the commons'*[32] that leads eventually to unsustainable development. Numerous and diverse formal and informal organizations administer and manage resource rights at various spatial/organizational levels. Unclear relationships and lack of co-ordination among them

---

[32] The *Tragedy of the Commons* is a type of social trap, often economic, that involves a conflict over finite resources between individual interests and the common goods. The conception was popularized and extended by Carrett Hardin to denote the expected degradation of environmental resources when owned commonly. A tragedy unfolds when common-pool resources are exhausted by withdrawals (e.g., overgrazing of land) or harmful additions (i.e., GHG emission). The failure of common resources harms all. Hardin is sure that ruin is the destination toward which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons (Hardin G., 1968: The Tragedy of the Commons. *Science* **162**:1243-1248)

represent additional impediments to combining resources optimally, especially if solutions are proposed by actors distanced from the ultimate policy or recipients and ignore locally established resource rights (Briassoulis, 2004).

This author also notes that proposed policies require the specification of implementation means: legislative (laws, regulations, conventions, treaties), administrative economic (levies, prices, penalties), financial (subsidies, grants, etc.), physical (infrastructure, etc.), technological, and so on. Resource users differ with respect to the means they command; resource rights are critical among them. Economic and financial means determine the implementation chances of proposed solutions. Resource users with rights of use but without economic resources cannot to success in any development. Because of lack of funds many legislated and officially endorsed plans also remain inactive. The uneven distribution of economic resources among actors results in differences in power to promote their particular problem definitions and associated solutions as well as to manipulate resource-related institutions to achieve their ends.

A classical policy analysis in natural resource management is mainly focused on the implementation of certain measures (e.g., protection and use policies) and on the evaluation of the resulting effects (e.g., promotion of sustainability). In principle, this rule is adequate to decision-making and environmental assessment. Varone *et al*. (2002) understand policy design as all formal legal regulations, informal coordination clauses and institutional structures of a public policy that policymakers and social actors deem necessary to regulate, when using a natural resource, which is politically perceived as being scarce. A policy design always includes substantial, procedural, material and symbolic dimensions where these authors distinguish five constitutive elements:

1. *Political goals* including the social conditions to be aimed at in the area of a collective problem to be resolved;
2. *Instruments* comprising the measures to be implemented to achieve the defined aims and the procedural rules for their implementation;
3. *Target groups* that are social actors whose behavior is considered by the protection or use policy as relevant to the resolution of the problem in question;
4. *Institutional (implementation) arrangements* defining the authorities and offices responsible for the instruments implementation;
5. *Policy rationale* to realize the desired effects, which comprises causal and intervention hypotheses on the effect structure behind the collective problem and the possible forms of state action.

In the last constitutive elements the causal hypothesis responds to the question who or what is to blame or is objectively responsible for the unacceptable use of a resource that gives a rise to the political definition of target groups. The intervention hypothesis responds to the question how the behavior of these target groups can be influenced in a way to achieve the defined aims. This gives rise to the political definition of policy instruments (Varone *et al*., 2002).

And, at last, in the early 1980s, to analyze how societies organize economic, political, and cultural institutions to address environmental crises, the ***ecological modernization theory*** *(EMS)* emerged within a group of scholars at Free University and the Social Science Research Centre in Berlin (among them were J. Huber, M. Jänicke, U.E. Simonis and other). EMS basic assumption relates to environmental readaptation of economic growth and industrial development. Mol (2001, p. 3)[33] defined this process as *"…centripetal movement of ecological interests, ideas and considerations in the social practices and institutional developments of modern societies"*. Ecologically modernized societies incorporate principles of environmentalism in the design of institutions to regulate human interactions with nature. A market economy, democratically elected government, and constitutionally guaranteed rights and freedoms are necessary institutions for ecological modernization. These institutions function as reflexive mechanisms with the potential to soften the human footprint on the planet.

Some statements (elements) of EMS are discussed by Zahran *et al.* (2007). In particular, based on the literature analysis these authors emphasize that an economic dimension of ecological modernization results in the restructuring of production to increase energy efficiency while to decrease environmental externalities. This involves a series of technical solutions – *refinements of production* – that transform the composition of an economy from 'heavy' to 'lighter' industry rested on technological innovation and increasing productive efficiency. Efficiency gains help to preserve resources and reduce pollution. At the same time, a lighter economy requires effective governance. This political dimension of EMS stresses democratic openness as an institutional requirement for balancing economic and environmental imperatives. Flexible governance, extensive civil liberties, political rights, and participatory policymaking characterize ecologically modernized countries. The presence of democratic institutions increases the probability that environmental and economic values are given fair consideration in policy formation.

Ecologically modernized countries couple market-based approaches with traditional command-and-control regulation to coordinate production-side environmental problems and do not see the world as 'an anarchic game between egoists'. *"The willingness to cooperate internationally is a partial function of strong internal democracy and the presence of an environmentally concerned public. This brings us to the third dimension of ecological modernization – culture"* (Zahran *et al.* 2007, p. 42).

Really, one of the basic rules of international law[34] is that States shall not inflict damage on or violate the rights of the others. In environmental law this is captured in the so-called *'no harm rule'*, which in turn has its foundations in the principle of good neighborliness between States that are formally equal under international law. Principle 2 of the 1992 Rio Declaration reiterates this rule of customary international law, outlawing transboundary environmental injury:

> *"States have the sovereign right to exploit their own resources pursuant to their own environmental and developmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction".*

[33] Mol, A.P.J. 2001. *Globalization and environment: The ecological modernization of the global economy*. Cambridge, MA: MIT Press

[34] Under *international law*, Tol and Verheyend (2004) have in mind only public international law, defined as the law between nation states, as opposed to private international law, which tackles issues of law between persons of different jurisdictions, and domestic law, such as tort law in distinct jurisdictions. States are responsible for violations of public international law and are obliged to compensate the indirectly or directly affected states for the damage caused

With regard to environmental damage, Tol and Verheyend (2004) distinguish two basic views in international law: (i) a state has to violate a duty of care or a rule of international law to incur responsibility, or (ii) where significant environmental injury is concerned, the causal link between injury and activity attributable to the state is enough to trigger state responsibility and compensation duties.

2.3.4 Evolution of EA policy and law in transitional countries

2.3.4.1 Environmental law and policy research and networks

As it is noted more than once in this book, the Eastern European transitions are unique because they involve changes in both economic and political systems and their corresponding institutions[35]. As to 'environmental transition', a peculiar combination of strong environmental legislation and high pollution levels was seen here: the former was rarely respected since the responsible bodies were vastly weaker than the industrial ministries (Pickvance, 2002). The 1990s decrease in pollution, including in GHG emissions, was caused primarily due to decreasing economic activity.

Cherp and Antypas (2003) identified three 'waves' in environmental assessments and policy research in transition countries (EITs).

The first examinations appeared almost in parallel with the beginning of the profound reforms in the early 1990s and to the mid-1990s were mainly concerned with comparative legal analysis. They were aimed to meet the agenda of reforms, focused on approximating the EITs' emerging systems to those of developed countries. The policy advice arising from these studies attempted largely to help lawmakers to bring EA[36] related statutes into closer conformity with EU regulations and EA systems of Western countries and International Financial Institutions. However, addressing this first and most obvious challenge, that time research left unexamined the politics of environmental legal reform as well as institutional arrangements and capacities of the EITs themselves. The legal requirements, even precisely reflecting the best international practice, could not be directly translated into local administrative and other institutional action. In reality, a policy advice arising from such studies was often ignored because was focused heavily on further legal reforms that in many cases were difficult or even impossible to accomplish. Additionally, the correlation between 'advanced' law and good practice in EITs was not as strong as it was expected. In a number of cases EA systems functioned poorly in the *presence* of 'improved' law and, on the contrary, better in the *absence* of formal legal acts or under rather 'unreformed' legislation.

The second wave of research was based on the case studies of EA application in transition countries, providing with either positive or negative examples. The main shortcoming of this approach was the low representativeness of case studies due to their description of unique situations, their funding from foreign or international sources and thus difficulties in wide replications.

---

[35] Process of transition and countries in transition as a special issue are discussed in Sect. 5.2

[36] In the quoted paper the term EA relates to both project-level Environmental Impact Assessment (EIA) and Strategic Environmental Assessment (SEA) of policies, plans and programs

The third wave in the analyses of EA law and practice started at the end of the 1990s. This more systematic and integrated research reviewed, for example, the quality of environmental impacts statements and attempts to measure their impacts on decision making. They also have put capacity analysis into research agendas and tried to relate the features of EA procedures and practice to the institutional context of particular countries. The major finding of these studies showed that EA systems in transition countries followed the different paths of reforms, depending on their economic, political and international contexts. Since social, political, economical, and other changes are occurring very quickly, a significant amount of non EA-specific analysis should be done to ensure that proposals of EA systems reform are 'in gear' with their transforming contexts. A challenge is to translate this general conclusion into practical recommendations for policy-making.

In summary, Cherp and Antypas (2003) believe that relative studies in transition countries have so far not fully succeeded in answering three fundamental questions:

1. To which extent is it feasible and desirable to model EA provisions in EITs on the approaches accepted in "best international practice"?
2. What are the reasons for the varying extent of implementation of EA provisions in EITs and what can be done to reduce the gap between law and practice?
3. What have been the effects of EA systems on societies and the environment? How can beneficial effects be enhanced?

Moreover, most studies of EA systems in EITs have been centered on formal documents (laws, regulations, guidelines) defining EA requirements in a particular country or internationally. Implementation of such formal policies in practice was at the 'periphery' of these studies. The contemporary notions of policy are different from such an approach in at least two major respects:

a) At the level of *action*, a policy is an ongoing *process,* rather than a simple declaration found in one or more official documents, plus its implementation involving analytically distinct but often temporally overlapping elements and stages in a policy cycle.
b) At the level of *structure*, policy processes involve a much wider range of *actors* than governmental policy makers and bureaucratic implementation structures. Such linked and interdependent actors form a single unit of analysis, usually referred to as *policy networks.*

The concept of policy as a dynamic process implies that "…an analysis of official policy content as embodied in laws and other formal texts should be supplemented by an analysis of all the stages of the corresponding policy process including agenda setting, policy formulation, legitimation, adoption, implementation, and evaluation. The empirical evidence from EITs seems to suggest that the success of EA policies depended upon the process by which they were developed, implemented and evaluated" (Cherp and Antypas, 2003, p. 461). More successful EA systems had been developed through a long inclusive process involving international and domestic experts and stakeholders and trying suggested approaches in multiple pilot cases; less successful EA were developed by narrow circles of experts within short time and with little possibility for trial-and-error adjustments.

Thus, in contemporary policy science "…each stage of a policy process is seen as a contestation between a variety of actors with disparate conceptions of their own interests and in varying modes of relationship to each other. Coordination between actors is seen as an outcome of direct or indirect negotiation and interpretation, attempts to control through coercion or persuasion, and subject to subtle or sudden shifts through the intervention of other actors or a change in the policy relevant context" *(Ibid,* p. 462).

The relevant actors in any given policy arena (or a 'policy subsystem' such as EA) consist of all of those organizations, units within organizations, and individuals that in one or another way work on a particular policy issue. These include the legislators, administrators, bureaucratic offices and staffs, nongovernmental and industry organizations, consultants, scientists, policy analysts, and others. Each of these policy issues is associated with a kind of separate community ('subsystem') that is segmented from the rest of the policy system.

Policy networks are the principle components of policy subsystems. The network concept is particularly useful in illuminating the importance of the flow of resources that define the interdependence between actors. Interaction within networks can be understood as a continuous process of 'translation' and 'enrollment' in which actors negotiate the definition of each others' interests and try to link the interests of others to projects that they want to carry out. The networks within policy subsystems are therefore seen as structures for collective action with greater or lesser degrees of institutionalization.

The concept of actor-networks is potentially an analytically powerful tool for studying EA systems in EITs. First, it is easy to identify the presence of such networks on both national and international levels, e.g., 'the participants of the Sofia Initiative'. Secondly, the development of such networks and their 'translation' functions may be instrumental in understanding the regional patterns of EA systems in EITs evolution (Box 2.17).

Thus, the concept of EA policy would need to encompass all elements of the policy process, recognizing the complex interactions and mutual learning between legal provisions, their multiple and contested interpretations and potentially diverse application. Shortcomings of practice are not merely as "deficiencies of implementation" of otherwise perfect policy, but as part of the policy process that needs to be evaluated. Where the links between these elements function properly, EA policy can develop with reasonable chance of success. A proper focus on the *process* and *structure* is able to tell the difference between dynamically developing EA systems (where legislation and practice, while not always in compliance, tend to converge through integrated networks of actors) and the systems where the practice and legislation are systematically out of touch with each other because policy making and policy implementing institutions are not well linked. At this point, understanding EA policy as a dynamic process occurring in interrelated formal and informal structures, we may well ask to what extent any of this can be designed in order to be more intelligent or effective. This is where the concept of *adaptability* comes in.

2.3.4.2 Toward adaptive EA policy systems in countries in transition

In response to the need to account for the dynamic institutional environment and the rapid rate of social change in transition countries, Cherp and Antypas (2003) proposed the conception of *adaptive EA policies*. The conclusion that successful EA policies should be 'in gear' with societal reforms requires precisely a corresponding shift of attention from

Box 2.17 Environment Assessment network in New Independent States

In CEE*,* the networks of EA specialists have largely been international in character and intermeshed with already established networks of Western experts. Consequently, flows of information, values and expertise from West to East have been greatly facilitated. At the same time, domestic advocates of EA reforms managed to 'enroll' the powerful proponents of the EU accession into their agenda of promoting the best international EA practice. As a result, there was not only a successful reform of formal EA provisions but, in the majority of cases, a widespread uptake of new approaches, especially by professional communities and policy-makers (e.g., Hungary, Lithuania and Slovakia).

The reach of international EA networks into the NIS has been much more limited. Younger professionals participating in these networks were largely isolated from senior policy makers and have failed to advocate the need for reforming EA systems. The latter followed the views on what is the 'right' EA, expressed by the networks of former Soviet officials, many of whom have kept key positions in Environmental Ministries. Due to strong previous links, the NISs have always been attentive to the policies of their neighbors, particularly to Russia. The fact that old practices were especially deeply rooted in federal agencies in Moscow has not facilitated EA reforms in the rest countries. Even where some change of formal provisions was achieved it was rarely translated into practice because the advocates of this change typically failed to understand and to enroll implementation bureaucracies (e.g., Belarus, Russia, Kazakhstan and Armenia).

In Russia, in the early and mid-1990s the policy discourse in the EA field was dominated by the intensive debate between the 'SER camp' advocating this system inherited from the USSR and the 'OVOS camp' advocating a radical reform and introduction of Western-type EIA provisions. The SER advocates were better connected to domestic institutions, while the OVOS advocates had stronger international connections and expertise. Inability of the two camps to cooperate has resulted in stagnation of environment evaluation systems. When the Russian Government abolished the Ministry for Environmental Protection and threatened to repeal SER requirements in 2000, both camps felt sufficiently threatened to finally initiate meaningful co-operation. They tacitly agreed on a concept of the "*Russian EA system*" that included both SER and OVOS and needed strengthening in its entirety. Moreover, the Russian EA community successfully enrolled the World Bank, some large industries, many environmental consultancies and NGOs as well as regional environmental bureaucracies willing to experiment with pilot approaches into the project of 'strengthening the Russian EA system'. Much of this 'translation' and 'enrollment' occurred in the course of the World Bank's and Russian Government's joint study of the effectiveness of EA in Russia (von Ritter and Tsirkunov, 2002). As a result, though the future of the Russian EA system is still unclear, it is now evident that its capacity to survive and develop has increased as the result of the network formation. The SER bureaucracies started to feel associated with rather than threatened by EA reforms, and the OVOS advocates started to fight to preserve SER rather than to dismantle it.

Source: Adapted from Cherp and Antypas (2003)

static 'snapshots' of EA policies to policy processes and related structures. In other words, adaptability of EA policies should be considered from the *process* and *structural* perspectives.

From the ***process*** point of view, adaptive policies are characterized, on the one hand, by their strong connection to the existing social realities and, on the other hand, by their ability to learn, experiment and change when the reality changes. Thus, the idea behind adaptive policies involves translating the major strength of science into the policy world: the capacity of science to challenge existing assumptions, to consider the value and meanings of multiple frameworks at once, and to adapt and adjust according to provisional outcomes of experiments, which may be conceptually laden but are not ideologically bound. It is clear that in countries in transition, experimentation in environmental policy-making should be even more conscious and deliberate.

From the ***structural*** point of view, the adaptive policy systems must be capable to adjust to external circumstances, also being 'in gear' with transition. Weakness of networks reduces the overall capacity of the policy system to make intelligent and adaptive choices. The dynamic nature of policy networks is such that they provide the raw institutional terrain in which adaptive self-reflective and critical policy making can take place.

In conclusion, Cherp and Antypas pointed a number of new directions and challenges for research of EA systems in transition countries. Such process- and structure-oriented research should be able to both determine the extent to which a particular EA policy system is adaptive and recommend measures on increasing its adaptive capacity. Table 2.8 summarizes the features of such research, contrasting it with more traditional criteria used for evaluating EA policies.

Table 2.8 Shift from "policy snapshots" to "policy process and structure" in EA systems studies

"Traditional criteria" for evaluating EA policies	*"Process and structure-oriented" analysis for EA policies in transition countries*
▪ Conformity of EA formal provisions to the requirements of "best international practice" ▪ The extent of practical implementation of legal provisions ▪ Capacity of EA actors in terms of their individual resources ▪ Quality of EIS and related scientific studies ▪ "Effectiveness" of EA, i.e. utilization of its findings in decision-making.	▪ Participation of key stakeholders and policy networks in the EA policy process ▪ Understanding of policy as a dynamic process of change not exclusively limited to "laws" and their "implementation". Monitoring and feedback within such policy processes ▪ Openness of EA policy processes to diverse forms of knowledge, perspectives and international experience ▪ Integration of EA policies with other institutions and processes in CITs ▪ Capacity (systemic, institutional and individual) with a special focus on interaction of actors and networks.

Source: Cherp and Antypas, 2003

2.3.4.3 Legislation in NIS

Research of EA systems in transitional countries is complicated by rapidly changing legal requirements, traditional secrecy, low awareness, scarcity of data and practice, not necessarily adhering to the law (Bektashi and Cherp, 2002; Cherp and Antypas, 2003; Cherp and Golubeva, 2004).

At present, nearly all transitional countries, including NIS, have established some type of EIA legislation and comparable SEA approaches, though they vary in consistency and comprehensiveness. Some countries (mainly CEE) have incorporated provision for SEA under these frameworks and already have considerable practical experience at PPP level (e.g., Czech Republic, Slovakia, Poland). But in NIS countries they are not always implemented in the way intended, available experience is still limited and processes are not yet aligned with internationally accepted practice. The question is whether these developments have met the expectations of the societies that simultaneously try to achieve economic, environmental and democratic improvements (Cherp, 2001; Dalal-Clayton and Sadler, 2005).

The most commonly weakness in the NISs' legal frameworks, denoted by Cherp (2001; nd), is the lack of specific procedural and methodological provisions and details for SEA; sometimes there is seen a mechanical extension of project-level EIA requirements to all types of strategic actions. Both these deficiencies deprive practitioners of clear and realistic guidance. As a result, SEA practices are often conducted outside legal frameworks and vary between individual NISs more than the legislation does. In those countries where EIA/SER laws were passed in the early- or mid-1990s, considerable practical experience has been accumulated, and many thousands of SERs have been conducted. In some other NISs where the comprehensive EIA legislation was introduced only in the late 1990s or is still under consideration the EIA practice is more limited.

The Sofia Initiative on the application of EIA provided a flexible, co-operative framework for regional networking and exchange of views and information among administrators and professionals. Giving a high priority to the development and use of SEA in transition countries, it provided the model that might be adapted to wide international application. However in reality, as Dalal-Clayton and Sadler (2005) stated, a somewhat different perspective had emerged when NIS legal frameworks were compared with World Bank Operational Policy 4.01[37], considered as a proxy for internationally accepted procedural standards. As of the beginning of this century the ranking of SER/OVOS systems according to the World Bank's five broad evaluation criteria on three levels of comparability resulted in the following picture (Klees *et al*., 2002):

- *High comparability* – indicating a legal framework and process that includes all internationally accepted elements and requires only minor adjustments; only Ukraine was qualified from the NIS;
- *Medium comparability* – indicating evident progress in updating legislation but with issues related to implementation, compliance and enforcement of various provisions and the involvement of the public; Georgia, Moldova, Kazakhstan, Russia, Kyrgyzstan, Uzbekistan, Azerbaijan and Turkmenistan were included (in order of ranking);
- *Low comparability* – indicating limited progress in the development of EA systems; Armenia, Tajikistan and Belarus were named (in order of ranking). Countries in this group require usually significant medium-term assistance to develop EA frameworks and the institutional capacity to deliver them, especially at the strategic level.

The Kiev SEA Protocol, which was drafted with participation of many NISs, including those from Central Asia, and despite its obvious importance for EECCA countries, also was not readily accepted and smoothly implemented in the region. A. Cherp (nd) sees a main obstacle for this in these countries' traditions of environmental assessment that differ significantly from the West. Although NISs have formal systems providing for environmental evaluation of strategic activities, there are two closely related weaknesses in these provisions: the lack of specific procedural and documentary

[37] *World Bank Operational Policy and Procedures OP/BP 4.01.* Available at *http://wbln0018.worldbank.org/Institutional/Manuals/OpManual.nsf/toc2/9367A2A9D9DAEED38525672C007D0972?OpenDocument*

requirements for SEA and the mechanical transformation of EIA provisions to the SEA level. Moreover, the following issues may prove to be particularly difficult to address while introducing the Protocol's requirements here:

- The weaknesses and poor compatibility with international requirements of existing project-level EIA systems which could provide the institutional basis for the introduction of SEA mechanisms;
- The traditionally highly sectionalized and technocratic planning systems which allow for little public participation and inter-sectoral coordination;
- Reluctance to address requirements for transboundary consultation due to political disputes related to numerous transboundary issues.

In particular, Dalal-Clayton and Sadler (2005) could not find in NIS any examples of SEA arrangements that were comparable to international legal or policy instruments. In most cases the strategic actions were addressed under SER rather than OVOS frameworks. Moreover, although OVOS legislation applies also to policies, plans and programs (without specifying the procedure to be followed), it has been rarely applied at this level in practice (Klees *et al*., 2002). From an SEA perspective, these concerns raise general questions about the adequacy of the SER legal framework and the consistency of its procedural application at the strategic level.

The survey of the SEA formal provisions has leaded Cherp (2001) to the following conclusions. Though most of NIS formally requires some form of SEA, it often lacks internal consistency. SEA provisions suffer from a lack of specifics in their requirements or the mechanical transformation of EIA provisions to the strategic level. Both features complicate compliance with SEA laws and regulations: the first – because practitioners have no guidance; the second – because the legal standards are not realistically attainable. As a result, it seems that *ad hoc* SEA practice prevails: the absolute majority of internationally reported SEA cases were conducted outside national legal frameworks. There are also significant variations between the systems in NIS and CEE countries; in the latter, in some cases, advances in SEA legislation and practice have been impressive, even by international standards (Dalal-Clayton and Sadler, 2005).

It seems, Cherp (2001) continues, that despite intentions of the post-independence environmental legislation in the NIS to extend SER to all levels of strategic activities, it was the Soviet project-oriented system with its specific set of concepts, procedures and methods that has been inherited by the NIS and are practiced in reality. In addition to the historical explanation for the absence of strong SEA legislation in the NIS, there may be an institutional one. While project-level EIA procedures are "a burden" to individual, mostly private developers, SEA is often viewed as an "encroachment" on the territory of governmental agencies that prepare and approve strategic actions. Therefore, it is not surprising that SEA meets much more effective political resistance than EIA.

Thus, introducing appropriate legal provisions may prove to be only the first and relatively minor step of implementing the SEA Protocol's requirements in EECCA. Other necessary measures should include (Cherp, nd):

→ fostering understanding and acceptance of SEA among environmental, health and sectoral authorities as well as NGOs and the general public

→ training experts in SEA and strategic planning
→ creating networks of SEA practitioners, officials and academics
→ initiating research on SEA models compatible with existing planning structures, and
→ ensuring continuous learning from both domestic and international SEA experience.

2.3.4.4 Implementation of EC Environmental Legislation

In the previous section, the lack of internal consistency in EA provisions in many EIT countries was emphasized. These inconsistencies were partially attributed to the lack of good guidance for practitioners and to the fact that many assessments were conducted outside national legal frameworks. A generally accepted way to rectify the situation is the wide implementation of the European Community (EC) Environmental Legislation that reflects the EC's overriding objective of promoting sustainable development. Such an approach is in accordance with specific treaty obligations regarding the integration of environmental protection requirements into the definition and implementation of other Community policies, as well as with the inherent integrated nature of effective environmental legislation. As a result, no individual EC legal act is implemented in isolation.

The concept of integration is also realized in the special Handbook (REC, 2008) that was developed to provide a planning framework and step-by-step guidance on the approaches and specific activities that are required to ensure the effective and legally compliant implementation of the EC Legislation in the *'environmental sector'*[38]. The Handbook targets existing EU Member States, but also candidate countries and potential candidate countries. The approximate distribution of directives, regulations and decision, included in the Handbook as of December 2007, is shown in Table 2.9.

Table 2.9 Summary of EC Environmental Legislation considered in the Handbook on its implementation

Sector	*Directives*	*Regulations*	*Decisions*	*Total*
Horizontal	7	3	0	10
Air quality	16	6	7	29
Waste management	19	1	8	28
Water protection	13	0	1	14
Nature protection	4	4	1	9
Industrial pollution control	3	2	1	6
Chemicals and genetically modified organisms	7	3	5	15
Noise	1	–	–	1
Civil protection	–	1	5	6
Total	70	20	28	118

Source: REC, 2008

The process of approximating the legal and administrative systems to the large and complex body of EC regulations in the environmental sector is a huge task that requires careful planning and management on an ongoing basis and usually involves three

[38] Here, the term *'environmental sector'* refers to the grouping of EU legal instruments in the environmental *acquis*. See more about '*acquis communautaire*' in Sect. 5.2.3

elements: *transposition* (of legislation), *implementation* and *enforcement*. However, although this sequential listing appears logical and straightforward, the elements are, in fact, dependent on one another. In particular, effective transposition requires the understanding of implementation and enforcement practices and capabilities (application in practice); in turn, the proper understanding of actual legal texts takes into account the obligations relevant to effective implementation, thus ensuring real and effective enforcement.

The planning process of accession to EC Environmental Legislation should be driven by the National program for the adoption of the *acquis.* This Program must set out:

– the current situation (transposition as well as implementation and enforcement)
– short- and medium-term priorities in line with the accession partnership
– institution-building needs, and
– estimations of financial needs in the short and medium term.

Further, effective implementation and enforcement requires:

– reliable data collection systems
– effective systems and institutions for monitoring and reporting on emissions, environmental quality and their inspection
– procedures and tools for raising the environmental awareness in order to secure understanding, co-operation and support of environmental measures to be taken
– institutions and procedures facilitating public participation in environmental management
– administrative and judicial recourse in relation to actual and threatened violations of environmental laws, accompanied by appropriate systems of adequate and dissuasive fines and penalties
– training of staff and affected sectors of society
– adequate funding of implementing and enforcement institutions.

Implementation of the EC Environmental Legislation may cause significant change to national laws; therefore, the country should have in place a framework for co-coordinating legislative and administrative practices across different ministries with a view to achieving their full implementation. It is also important to organize an implementation process that involves as many stakeholders as possible in the discussions regarding the pace at which change in the law is introduced, the manner in which it gives legal effects, and how changes in regulatory practice are to be managed. The experience of different European countries demonstrates that in preparing for accession it is valuable to establish cross-ministerial working groups for the coordination of approaches to certain environmental issues, to develop the long-term programs to recruit and train staff for public organizations in each sector and to use the new "twinning" schemes, and facilitate the transfer of administrative know-how, whereby environmental administrative structures in the country are matched with corresponding administrations in Member States (REC, 2008).

The Handbook is predominantly concerned with the implementation of directives, although there are a number of regulations and decisions with their own challenges as regards their implementation and effects after accession; they are presented in sections specifically dealing with regulations.

Successful implementation of the *environmental acquis* depends to a large extent on the administration. Effective and efficient administrations may be regarded as those having a number of strengths, which the Handbook sees as follows:

- clear competencies for the administration of environmental and related legislation
- clear and efficient procedures for decision making and the implementation of decisions
- skilled professionals, from environmental scientists, engineers and ecologists to environmental law experts
- sufficient staff and funding to carry out the tasks
- strong enforcement rights and capabilities.

As to enforcing the law, this is sometimes more difficult than its developing (see Box 2.18 as an example). Strong enforcement implies strong and committed environmental inspectorates with adequate resources, systems of fines and penalties, and criminal liability for serious violations. It is therefore important to design regulatory systems that can monitor and control the implementation of the environmental *acquis* in a practical and cost-effective manner and to ensure that they operate as intended. Governments are increasingly turning to a range of policy instruments, including economic instruments and incentives, to promote legal compliance, as well as systems of administrative, civil and criminal sanctions.

Box 2.18 Environmental Legislation of Moldova

The initial formation of the Republic of Moldova as an independent state was characterized by a high level of interest in the improvement of its environment, which suffered greatly in the Soviet period when agricultural and industrial pollution as well as overuse of soils, water resources and natural landscapes was common place. Currently, arable lands occupy 76% of the country's territory, so landscape diversity and sustainability are relatively low, although the *Constitution* of Moldova (1994) refers several times to the principle of sustainable environmental management.

First of all, being situated in an area that suffers from aridity, especially in the South, Moldova needs clear water-related legislation, which promotes the complete use of landscapes' capacities to accumulate water for its effective discharge during dry periods. Also, the role of forests as water 'accumulators' should be raised. At present forests cover only 10% of the country's territory. In addition, a significant part of wetlands especially those located along the downstream Dniester and Prut Rivers were drained in Soviet times for agricultural use. Famous Moldavian chernozems – the specific type of steppe soils – cover almost three quarters of total land area. These fertile soils (along with the warm climate albeit with periodic summer droughts) is the main natural resource of the country and creates a good basis for crop production. However, the soils suffer from erosion processes, and a negative trend in crop yields have been observed in recent decades.

Box 2.18 (continued)

Given that about 59% of Moldova's population lives in rural areas, the slogan *"the land should work"* is still very popular despite the fact that its agricultural market is limited, and agriculture is highly dependent on a consistent water supply, which is not sustainable when droughts occur.

The primary national legal act governing water legislation is the 1993 *Water Code*, which will soon be changed to the new *Law on Water* which brings the current legislation into harmony with the EU Water Framework Directive. Two other documents (the 1995 *Law on water protection zones and belts along rivers and water bodies* and the 2001 Governmental Regulation on *Activities to establish water protection zones and belts along rivers and water bodies)* aim at decreasing the diffuse run-off and increasing the water quality in rivers and reservoirs. Important components of these documents are regulations of activities that are allowed in the water protection zones and the establishment of forest belts and hayfields along the watercourses. Delimitation of water protection zones has been made, but the process of establishing them in practice is very slow. The above-mentioned law was adopted when the process of land privatization had finished, and the small rivers' banks became private property, often leading to intensive soil erosion and organic water pollution. At the same time, the 'voluntary approach' has not become a part of Moldovan legislation, and in many cases the laws application faces significant obstacles.

Being a party of the Ramsar Convention on wetlands (2000), Moldova has declared three wetlands of international importance (Ramsar sites with total area of about 947 km^2) in the Dniester and Prut basins. The government produced the model regulation on management of these sites, but there is no experience in coordinating the interests of different public and private stakeholders. As a result, the management plans or are absent, or have not been implemented.

The use of forests' capacity to collect water is a national challenge, but there is a weak understanding of the relationship between forests and water availability as well as a lack of political will to develop and use their ecosystems' service through the expansion of forest areas. Recently, the *Law on the Ecological Network* (2007) was passed, which has the scope to develop a 'forest mosaic' of the territory by creating biological corridors and nuclei, and thus to preserve biological and landscape diversity. However, because implementation of this law could harm the interests of land owners and is needed in investments, nothing has yet been done, and its implementation has been postponed until 2012. Another gap in the forestry issue is a desire to gain profit from forests' industrial exploitation. Over the last two decades, the intensive felling of oaks and other native species has worsened the forests' structure and provoked the domination of acacia – an aggressive alien species, which does not execute effectively a water accumulation function.

There is also evidence of the inefficiency of the institutional framework of natural resource management. Water and other natural resources are managed by the Ministry of Environment, but forests are managed by the Forestry Agency which is directly subordinate to the Government. The *Law on State Fund of Protected Areas* (1998) establishes 12 types of protected areas in Moldova; in total they cover 4.65% of the whole territory.

Box 2.18 (continued)

However, there is a long-term conflict between this law and the *Forestry Code* (1997) because each legal act treats the subordination of reservations differently: according to the Law they are managed by the Ministry of Environment, while the Code subordinates nature reserves to the Forestry Agency. This and other contradictions demonstrate the long-term national-level dispute of two concepts: sustainable development and intensive use of natural resources and ecosystems.

Thus, it is possible to state that environmental legislation in Moldova is still far from being state-of-the-art and significant improvement and enforcement is needed.

Source: Ilya Trombitsky, personal communication

Chapter 3
Vulnerability and Adaptation to Climate Change

3.1 Resilience, vulnerability and adaptation in socio-environmental science

3.1.1 To meaning of terms and concepts

Last-decades climatic extremes bring to light the real and complex interactions of vulnerability, adaptation and resilience – the terms, which scientists are grappling with in the global environmental change and related scientific communities. Modern day science of vulnerability, adaptation and resilience is rooted in several decades of multidisciplinary research under a range of paradigms, theories, and methodologies. These concepts have increasingly been used in the research on the human dimension of global environmental change and sustainable development (Adger, 2006; Folke, 2006; Gallopín, 2006; Janssen *et al.*, 2006; Smit and Wandel, 2006; van der Leeuw, 2008; Young *et al.*, 2006; and others). The wide review of the literature on an effective exchange between researchers and potential information users in this field of science was made by Vogel *et al.* (2007).

Human societies and globally interconnected economies rely on ecosystems services and support (Millennium Ecosystem Assessment, 2005), and it is clear now that patterns of production, consumption and wellbeing are developing not only from economic and social relations within and between nations or regions, but also depend on the ecosystems capacity to sustain them. Therefore, a major challenge is to develop governance systems that make it possible to relate to environmental assets in a fashion that secures their capacity to support societal development for a long time. This requires adaptive forms of governance (Folke, 2006).

Studies of the core concepts in the title have moved forward in tandem, from analyses focusing either on ecological systems or on social systems – toward holistic conceptualizations and models of *socio-ecological systems* (Adger, 2006), *coupled social-ecological systems* (Walker, 2006), or *coupled human–environment systems* (Polsky *et al.*, 2007; Schröter *et al.*, 2005; Turner *et al.*, 2003)[1]. The diversity in definitions is largely explained by the distinct communities from which the concepts originate. But whereas there may be some minor differences in these terms' meanings, they all reflect the importance of the system's social, ecological and economic features alike and emphasize

[1] Metzger and Schröter (2006) cite examples of other terms have been coined to name such systems (e.g., 'nature-society system' or 'eco-social system'), and processes in such systems (e.g., 'civilization–nature interactions'). However, they all acknowledge the fact that humans, as users, actors and managers of the system, are not external, but integral elements of the studied unit

the importance of including both social and ecological systems as well as their mutual interactions when studying their dynamics. These concepts are focused particularly on the behavior and evolution of such systems in the face of threats or hazards posed by different forms of perturbation or stressors. The concept of a socio-ecological system reflects the idea that human action and social structures are integral to nature, and hence any distinction between social and natural components is arbitrary. While the former refer to biological and biophysical processes, the latter are made up of rules and institutions that mediate human use of resources and the systems of knowledge and ethics that interpret natural systems from a human perspective (Adger 2006; Folke 2006; Gallopín, 2006; Janssen *et al.*, 2006; Janssen and Ostrom, 2006; Smit and Wandel, 2006; Young *et al.*, 2006). Therefore, let us decide in favor of the term *socio(al)-ecological system* (SES), defined as the system that includes societal (human) and ecological (biophysical) subsystems in mutual interaction; sometimes, referring to a particular literature source, its author(s)'s original definition will be saved. The SES can be specified for any scale from the local community and its surrounding environment to the global system constituted by the whole of humankind (the 'anthroposphere') and the ecosphere (Gallopín, 2006). Resilience Alliance (2010) defines the "social-ecological system" as a multi-scale pattern of resource use around which humans have organized themselves in a particular social structure (distribution of people, resource management, consumption patterns, and associated norms and rules).

Resilience and two related concepts – '*robustness*' and '*vulnerability*' (all three are properties of combined SESs) – point to structural characteristics of the systems concerned and to whether or not change is necessary for their survival, and only as such they can be understood in relation to one another (van der Leeuw, 2008; Young *et al.*, 2006). These terms, just as *adaptive capacity,* are relevant both in the biophysical and social realms. This also may be the case in international research on global change where understanding of a system's dynamics involves the consideration of both its social and biophysical components and their mutual interactions (Gallopín, 2006). However, being widely used by the life and social science fields with different foci, these concepts are often used with different meanings. The diversity of their interpretations and reformulations across disciplines and problem areas are as varied as evolutionary biology, ecology, cultural studies, computer and other sciences refer to them. Sometimes, the concepts are used interchangeably or as polar opposites. The plurality of definitions is possibly functional to the needs of the different disciplinary fields, reflecting the different intellectual traditions (Adger, 2006; Janssen *et al.*, 2006), but sometimes may also become a hindrance to understanding and communication across disciplines.

The most recent of the terms in use is *robustness*, although its intrinsic meaning is still under discussion, and its use is rather limited. In the present context, it seems to refer to the structural and other properties of a system that allow it to withstand the influence of disturbances without changing structure or dynamics (Young *et al.*, 2006).

3.1.2 Resilience

3.1.2.1 Resilience as a concept

The idea of resilience of SES is a strong and, in some circles, predominant way of addressing adaptation. However, there is a considerable confusion about the meaning of resilience, both theoretically (Gallopin, 2006) and in practice (Klein *et al.*, 2007).

The general meaning of *resilience*, derived from its Latin roots 'to jump or leap back', is the ability to recover from or adjust to misfortune or change. As a core concept, resilience originated within ecology in the 1960s – early 1970s through studies of interacting populations, like predators and prey, and their functional responses in relation to the theory of ecological stability. At present it continues to be used by ecologists in their analysis of population ecology of plants and animals, but also in the study of managing ecosystems (Gallopín, 2006; Young et al, 2006)[2]. In the initial definition of Holling (1973, p. 17)[3], resilience determines "the persistence of relationships within a system and is a measure of the ability of these systems to absorb changes of state variables, driving variables, and parameters, and still persist." This concept was called 'ecological resilience' which, in principle, can be measured by the magnitude of the perturbation can be absorbed before the state of the system falls outside its domain of attraction. In contrast to resilience, the *concept of stability***,** as it is commonly utilized, focuses on the behavior of the system near an equilibrium point or trajectory, and can be measured by the speed at which the system returns to the stable point or trajectory following a perturbation (Gallopín, 2006).

Walker (2006, p. 82) formally, and in a more complicated manner, defined *resilience* as "the capacity of a system to absorb disturbance and to reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks—in other words, stay in the same basin of attraction" where a *'basin of attraction'* is a set (a configuration, a regime) of the system states within which it tends to remain due to its own internal dynamics. Proceeding from such a vision of the concept, *resilience analysis* is about understanding in which basin the system is, where in that basin it is (in relation to the basin's boundaries), how to navigate (either to avoid going into an undesirable basin or to get from an undesirable to a desirable one) and how to alter the stability landscape to make such navigation easier or more difficult. It is also about understanding how exogenous drivers and endogenous processes lead to changes in the stability landscape.

Later, the concept of resilience began to influence fields outside ecology. In particular, it became applicable in the realm of social and socio-ecological systems (Folke, 2006). Since the late 1980s, the concept has evolved from its original focus on resilience and multi-stable states in ecological systems to the study of nested cycles of adaptive change in SESs (in which persistence and novelty are intertwined), and finally to transformations that can cascade up scales when small, fast events trigger big, slow ones. It also has been increasingly used in the analysis of human–environment interactions, mainly to describe and understand how humans affect the resilience of ecosystems (Janssen *et al.,* 2006; Young *et al.,* 2006).

In the context of climate change, resilience has become a common concept related to vulnerability and adaptation (IPCC, 2007d; Jerneck and Olsson, 2008). Vulnerability is sometimes described as the flipside of resilience, implying that the loss of resilience results in vulnerability to changes that previously could be absorbed. This is illustrated by

---

[2] Hereafter, following the different works and reviews, the older references, used by their authors, in more cases are dropped

[3] Holling, C.S., 1973. Resilience and stability of ecological systems. *Annual Review of Ecology and Systematics* **4**:1–23

three dimensions of resilience (Carpenter *et al.*, 2001), adopted also by the Resilience Alliance (2010)[4]:

(1) the amount of disturbance a system can absorb and still remain within the same state or domain of attraction;
(2) the degree to which the system is capable of self-organization (versus lack of organization, or organization forced by external factors), and
(3) the degree to which the system can build and increase the capacity for learning and adaptation.

In other words, re*silience* of a given system is evaluated in terms of the amount of change it can undergo (e.g., how much disturbance or stress it can handle) and still remain within the set of natural or desirable states, i.e. remain within the same 'configuration' of states, rather than maintain a single state (Turner *et al.*, 2003). This understanding is very close to the IPCC definition that refers to resilience as "the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organization, and the capacity to adapt to stress and change" (IPCC, 2007d, p. 880).

In a similar manner, the *resilience perspective,* which emerged from a stream of ecology that addressed system dynamics, in particular, ecosystem dynamics, and where human actions early became a central part of understanding the capacity of ecosystems to generate natural resources and ecosystem services, is also increasingly used as an approach for understanding the *dynamics* of social–ecological systems (Folke, 2006). Folke describes that aspect of resilience, which concerns the capacity for renewal, re-organization and development that is essential for the sustainability discourse. He believes that if to define resilience "as the capacity of a system to absorb disturbance and re-organize while undergoing change so as to still retain essentially the same function, structure, identity and feedbacks" (p. 259), then in a resilient SES disturbance has the potential to create opportunity for doing new things, for innovation and for development. Adger (2006) argues that in vulnerable systems even small disturbances may cause dramatic social consequences. He also guesses that emerging insights into the resilience of SESs complement and can significantly add to a converging research agenda on the challenges faced by human-environment interactions under stresses caused by global environmental and social changes.

3.1.2.2 Resilience management and governance

It is argued (e.g., Smit and Wandel, 2006) that the resilience perspective shifts policies from those that aspire to control change in SESs, assumed to be stable, to managing their capacity to cope with, adapt to, and shape change. The *basic concepts* underpinning a resilience approach to policy and management are: non-linearity, alternate regimes and

---

[4] *The Resilience Alliance (RA)* is a research organization comprised of scientists and practitioners from many disciplines who collaborate to explore the dynamics of social-ecological systems. The body of knowledge, developed by the RA, encompasses key concepts of resilience, adaptability and trans-formability, and provides a foundation for policies and practices of sustainable development. The focus of the RA is social-ecological systems

thresholds, adaptive cycles, multiple-scale and cross-scale effects, adaptability, transformability, and general vs. specified resiliencies (Resilience Alliance, 2010)

Resilience and related concepts influence a variety of interdisciplinary research focused on SESs, especially through the key components of adaptive capacity, the flexibility of ecosystems, and the ability of social systems to learn in response to disturbances. Because different SESs differ in their resilience characteristics, the explicit incorporation of differential resiliencies has become a critical element of their analysis (Turner *et al.,* 2003). Managing for resilience enhances the likelihood of sustaining desirable pathways for development in changing environments where the future is unpredictable and surprises are likely. One alternative to the command-and-control paradigm is the adaptive governance and management approach that aims to understand and manage the resilience of SESs. The erosion of resilience leads to increasing vulnerability to external shocks and results in progressively smaller amounts of disturbance needed to push the system across a threshold into an alternate regime, with concomitant social, economic and ecological costs.

A rationale for such a vision is the following (Walker, 2006).

The essential feature of a SES is that any region has a defined pattern of resource use around which humans have organized themselves in a defined social structure – resource management and consumption patterns, associated norms and rules. The aim of ***resilience management*** is to keep the system within a configuration of states *('a regime of the system')* that will continue to deliver at least existing levels of ecosystem goods and services, and to prevent it from moving (shift) into undesirable configurations, expressed in delivering fewer goods and services from which it is either difficult or impossible to recover[5].

A basic tenet of a resilience approach is that SESs are essentially non-linear in their dynamics and are self-organizing, conforming to complex adaptive systems behavior. With no possibility of regime shifts and non-returnable thresholds, there is no fundamental problem in resource management or governance because the system is always smoothly reversible within current technology and resource constraints. In non-linear systems, however, the likelihood of alternates, with thresholds between them, is high. Any intended or unintended shift from one system regime to the other can be irreversible or very hard to reverse. Therefore, resilience management is emphasized on identifying alternate regimes and the capacity to avoid or change the thresholds between them.

A more complex SES where two, three or even more possible regime shifts can occur at different scales and in different domains (ecological, social, economic) demands the development of a comprehensive theoretical basis for their interactive effects, or the best way to include them in developing a program for resilience analysis and management. In particular, the issue of specified (or targeted) resilience, versus general resilience, emerges here. Making one part of a system very resilient to one set of external shocks can impact the resilience of some other parts to a different set of shocks. Walker explains this

[5] Resilience Alliance (2010) propose a very close in meaning, but slightly expanded definition: "The aim of resilience management and governance is either to keep the system within a particular configuration of states (system 'regime') that will continue to deliver desired ecosystem goods and services (preventing the system from moving into an un-desirable regime from which it is either difficult or impossible to recover) or to move from a less desirable to a more desirable regime"

situation by the fact that systems, responding to the most frequent kinds of disturbances they experience, become very resilient (robust) to them. But they do not self-organize in ways to be resilient to very infrequent disturbances, and hence are very fragile in that regard. Thus, increasing the resilience of one part of a system to one set of shocks will lower its resilience in other directions. The challenge is to incorporate both specified and general resiliencies into any resilience analysis and management program.

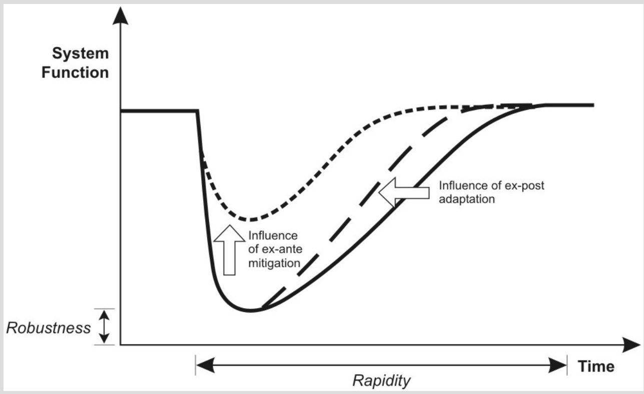
As an example, the vision of resilience to extreme events of an infrastructure system is shown in Box 3.1.

Box 3.1 Decision contexts of resilience to extreme events within infrastructure systems

When looking at natural hazards and disasters, resilience is considered as the ability of a specific infrastructure system (or facilities in this system) to absorb the shocks of such extreme events. Moreover, as a quality of the system, resilience reflects not only its inherent vulnerabilities and capacities, but also decisions and actions that could be taken to foster infrastructure system resilience within an established administrative framework.

The occurrence of any disaster leads to a rapid decrease in system performance. The extent to which the system's function is maintained (i.e. is not driven to zero) reflects its robustness to a given external shock.

Following the disaster, the system is regaining some level of stability or equilibrium. The speed with which this recovery of function is achieved reflects the system's rapidity. The figure illustrates that robustness and rapidity can be improved by both ex-ante and ex-post (before and after an extreme event) decision making. That is, resilience can be enhanced by both risk mitigation activities undertaken before the disaster and response activities following the event.



Effect of decision-making on resilience

Source: McDaniels *et al.*, 2008

Building adaptability may, undoubtedly, involve some duplication, and because resilience has a cost, the identification of the consequences of a known regime shift allows determining how much it is worth to invest in resilience or, vice versa, to assess the likely consequences of not investing in it. The imperative for policy and decision makers is to explicitly show tradeoffs. Thus, *"getting an understanding of resilience into policy arenas and replacing the mindset of command-and-control partial solutions with a resilience management and governance approach"* (Walker, 2006, p. 91) is one of the most pressing issues confronting the achievement of sustainable development.

3.1.3 Vulnerability

3.1.3.1 Concept of vulnerability: evolution of understanding

Vulnerability has emerged as one of the central organizing concepts for research on global environmental change (Adger, 2006; Füssel H.-M., 2007; Gallopín, 2006; Schröter *et al.*, 2005; Smit and Wandel, 2006; Turner *et al.*, 2003; Young *et al.*, 2006). The scientific use of 'vulnerability' has its roots in geography and natural hazards research, but generally this concept has been used in different research traditions such as ecology, public health, poverty and development, secure livelihoods and famine, sustainability science, and finally – in climate change research. Given the diverse fields that this term is linked with, vulnerability is not a straightforward concept, and there is no consensus as to its precise meaning. Some definitions of this term are contradictory, and it is used to mean different things by different authors. Nevertheless, whereas vulnerability is defined in different ways, it generally includes the attributes of persons (systems) or their groups that enable them to cope with the impact of disturbances, like natural hazards (Janssen and Ostrom, 2006). Depending on the research area, this concept has been applied exclusively either to a societal subsystem, to an ecological, natural or biophysical subsystem, or to a coupled SES, variously referred also as a target system, an unit exposed, or a system of reference (Gallopín, 2006).

In the 1990s, natural hazards scholars started to focus on the vulnerability of people to impacts of environmental change. At that time vulnerability was defined as "the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard. It involves a combination of factors that determine the degree to which someone's life and livelihood is put at risk by a discrete and identifiable event in nature or in society" (Blaikie *et al.*, 1994, p. 9)[6]. At present, a number disciplines use the term vulnerability, but only in the area of human–environment relationships, by the opinion of Adger (2006), it has common, though contested, meaning. Moreover, in the environmental arena, despite the different approaches, there are many commonalities in vulnerability research, two of which Adger describes as follows:

1. *Vulnerability* to environmental change does not exist in isolation from the wider political economy of resource use. Vulnerability is driven by inadvertent or deliberate human action that reinforces self-interest and the distribution of power in addition to interacting with physical and ecological systems;
2. There are common terms across theoretical approaches. In particular, vulnerability is most often conceptualized as being constituted by components that include *exposure* and *sensitivity* to perturbations or external stresses and the *capacity to adapt,* or it is the function of three overlapping elements: *exposure, sensitivity*, and *adaptive capacity. Exposure* is the nature and degree to which a system experiences environmental or socio-political stress; the characteristics of these stresses include their magnitude, frequency, duration and spatial extent of the hazard. *Sensitivity* is the degree to which a system is modified or affected by perturbations.

---

[6] Blaikie, P., T. Cannon, I. Davies, and B. Wisner, 1994: *At Risk: Natural Hazards, People's Vulnerabilities and Disasters.* Routledge, New York, NY, USA

A very close position is supported by other authors. So, regardless of whether physical or social factors are in play, Tol and Yohe (2007) also believe that vulnerability of any system to external stresses is determined fundamentally by its exposure to the manifestations of those stresses and its baseline sensitivity to those manifestations. A system's ability to cope with exposure and/or sensitivity depends, in turn, on the degree to which it can exploit its innate (or developed) *adaptive capacity* – a property that itself is supported by underlying determinants such as the availability of economic resources, technology, information and skills, infrastructure, institutions, and equity. All three factors work together to define social-economic thresholds of tolerance to external stresses (of which climate change and climate variability, for example, may be two of many) in ways that are clearly path dependent and site specific (Smit *et al*., 2001).

The concept of ***sensitivity*** also varies amongst authors. For instance, Smit and Wandel (2006), additionally to the above understanding of Adger (2006), talk about exposure-sensitivity and argue that sensitivity is not separable from exposure. Luers (2005), combining two concepts, defines sensitivity as the degree to which a system will respond to an external disturbance and includes in the concept the system's ability to resist change and to return to a previous condition after the stress has been removed, i.e. properties that are usually considered as associated with resilience or with coping capacity. For Gallopín (2006), if sensitivity, in its general sense, is the degree to which a system is modified or affected by an internal or external disturbance (or set of disturbances) and, conceptually, can be measured as the amount of the system's transformation per unit of change in the disturbance, then in the simplest case it specifies only whether or not this system is sensitive to a given factor. In this view, *"sensitivity is an inherent property of an SES, distinguished from its capacity of response… It is an attribute of the system existing prior to the perturbation and separate from exposure"* (Gallopín, p. 295).

Adaptive capacity, according to Adger (2006), is the ability of a system to evolve in order to accommodate environmental hazards or policy change and to expand the range of variability with which it can cope. The system's adaptive capacity is also understood and called the *coping capacity* (Turner *et al.*, 2003). As noted by Smit and Wandel (2006), some authors apply 'coping ability' to shorter-term capacity or the ability to just survive, and employ 'adaptive capacity' for longer-term or more sustainable adjustments. In view of this lack of agreement, Gallopín (2006) used for this component of vulnerability the term '*capacity of response*', generally understanding under this term a system's ability to adjust to a disturbance, moderate potential damage, take advantage of opportunities, and cope with the consequences of a transformation that occurs. *Capacity of response* is clearly an attribute of the system that exists prior to the perturbation. Sometimes both concepts – *adaptive capacities* and *capacities to response* – are treated as synonymous, but, e.g., the IPCC definition of adaptive capacity may be too restrictive for use in broader problems of the dynamics of global SESs. That is why Gallopín (2006) argue that, in general terms, *adaptive capacity* would seem to be broader than *capacity of response* because specific adaptations may include modifying the sensitivity of the system to perturbations, thus increasing its resilience.

Adger (2006) identified two relevant theories that relate to human use of environmental resources and to environmental risks: the vulnerability and related resilience research on social-ecological systems and the separate literature on vulnerability of livelihoods to poverty. He also attempted to portray the overlap in ideas as well as those ideas, which are distinct from each other (Fig. 3.1).

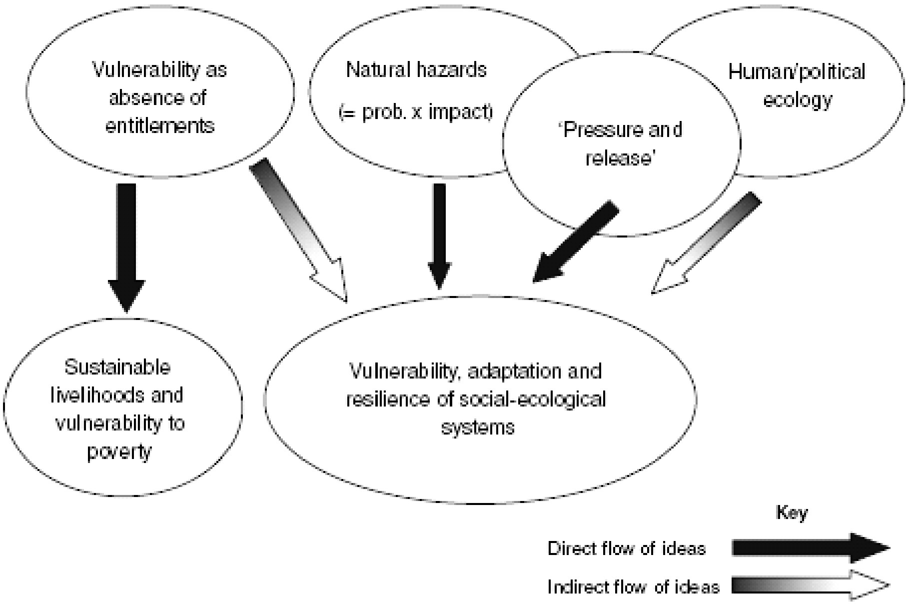


Fig. 3.1 Traditions in vulnerability research and their evolution. *Source:* Adger, 2006

In his discourse, two major research traditions in vulnerability (the analysis of vulnerability as lack of entitlements and the analysis of vulnerability to natural hazards) acted as seedbeds for ideas that eventually translated into the current research on vulnerability of social and physical systems in an integrated manner. In turn, the hazards tradition delineated into three overlapping areas: human or political ecology, natural hazards, and the so-called '*Pressure and Release*' model that spans the space between these two approaches. A basis for hazard tradition is physical elements of hazards exposure, probability and impacts, both natural and unnatural. Virtually all types of natural hazard and all social and political upheavals have vastly different impacts on different groups in society. The vulnerability of human populations is based on where they reside, their use of the natural resources, and the resources they have to cope.

The conceptualizations of vulnerability, which are built on risk-hazard and pressure-and-release models of coupled social and ecological systems, consider both systems and their capacity to respond as well as the origins of hazards within the systems themselves and in the world beyond (Turner *et al.*, 2003; O'Brien *et al.*, 2004). The factors that make a system vulnerable to a hazard will depend on the system's nature and the type of hazard in question. Those, which are developmental factors including poverty, health status, economic inequality and elements of governance, may be referred to as *generic* determinants of vulnerability, as opposed to *specific* determinants relevant to a particular context and hazard type (Brooks *et al.*, 2005). Although the relative importance of different generic factors will exhibit some variation, they may be viewed as the foundation on which specific measures for reducing vulnerability and facilitation adaptation are built. *"The concept of generic, as opposed to hazard- and context-specific determinants of* *vulnerability, is a useful one if we wish to undertake comparative assessments of vulnerability at the national level" (Ibid,* p. 153).

The concept of vulnerability is attractive because it is inclusive. "Humans and the natural environment are not independent systems, homogeneous and unable to adapt to threats, be they anticipated, realized, or perceived but not realized. Instead, human and natural systems are viewed as intimately coupled, differentially exposed, sensitive, and adaptable to threats", – Polsky *et al.* (2007, p. 472) argue. Some of the factors that define the vulnerability of any human system are defined by the physical properties of its environment, but other factors are framed by social-economic context and social preferences. Additionally, like resilience, vulnerability is generally viewed as being specific to perturbations that impinge on the system. In other words, a system can be vulnerable to certain disturbances and not to others. Two other widely accepted points are (1) the multiscale nature of the perturbations and their effects upon the system, and (2) the fact that most SESs are usually exposed to multiple, interacting perturbations (Turner *et al.*, 2003).

3.1.3.2 Linkages between resilience and vulnerability

Two concepts – resilience and vulnerability – express a temporary condition of the interaction between a system and its environment and can be used at all spatial and temporal levels in a dynamic structure, whether societal, environmental, or socio-ecological. They may refer to the system as a whole, but also to those of any one (or more) of its components, even down to the level of the individual actor. Moreover, both resilience and vulnerability studies now accept the interaction between endogenous and exogenous processes as central to their understanding (Young *et al.,* 2006).

Although resilience is clearly related to the capacity of the response component of vulnerability (Gallopín, 2006), the difference between the two concepts seems to lie in the extent to which non-structural changes in dynamics may be introduced into a system under the impact of perturbations (Young *et al.*, 2006). Resilience allows for temporary changes in functioning and dynamics, as long as the system remains within the same stability domain or, as discussed earlier, 'applies to the preservation of the behavior of the system as expressed' (Gallopín, 2006). Vulnerability refers to situations in which neither robustness nor resilience enable a system to survive without structural changes. In such cases, either the system does adapt structurally or it is driven to extinction.

Part of the potential convergence and learning across vulnerability and resilience research comes from a consistent focus on SES, in the context of which resilience refers to the magnitude of disturbance that can be absorbed before a SES changes to a radically different state as well as the capacities to self-organize and to adapt to emerging circumstances (Adger, 2006). Vulnerability, by contrast, is usually portrayed in negative terms as the susceptibility to harm. Such a vision is clearly expressed in the IPCC definition of vulnerability: "…the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change" (IPCC, 2007c, p. 833). However, in all formulations, the key parameters of vulnerability are the stress to which a system is exposed, its sensitivity, and its adaptive capacity. *"Thus, vulnerability research and resilience research have common elements of interest—the shocks and stresses experienced by the social-ecological system, the response of the system, and the capacity* *for adaptive action. The points of convergence are more numerous and more fundamental than the points of divergence"*, – Adger (2006, p. 269) concludes. He believes that different formulations of needs, methods, and normative implications of resilience and vulnerability research stem, in each case, from the formulation of the objectives of study. The vulnerability of SES is influenced by the build up or erosion of the elements of social-ecological resilience – the ability to absorb the shocks, the autonomy of self-organization and the ability to adapt both in advance and in reaction to shocks. Current levels of robustness, resilience, or vulnerability may be based on past adaptations, and if these adaptations were highly specific, the system may need to adapt again upon encountering new types of disturbances (van der Leeuw, 2008).

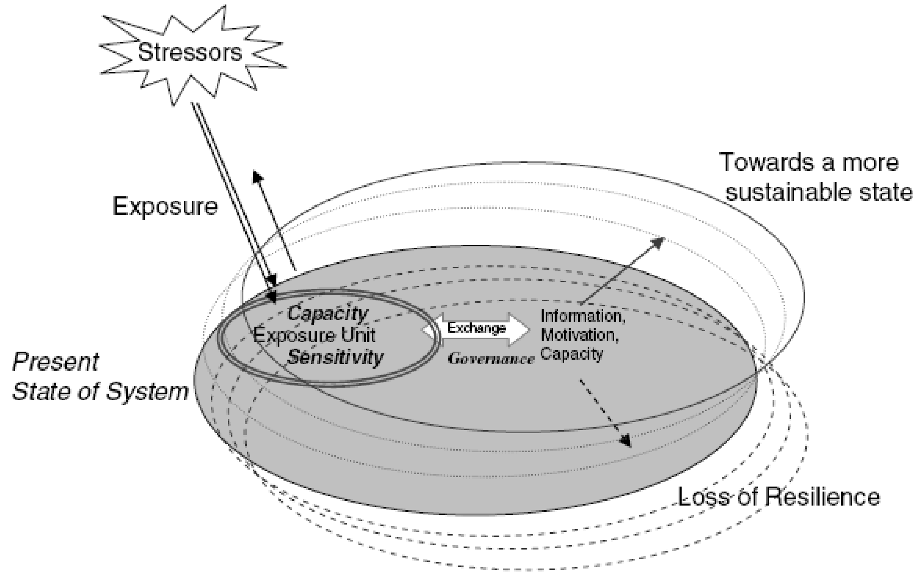


Fig. 3.2 Linking local vulnerability to social-environmental system sustainability in a resilience framework. *Source:* Eakin and Wehbe, 2009

Eakin and Wehbe (2009) provided empirical evidence of the connection between local response to vulnerability and the trajectory of local social–environmental development. In Fig. 3.2 an exposed unit of analysis (e.g., a household) is one component of a hypothetical SES. This unit's sensitivity and internal capacities determine the impacts it experiences and its response. The interaction of the exposed unit with the broader SES through exchange of information, motivation and capacities generates a cumulative effect that can influence the trajectory of the system's development toward a sustainable or less resilient future. In this resilience framework the authors consider information, motivation and capacity as a useful simplification and synthesis of the mechanisms that alter the direction of human–environment interactions: epistemological concerns (what is known, understood, and disseminated as information), issues of power, empowerment and influence (motivations) and capacities (assets, technology, resources, social networks and values that circumscribe these assets). An exposed unit is vulnerable when external disturbance and change (stressor) not only results in significant losses (demonstrating high sensitivity) but also when it lacks the capacity to regain a trajectory of social–environmental development, thus potentially creating a negative spiral of increasing loss. However, the vulnerability of any particular unit of analysis is not necessarily representative of the resilience of the SES in which it is embedded. In contrast, the concept of resilience theoretically allows for some degree of losses and 'harm' in order to achieve a more flexible, adaptive system on the whole. Thus, in some circumstances addressing very local vulnerability to multiple stressors may be considered central to any utilitarian strategy for achieving broader system resilience.

3.1.3.3 Conceptual framework of vulnerability

The short review in the above sections had demonstrated a divergent understanding of vulnerability due to the different epistemological positions of research traditions and because of differing objectives of research.

Turner *et al.* (2003) presented a conceptual framework of vulnerability that aims to make vulnerability analysis consistent with the concerns of sustainability science. The basic recognition of this group of authors is that understanding vulnerability as "the degree to which a system, subsystem, or system component is likely to experience harm due to exposure to a hazard, either a perturbation or stress_stressor"[7] (*Ibid,* p. 8074) limits its focus to perturbations and stressors and is insufficient for understanding the impacts on and responses of the affected system or its components. To base this conclusion, the authors consider two archetypal models that have informed vulnerability analysis: the *risk-hazard (RH)* and *pressure-and-release (PAR)* models (Fig. 3.3).

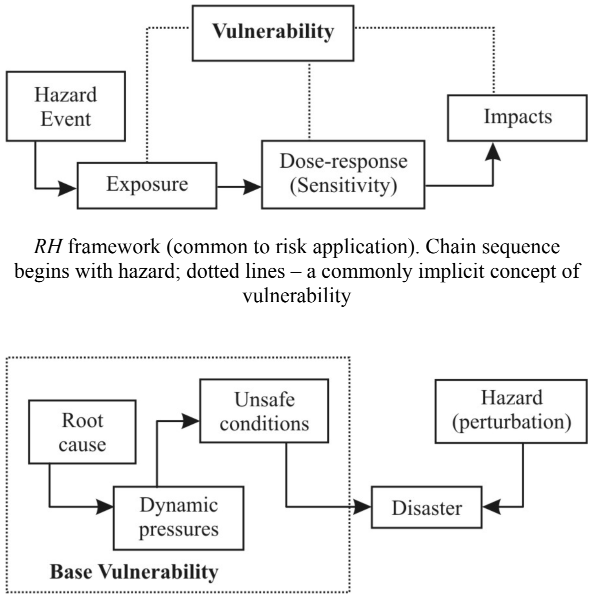
Foundational RH models understand the impact of a hazard as a function of exposure to the hazard event and the dose–response (sensitivity) of the entity exposed. Past quantitative applications of this model in environmental and climate impact assessment generally emphasized exposure and sensitivity to perturbations and stressors and worked from the hazard to the impact. This recognition has led to the PAR model in which risk is explicitly defined as a function of the perturbation, stressor or stress, and the vulnerability of the exposed unit. It directs attention to the conditions that make exposure unsafe, leading to vulnerability and the causes creating these conditions. PAR model addresses primarily the social groups facing disaster events, and its application emphasizes distinctions in vulnerability by different exposure units (e.g., class, ethnicity).

However, explicitly highlighting vulnerability, the PAR model seems insufficiently comprehensive for the broader concerns of sustainability science. Theoretically, a comprehensive vulnerability analysis considers the totality of the system, what is

[7] Here, in Turner *et al.* (2003) definition, *hazards* are threats to a system, comprised of perturbations and stress (and stressors), and the consequences they produce. A *perturbation* is a major spike in pressure (e.g., a tidal wave or hurricane) beyond the normal range of variability in which the system operates. Perturbations commonly originate beyond the system or location in question. *Stress* is a continuous or slowly increasing pressure (e.g., soil degradation), commonly within the range of normal variability. Stress often originates and *stressors* (the source of stress) often reside within the system. *Risk* is the probability and magnitude of consequences after a hazard (perturbation or stress)

unrealistic in practice. Real world data and other constraints invariably result in a 'reduced' vulnerability assessment.

Usually, in the development of vulnerability analysis, anticipated by or explicitly embedded within the RH and PAR models, Turner *et al.* (2003) emphasize three major concepts: entitlement, coping through diversity, and resilience. So, because different systems maintain different sensitivities to perturbations and stressors, the vulnerability of individuals and groups is strongly linked to *entitlements:* legal and customary rights to exercise command over different necessities of life. For example, modern famines are mainly driven not by insufficient food stocks but by inability of social units to command food access through legal and customary mean, and entitlement helps to explain why this situation occurs. Social units also have different *coping capacities* enabling them to respond to a registered harm or to avert the potential harm of a hazard. On the whole, these and other considerations direct attention to such questions as: Who and what are vulnerable to the multiple environmental and human changes underway, and where? How are these changes and their consequences attenuated or amplified by different human and environmental conditions? What can be done to reduce vulnerability to change? How may more resilient and adaptive communities and societies be built? Answering these and related questions requires conceptual frameworks.



RH framework (common to risk application). Chain sequence begins with hazard; dotted lines – a commonly implicit concept of vulnerability

PAR framework (common to risk research) with emphasis placed on *social* conditions of exposure; concept of vulnerability usually explicit

Fig. 3.3 Frameworks of risk-hazard *(RH)* and pressure-and-release *(PAR)* models of vulnerability analysis. *Source*: Turner *et al.,* 2003

Turner and co-workers developed a **vulnerability framework** (Fig. 3.4) that is guided by such a need to provide a template suitable for 'reduced-form' analysis. This framework is not explanatory but provides the broad classes of components and linkages that comprise a coupled system's vulnerability to hazards. Its basic architecture consists of: (1) linkages to the broader human and biophysical (environmental) conditions and processes operating on the coupled system in question; (2) perturbations and stressors_stress that emerge from these conditions and processes; and (3) the coupled human–environment system of concern in which vulnerability resides, including exposure and responses (i.e., coping, impacts, adjustments, and adaptations). These elements are interactive and scale dependent, such that analysis is affected by the way in which the system is conceptualized and bounded for study.

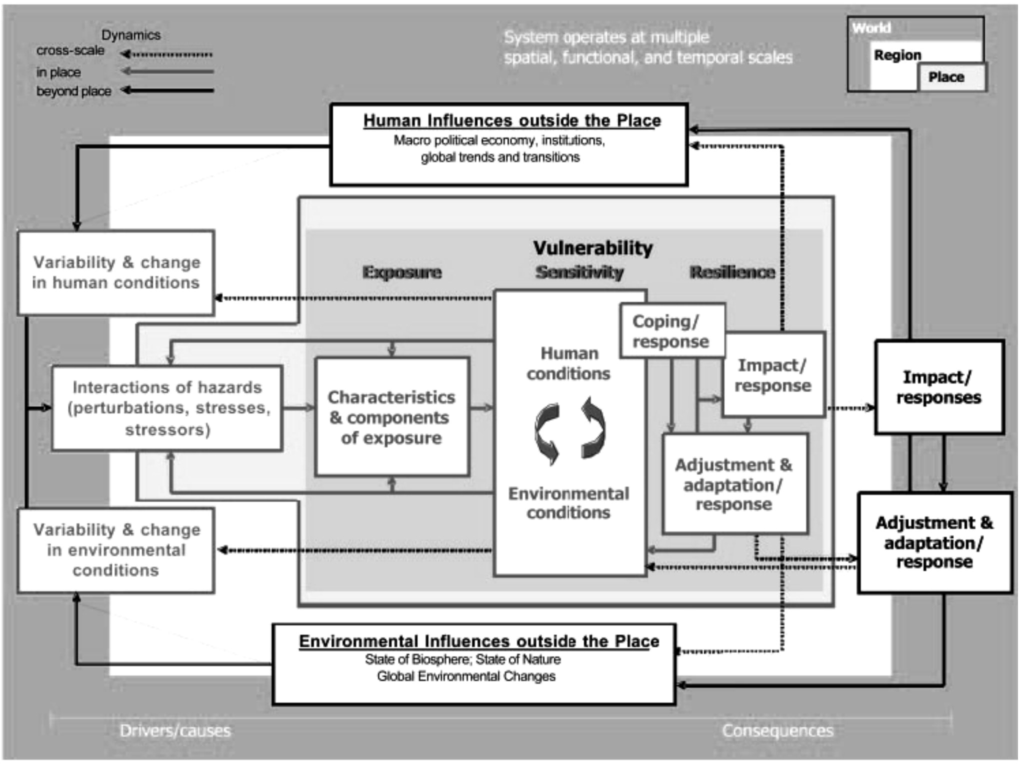


Fig. 3.4 Vulnerability framework. Components of vulnerability identified and linked to factors beyond the system of study and operating at various scales. *Source:* Turner *et al.*, 2003

This framework is a good illustration of the complexity and interactions involved in vulnerability analysis, drawing attention to the array of factors and linkages that potentially affect the vulnerability of the human–environment system. Its systemic qualities are open to left–right (hazards–consequences) or right–left (consequences–hazards) application, depending on the interest and aims of the user. Therefore, "vulnerability analysis must be comprehensive, treating not only the system in question but also its many and varied linkages" (Turner *et al.*, 2003, p. 8076).

Those, who are interested in a more detail rationale of this framework, should refer to the original source. Two items below highlight only a part of Turner *et al.* (2003) discussion.

1. Vulnerability analysis may be undertaken at any spatial or temporal scale suitable for the problem in question. The strong variation in vulnerability by location, even to hazards created by global-scale processes and phenomena, elevates the role of 'place-based' analysis where the term 'place-based' implies a spatially continuous distinctive ensemble of human and biophysical conditions. Narrowly defined, place means location, but does not imply specific spatial parameters. It is a relational concept, denoting the existence of larger spatial scales in which the coupled human–environment system and its location are embedded. For instance, in the global change

and geographic literature at least three terms imply descending order of spatial scale: global, regional, and local. In this context, a coupled human–environment system, whatever its spatial dimensions, constitutes the place of analysis. The hazards acting on the system arise from influences outside and inside the system and place but, given their complexity and possible nonlinearity, their precise character is commonly specific to the place-based system. For these reasons, the hazards themselves are located both within and beyond the place of assessment, holding the potential to affect the system, including the ways in which it experiences perturbations and stressors.

2. The human–environment conditions of the system determine its sensitivity to any set of exposures. These conditions include both social and biophysical capital that influences its existing coping mechanisms. For the human subsystem, these mechanisms may be individual or autonomous action and/or policy-directed changes. The social and biophysical responses or coping mechanisms influence and feed back, affecting each other, so that a response in the human subsystem could make the biophysical subsystem more or less able to cope, and *vice versa*. In some cases, coping mechanisms *per se* give way to adaptation and significant system-wide changes in the human–environment conditions. The responses, irrespective of their nature and their outcomes, determine collectively the resilience of a coupled system and may transcend the system or location of analysis, affecting other scalar dimensions of the problem with potential feedbacks of the system in question.

Since vulnerability is conceptualized in very different ways by scholars from different knowledge domains, and even within the same domain, Füssel (2007) presented the framework that provides the much-needed conceptual clarity and facilitates bridging the various approaches to researching vulnerability in relation to climate change. His conceptual framework of vulnerability combines: (1) a nomenclature for describing any vulnerable situation in terms of the vulnerable system, the hazard(s) of concern, the attribute(s) of concern, and a temporal reference; (2) a classification scheme for vulnerability factors according to their sphere and knowledge domain; and (3) a terminology for vulnerability concepts that is based on the included factors of vulnerability. The author believes that framework allows describing concisely any vulnerability concept as well as the differences between alternative ones.

In particular, Füssel considers two largely independent dimensions of vulnerability factors: *sphere* (or *scale*) and *knowledge* domains (Table 3.1) where:

- In ***sphere (or scale)*** dimension the *internal* (or 'endogenous', or 'in place') vulnerability factors refer to properties of a vulnerable system or community itself, and *external* (or 'exogenous', or 'beyond place') factors refer to something outside the vulnerable system. This distinction typically reflects geographical boundaries or the power to influence.
- In ***knowledge domain*** the *socio-economic* vulnerability factors are those that relate to economic resources, the distribution of power, social institutions, cultural practices, and other characteristics of social groups typically investigated by the social sciences and the humanities; the *biophysical* vulnerability factors, in contrast, are related to system properties investigated by the physical sciences. These two categories can overlap, for instance, in the case of built infrastructure.

Table 3.1 Examples of vulnerabilities actors, classified according to the *'dimension sphere'* and *'knowledge domain'*

Sphere	Domain	
	Socioeconomic	*Biophysical*
Internal	Household income, social network, access to information	Topography, environmental conditions, land cover
External	National policies, international aid, economic globalization	Severe storms, earthquakes, sea-level changes

Source: Füssel, 2007

Table 3.1 illustrates the independence of the 'dimension sphere' and 'knowledge domain' by providing examples for each of the four categories of vulnerability factors implicitly defined by them. Taken together, the four categories constitute the vulnerability profile of a particular system or community to a specific hazard at a given point in time.

3.1.3.4 Vulnerability assessment and management

Global change vulnerability assessment

"Vulnerability assessment describes a diverse set of methods used to systematically integrate and examine interactions between humans and their physical and social surroundings" (Hahn *et al.*, 2009, p. 75). Considered as systematic examinations of who is vulnerable, to what and why, it is a widely used instrument comprising a broad group of tools with varying characteristics and goals. Assessments of vulnerability have typically either focused on the vulnerability of people in relation, e.g., to food security or natural hazards, or otherwise the vulnerability of places, regions or sectors such as agriculture to climate change. These social and biophysical orientations have come together to examine the vulnerability of SES (see Sect. 3.1.1). How to incorporate multiple and often conflicting values into the analysis of SES and their vulnerability is posed as an important challenge for future work in global environmental change (Adger, 2006; Eakin and Wehbe, 2009). The new emphasis on treating the social and biophysical systems jointly, together with emphasizing the role that their values play in determining assessments, represents a shift away from what have traditionally been viewed as more 'scientifically' orientated assessments in this domain (Füssel and Klein, 2006; McLaughlin and Dietz, 2008).

Thus, origins of vulnerability assessment lie in the areas of impact assessments and hazard research, and their goals have changed over the past decade from mapping, e.g., potential climate change impacts to an increased focus on strategies to facilitate adaptation (Füssel and Klein, 2006). The definitions of vulnerability and related terms – exposure, sensitivity, and adaptive capacity – form a suitable starting position to explore possibilities for quantification of vulnerability (Metzger and Schröter, 2006).

Adopting *a vulnerability perspective* demands a thorough investigation of biophysical, cognitive, and social dimensions of human–environment interactions. To minimize the potential harm associated with global changes, the people and societies are needed in accurate assessments of the vulnerability of coupled SESs, in which they live, as well as in associated adaptation opportunities and constraints. The concepts and methods for global change vulnerability assessments represent a new research frontier (Schröter *et al.*, 2005), yet it is unclear exactly how this procedure differ in conceptual and/or methodological terms from analogous research on impacts and adaptation. Despite a growing need for information on the vulnerability of SESs, there are a little consensus on best practices and little guidance on how to structure vulnerability assessments so that their findings are comparable and generalizations can be made, or how to implement an initial scoping to support a broader vulnerability assessment (Polsky *et al.*, 2007).

Adger (2006) notes that vulnerability, as a dynamic phenomenon, is often in a continuous state of flux of both the biophysical and social processes which shape local conditions, and the ability to cope are themselves dynamic. Measurements of vulnerability must therefore reflect social processes as well as material outcomes within systems that appear complicated and with many linkages that are difficult to define. Vulnerability is, therefore, not easily reduced to a single metric and is not easily quantifiable. Since SESs are vulnerable to multiple stresses, and vulnerability is manifested in various and not always material outcomes, there are in effect different thresholds on vulnerability informed by values and social context. Nonetheless, it is important to have consistent frameworks for measuring vulnerability that provide complementary quantitative and qualitative insights into its outcomes and perceptions. A generalized measure of vulnerability, built on both sustainable livelihoods and hazards tradition, needs to account for its dynamics (what is vulnerable in one period is not necessarily vulnerable in the next period), degree and severity. Similarly, any meaningful threshold of vulnerability is also likely to be highly heterogeneous. Vulnerability manifests itself in specific places at specific times: hence the determination of the level that constitutes a threshold is not a simple proportional measure that is the same for all components of SES.

A second challenge in vulnerability assessment is seen by Adger in the tension between objective and perceived elements of vulnerability and risks. Trends in environmental change, technologies and other social and demographic processes always make individuals and social systems vulnerable to surprise and susceptible to unforeseen consequences of action.

Schröter *et al.* (2005) emphasized as a serious shortcoming of the discussions on vulnerability assessments their focus more on particular techniques as opposed to an overarching methodological framework for guiding and integrating the entire analysis. Such an integrative framework is essential to the success of global change vulnerability assessments because these analyses necessarily span multiple disciplines and require much time and attentive coordination to conduct. For these reasons, the authors offered an overarching general methodological framework that is not meant to be a rigid prescription of specific techniques, but presents a general approach that being implemented in specific cases will guide global change vulnerability assessments toward a common end, even if the particular techniques employed vary from case to case.

In particular, Schröter *et al.* (2005, p. 575) define g*lobal change vulnerability* as "the likelihood that a specific coupled human–environment system will experience harm from exposure to stresses associated with alterations of societies and the environment, accounting for the process of adaptation". Using the term *a coupled human–environment system,* they highlight the fact that human and environmental systems are not separable entities but are the parts of an integrated whole, and the *global change vulnerability assessments* should include not only the analysis of vulnerability but also the identification of specific options for stakeholders to reduce that vulnerability. Proceeding from these definitions, the general objective of global change vulnerability assessments is to inform the decision-making process about options for adapting to the effects of global change. In this way, such assessments are linked directly with the broader aim of sustainable development and sustainability science where success is measured not only by scientific merit but also by the usefulness of resulting products and recommendations (Kates *et al*., 2005; Clark and Dickson, 2003). Strictly speaking, *"to conduct a vulnerability assessment means that no element of the human–environment system may be simplified away or considered a mere boundary condition"*, – Polsky *et al.* (2007, p. 472) note.

Global change vulnerability assessments, in Schröter *et al.* (2005) interpretation, draw heavily from three streams of research. The first two – impact assessments and risk/hazards research – focus generally on the multiple effects of a single stress and might examine the environmental or social effects of a specific action. These scientific traditions differ in that the impact assessments tend to underemphasize, relative to risk/hazards research, the processes by which society can inadvertently amplify the impacts of a stress, or enact anticipatory adaptations designed to reduce the importance of possible future impacts. The third tradition – e.g., food security studies – focus generally on the multiple causes of a single effect (in this case, hunger or famine), demonstrating that hunger is not

Box 3.2 Minimal criteria to achieve objectives of global change vulnerability assessments

- *The knowledge base engaged for analysis should be varied and flexible.* The need to engage all relevant academic disciplines is a direct consequence of examining coupled human–environment systems rather than human or environmental systems in isolation. This criterion goes beyond the standard call for interdisciplinary research because scientists should collaborate with stakeholders to learn their perspective, knowledge and concerns in depth. It is also imperative to engage indigenous or local knowledge, despite difficulties in testing such information within a scientific framework.
- *Vulnerability assessments should be 'place-based', with an awareness of the nesting of scales*. Here, a 'place' means generally a study area that is small relative to study areas commonly discussed in climate change impacts reports (e.g., a village or group of villages instead of a country or group of countries). The scale of the vulnerability studies needs to match the scale of decision-making of the collaborating stakeholders.
- *The examined global change drivers should be recognized as multiple and interacting*. The interaction of multiple trends may give rise to an amplification or attenuation of risk (NRC, 1999; O'Brien and Leichenko, 2002). For example, climate change goes along with change in atmospheric CO_2 concentrations that are coupled to socio-economic development which, in turn, goes along with land use changes. Ultimately, all these drivers interact and affect processes within the human–environment system.
- *Vulnerability assessments should allow for differential adaptive capacity*. The abilities of all people in a given place to adapt are rarely homogeneous. Some individuals or social classes will likely be better equipped to cope with specific stresses than others; sometimes adaptation options are constrained by inadequate resources, including information, or political–institutional barriers. Differential adaptation profiles can account for the possible combinations of adaptation constraints and opportunities for a given case, and how these factors may vary both between and within populations.
- *The information should be both historical and prospective*. However, in global change research, when the historical component is thorough, the prospective component is often underdeveloped, or *vice versa.* To achieve the stated objective, both components should be thoroughly explored.

Source: Schröter *et al.,* 2005

the necessary and inevitable consequence of a single cause, such as a drought, but instead is the contingent and often avoidable result of multiple causes, e.g., the co-occurrence of political marginalization with the environmental stresses. The novelty of global change vulnerability assessments is seen by these authors not so much in the development of new conceptual domains, as in the methodological integration across existing research traditions.

Schröter and co-authors have formulated five minimal criteria that global change vulnerability assessments should satisfy to achieve their objectives (Box 3.2).

The need to integrate across different research traditions challenged an all-embracing methodological approach that would capture the vulnerability perspective. Based on preceding works (Carter *et al.*, 1994; Klein *et al.*, 1999; Turner *et al.*, 2003; and others), Schröter *et al.* (2005) proposed an overarching method comprising eight general steps that try to describe, in general terms, the full array of analytical activities needed to characterize vulnerability in all its complexities and lead to achieving vulnerability assessment objective by satisfying all five criteria (Fig. 3.5). Such a graphical organization of the vulnerability assessments finding may also provide the basis for the inter-assessment comparisons that are a precondition for advancing vulnerability science.

In this Figure, eight methodological steps are artificially broken down into two broad classes: those that take place prior to modeling (Boxes 1–3), and those that take place as part of the modeling and modeling refinement process (Boxes 4–8). Under *modeling* in the context of vulnerability assessment, the authors mean undertaking a formalized attempt to describe a system in any kind of stringent, internally consistent concept; the role of numerical modeling is the projection of future states of a system. Modeling and analysis involves all the work necessary to create a useful representation of the system and must therefore address all steps that are ordered according to the natural flow of analytical activities. Generally, the measure in each of the boxes should be performed sequentially. However, in practice, over the course of an entire vulnera-

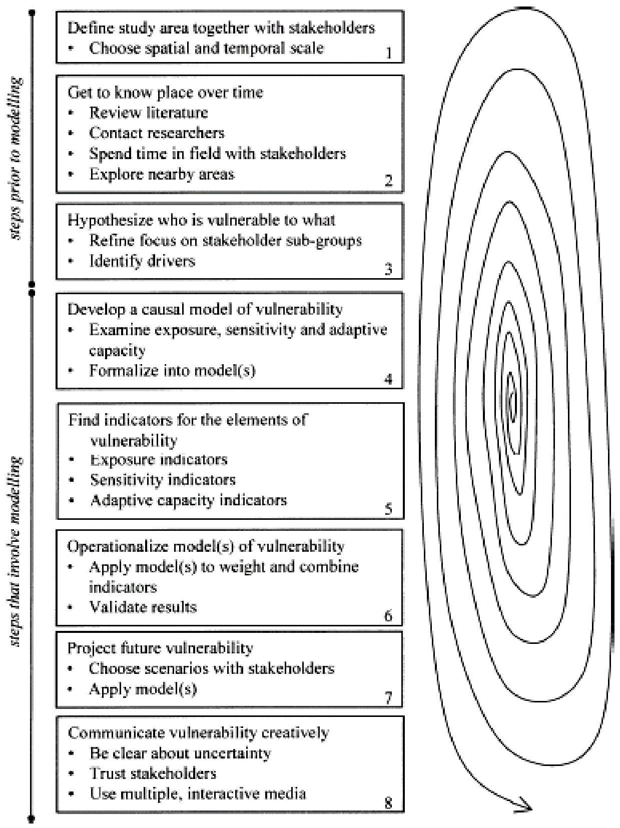


Fig. 3.5 An eight-step method for global change vulnerability assessments. *Source:* Schröter *et al.*, 2005

bility assessment, researchers do not necessarily have to follow this order strictly: some steps could be performed in parallel, and most steps – iteratively. The spiral next to the steps suggests the fluid nature of the research and assessment process (Polsky *et al.*, 2007).

On the whole, the eight-step method represents an iterative, flexible, and comprehensive general analytical approach, the particular application of which may be tailored to the demands of a specific research project consistent with the vulnerability conceptualization emerging in the literature. For example, Metzger and Schröter (2006) presented a method that allows quantitative spatial analyses of the vulnerability of SES that relies on *ecosystem services.* They proceed from their adjusted definition of vulnerability that, as they think, relates more directly to the human-environment system, namely: *"Vulnerability is the degree to which an ecosystem service is sensitive to global change plus the degree to which the sector that relies on this service is unable to adapt to the changes"* (p. 203). In particular, they assessed where in Europe people may be vulnerable to the loss of particular ecosystem services, associated with the combined effects of both climate and land use change.

Developing this idea further, de Chazal *et al*. (2008) proposed a method that allows quantification and measurement of a number of more abstract or intangible ecosystem services included in existing ecosystem service classifications. Three key features distinguish this method from previous works: (1) inclusion of multiple ecosystem services that are explicitly identified and differently valued by multiple stakeholders; (2) use of the series of matrices to quantitatively and sequentially link social and ecological information; (3) identification of ecosystem properties that underlie the delivery of the ecosystem services.

Thus, vulnerability assessments could be seen as a dialectic process, where different approaches provide different types of inputs to the assessment and contribute to creating space for producing many types of data useful for stakeholders with different needs and interests.

Vulnerability analysis for sustainable decision-making

Vulnerability assessments are also a necessary part of sustainability science. Really, using generally accepted conceptualization (Adger, 2006; IPCC, 2007a), to be vulnerable to the effects of stresses associated with global change, a system must not only be exposed and sensitive to the effects, but also must have a certain ability to adapt. Conversely, systems are less vulnerable, i.e. more able to persist in the long-term in the face of threatening stresses (that is the essence of sustainability) if they are less exposed, less sensitive or possess strong adaptive capacity. In vulnerable systems, some form of anticipatory action would be justifiable to mitigate the ecological, social, and economic damages anticipated from global change; the relatively sustainable systems have fewer reasons for concern and pre-emptive action (Polsky *et al.*, 2007).

Vulnerability poses a serious challenge both for the analysis of governance and for implementation of governance solutions to environmental change. Vulnerable people and places are often excluded from decision-making and from access to power and resources. Hence, as Adger (2006, p. 276) notes, *"policy interventions to reduce vulnerability need to be able to identify vulnerabilities within social-ecological systems, to recognize the mechanisms, which cause vulnerability in the first place, and to redress marginalization as* *a cause of social vulnerability…Inclusion of vulnerable sections of society and representation of vulnerable social-ecological systems within decision-making structures is an important and highly under-researched area"*. On the other hand, Næss *et al.* (2006) argue that the usefulness of vulnerability assessments for policymaking is contested. Many concerns relate to the interface between researchers and stakeholders, the information that vulnerability assessments can provide, and the ability of stakeholders to make use of it.

There are many recommendations on how to improve the use of vulnerability analysis for sustainable decision making.

A comprehensive framework for vulnerability analysis in sustainability science was proposed by Turner *et al.* (2003). These authors consider vulnerability of coupled human–environment systems as one of the central elements of sustainability research and think that the sustainability theme enlarges and redirects the focus of vulnerability analysis. They also defined the following set of elements for inclusion in any vulnerability analysis, particularly those which aimed at advancing sustainability:

- Multiple interacting perturbations and stressors_stresses and the sequencing of them;
- Exposure beyond the presence of a perturbation and stressor_stress, including the manner in which the coupled system experiences hazards and its sensitivity to the exposure;
- The system's capacities to cope or respond (resilience), including the consequences and attendant risks of slow or poor recovery;
- The system's restructuring after the responses taken (adjustments or adaptations); and
- Nested scales and scalar dynamics of hazards, coupled systems, and their responses.

In addition, based on the review of the literature and experience in developing a vulnerability framework, Turner *et al.* (2003) suggested the following lessons that increase the usefulness of vulnerability analysis and are directly applicable for vulnerability assessments in the interests of decision making:

- Attention to vulnerability should be anchored in the condition of the coupled human–environment system because human and biophysical vulnerability are linked and should be treated accordingly;
- Identify the complexity, interconnectedness, and iterative nature of the components giving rise to and comprising vulnerability; beware of one-dimensional vulnerability analyses and be cognizant of varied components and scalar linkages in the coupled system that increase the range of expected outcomes;
- Draw attention to the potential dynamics within the coupled system that give rise to new hazards and do not assume that broadly similar coupled systems have the same vulnerabilities; the complex dynamics may cause consequences to vary by system or locale;
- Do not assume that all parts of the coupled system have the same vulnerability; the subsystems and components, especially social units, may experience exposure differently, register different impacts, and maintain different response options;
- Illuminate the nested scales of the vulnerability problem but provide an understanding of the vulnerability of a particular place; although comprehensive vulnerability analysis and place based variations in the coupled systems and processes affecting them favour multiple approaches, vulnerability assessments should follow a common general methodological framework;

- Facilitates the identification of critical interactions in the human–environment system that suggest response opportunities for decision makers; critical response opportunities are contingent on the coupled system or place in question; thus, general guidelines for response options should be malleable;
- To be open to the use of both quantitative and qualitative data and novel methods to derive and analyze information, as well as to assist in the development of metrics, measures, and models for implementation.
- Conscious efforts must be made to create institutional structures that link vulnerability analyses to decision making.

Two examples of vulnerability assessment at local level

The local level is important because vulnerability is location-specific and a large share of decisions affecting vulnerability is local. Local vulnerability is not only a function of single effects but, equally with large-scale vulnerabilities, results from interactive effects related to the interplay among single effects. Different local processes are inevitably interlinked, and interactions can alter the initial profile of vulnerability. A multi-disciplinary approach to local-level assessment is thus a basic requirement for the evolvement of local adaptation policies and strategies beyond traditional local risk management (Næss *et al.*, 2006). To illustrate the challenges for local level adaptation, two research examples have been used.

1) Participatory vulnerability assessment at community level

Smit and Wandel (2006) presented a conceptual framework for the participatory vulnerability assessment approach (Fig. 3.6) that is based on a general summary of different works. In this case, the system under research was a community, but the analysis sought to identify the broader conditions and structures within which the community functions.

Participatory vulnerability assessments allow for the recognition of multiple stimuli, beyond those related to the issue in question, to include all political, cultural, economic, institutional and technological forces. Furthermore, the methodologies recognize the interaction of various exposures, sensitivities and adaptive capacities over time. What is vulnerable in one period is not necessarily vulnerable (or vulnerable in the same way) in the next, and some exposures and sensitivities are developing slowly over time. Finally, the approach recognizes that sources of exposures, sensitivities and adaptive capacities function across scales, from the individual to the national.

A research begins with the assessment of current exposures, sensitivities and current adaptive capacity, as well as insights from local and regional decision makers, resource managers, scientists, literature and other available sources of information. The aim of this step is an analysis to identify and document the conditions or risks (current and past exposures and sensitivities) that people have to deal with, including the factors and processes that constrain their choices (current and past adaptive capacity).

On the identification of relevant conditions and the consideration of future livelihoods, information from other scientists, policy analysts, and decision-makers are integrated into the analysis to identify potential future exposures and sensitivities (what conditions or risks the community may be facing) and future adaptive capacity (in what ways the community may potentially plan for or respond to these conditions) to determine future vulnerability. Opportunities to reduce future vulnerabilities are sought with community decision makers and representatives of other agencies with authority or influence. As experience shows, the common analysis practices involve modifying some existing resource management strategy, livelihood enhancement initiatives and sustainable development programs.

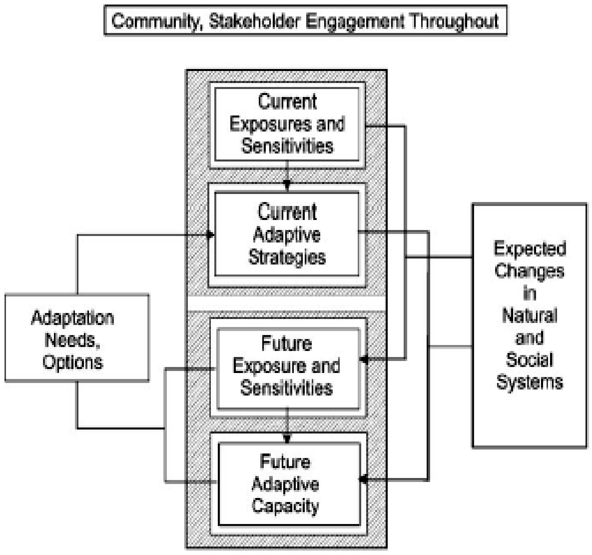


Fig. 3.6 Conceptual framework for vulnerability assessment and mainstreaming at community levels. *Source:* Smit and Wandel, 2006

Smit and Wandel don't see the goal of this kind of methodology in producing a score or rating of a particular community's current or future vulnerability, but rather to attain information on the nature of vulnerability, its components and determinants in order to identify ways in which the adaptive capacity can be increased and exposure-sensitivities decreased. While response options are evaluated in some way, the initiatives are rarely discrete and stand-alone. Instead, they tend to be incremental, modifying some existing management strategies, disaster plans, and so on, that is commonly known as *mainstreaming* (e.g., Huq and Reid, 2004). Successful vulnerability reduction appears to be most effective if it is undertaken in combination with other various-level strategies and plans.

2) Vulnerability in Environmental Integrated Assessment

The vulnerability of the environment or *environmental vulnerability* is one of the main factors determining the environmental consequences of development projects. Such consequences depend both on the vulnerability and value properties of the affected areas and the project properties (Fig. 3.7).

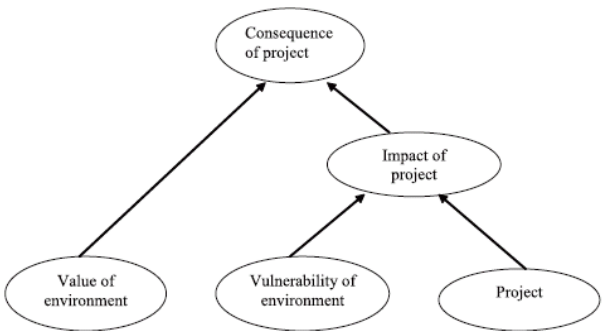


Fig. 3.7 Coherence of value- and vulnerability assessments and impacts of projects. *Source:* Kværner *et al.,* 2006

Although the term vulnerability is relatively frequently used in EIA, the vulnerability concept has been seldom used as a central interdisciplinary approach to environmental assessment. In the traditional EIA procedure *environmental vulnerability* is considered only to a minor extent in the early stages when project alternatives are worked out. This can result in environmental impacts that could have been avoided. The increasing awareness of the subjectivity of value assessments and the overlook of environmental impacts in EIAs brought more vulnerability and vulnerability analyses into focus. There is also no general agreement of what should be assigned to vulnerability analysis in EIA.

Based on Norway experience, Kværner *et al.* (2006) analyze different types of vulnerability analysis in EIA and show that concepts of specific and general vulnerability are complementary in the sense that they are suited to different levels of problem specification (Table 3.2).

Table 3.2 Different types of vulnerability analyses in EIA

Type of analysis	*Relation to type of influence*	*Stage in EIA/project*
General vulnerability	Independent of type of influence	General planning, SEA, beginning stage of EIA/project
Specific vulnerability	Type of influence is known	Stage of searching for alternatives in EIA; basis for screening and scoping
Detailed effect description	Type of influence and alternatives are known	Alternatives are worked out

Source: Kværner *et al.*, 2006

3.1.4 Adaptation in environmental science

3.1.4.1 General treatment of the adaptation concept

The term *adaptation* is widely used in international global change agenda, but various stakeholders define and interpret it quite differently.

According to explanatory dictionaries, *adapt* means to make more suitable (or to fit some purpose) by altering (or modifying). So, the Oxford Dictionary of Science defines *adaptation* as "any change in the structure or functioning of an organism that makes it better suited to its environment".[8] Usually, adaptation refers to both the process of adapting and the condition of being adapted. However, in particular disciplines, the terms have more specific interpretations. In ecology, for example, adaptation frequently refers to the changes by which an organism or species becomes fitted to its environment. In the social sciences, cultural adaptation refers to adjustments by individuals to the collective behavior of socio-economic systems. Adaptation in the context of human dimensions of global change usually refers to a process, action or outcome in a system (household, community, group, sector, region, country) in order for the system to better cope with, manage or adjust to some changing condition, stress, hazard, risk or opportunity. Smit and Wandel (2006) present numerous other definitions of adaptation that can be found in

[8] See: *http://en.wikipedia.org/wiki/Adaptation*

literature, although considering them as “mostly variations on a common theme”. We have no intention to repeat the history of using this term in the global change field, shown by these authors in their paper. It is enough to remind only that its origins and today’s broad use refers to the development of genetic or behavioral characteristics that enable organisms or systems to cope with environmental changes in order to survive and reproduce.

The ideas of *adaptation* and *adaptability* are somewhat older than *resilience, robustness* and *vulnerability*. In the life sciences, adaptation has a lengthy tradition and goes back to Darwin and others who attempted to explain the genesis of diverse forms of life. Adaptation of humans to environmental variability has been the focus of anthropologists since the early 1900s; in the social sciences it dates back at least to the cultural ecology of the 1940-1950s. In the 1990s, scholars began to widely use the term adaptation for the study of the consequences of human-induced climate change, without explicitly relating this back to its conceptual origins. Available applications of the adaptation concept vary by the phenomena of interest (biological, economic, social, etc.) and by time scales (instantaneous, months, years, decades, centuries). Considerations of adaptation within natural sciences encompass scales from an organism or individual to the population of a single species or an entire ecosystem. Social science perspectives on adaptation also span a wide range – from adaptation of an individual or household to a particular stress to the adaptation of humankind to all possible stresses and forces. A great set of work is adaptive management of complex systems – from human ability to manage such systems to the management strategies to adapt (Adger *et al*., 2005; Janssen and Ostrom, 2006; Reilly and Schimmelpfennig, 2000; Walker; 2006; Young *et al.*, 2006).

In a different context, Young *et al.* (2006) refer *adaptation* to the process of structural change in response to external circumstances, *adaptedness* – to the extent to which a particular dynamic structure is effective in dealing with its environment, and *adaptability* – to the capacity to adapt *(adaptive capacity)* to future changes in the environment of a system concerned. In general, a species, individual or population may also become better adapted by improving its condition in the environment, even in the absence of changes in the latter. This is especially applicable to human systems, capable of learning and technological progress. In the human realm, and thus in the SES, the criterion for *adaptedness* goes far beyond ‘being able to live and reproduce’; it includes the viability of social and economic activities, and the quality of human life. *Adaptability* of human systems can also be defined as its capacity, from the individual to humankind, “to increase (or at least maintain) the quality of life of its individual members in a given environment or range of environments” (Gallopín, 2006, p. 300). Thus, while the responses of biological systems to perturbations are purely reactive, the responses of human systems are both reactive and proactive.

From these considerations, Gallopín (2006) identifies two components in a generic concept of adaptive capacity of socio-ecological systems:

- the capacity to cope with environmental contingencies (to be able to maintain or even improve its condition in the face of changes in its environment), and
- the capacity to improve its condition in relation to its environment, even if the latter does not change, or to extend the range of environments to which it is adapted.

Some authors discuss the difference between adaptation and adjustment. The term *adjustment* is used, for instance, by the IPCC in its definition of adaptation (IPCC, 2007a). However, Kasperson *et al.* (2005) consider adjustments as a system's responses to perturbations or stresses that do not fundamentally alter the system itself; the adjustments are commonly (but not necessarily) short-term and involve relatively minor system modifications, while adaptations are responses that are sufficiently fundamental to alter the system itself, sometimes shifting it to a new state.

Such an interpretation of adaptations is close to the term *transformability,* which Walker (2006), using the above discussed concept of '*basin of attraction'* (a configuration or a regime of a system states, within which it tends to remain due to its own internal dynamics), explains as follows. When a society finds itself trapped in an undesirable basin that is so wide and deep that movement to a new basin or reconfiguration of the existing is beyond its ability, the only option may be to configure an entirely new stability landscape, defined by new state variables or by the old state variables supplemented by new ones. Transformability is the capacity to create such a new stability landscape – the untried beginnings from which to evolve a new way of living. Therefore, he defines *transformability* "as the capacity to create a fundamentally new system when ecological, economic, or social conditions make the existing system untenable. It means introducing new components and new ways of making a living, and often a change in the scales that define the system. New variables can either be introduced or allowed to emerge" (*ibid,* p. 85).

3.1.4.2 Linkages between resilience, vulnerability and adaptive capacity

The analysis of the concepts of vulnerability, resilience, and adaptive capacity from a systemic perspective and in the context of research on the dynamics of the global SES shows that they all are related with each other, having certain commonalities but also with evident differences.

In particular, *adaptation* and *adaptability* have a connotation of re-acting to changing exogenous circumstances, while *resilience, robustness, and vulnerability* are more often used in a setting where society and its environment are deemed to be inter-active and so dynamic. In other words, in Young *et al.* (2006, p. 305) argumentation, "…adaptation and adaptability are rather general concepts that do not point to the why and how of the underlying system dynamics. Resilience, robustness, and vulnerability point to structural characteristics of the systems concerned and to whether or not adaptation is necessary". Nevertheless, terms *resilience* and *adaptive capacity* are often used synonymously despite basic differences. At the same time, *adaptive capacity* suggests 'the ability of a system to adapt' ('to adjust', in the IPCC definition), or its ability to change into a state that is less vulnerable than before (Schröter *et al.*, 2005), while *resilience* is 'the ability of a system to absorb disturbances while retaining the same basic structure and ways of functioning', or to undergo impacts without changing its state.

Walker (2006), considering *adaptation* to social and environmental change as an essential feature of socio-ecological societies and *adaptability* – as the capacity of actors in a system to manage resilience, argues that because human actions dominate in a SES, its adaptability is mainly a function of the social component, or the collective capacity of individuals and groups to manage the system. Either intentionally or unintentionally, their actions influence resilience; their collective capacity to manage resilience intentionally determines whether they can successfully avoid crossing into an undesirable system regime, or cross back into the desirable one.

In Fig. 3.8, Gallopín (2006) summarizes the conclusions on the major conceptual relations among the three concepts, putting in evidence the important similarities and differences, and in some cases – contradictions between the concepts as they are specified, or utilized, in different fields. The comparison also shows that there is no generally accepted meaning of the concepts; the lack of general agreement on the concepts, when they are considered one by one, becomes more visible when they are taken together.

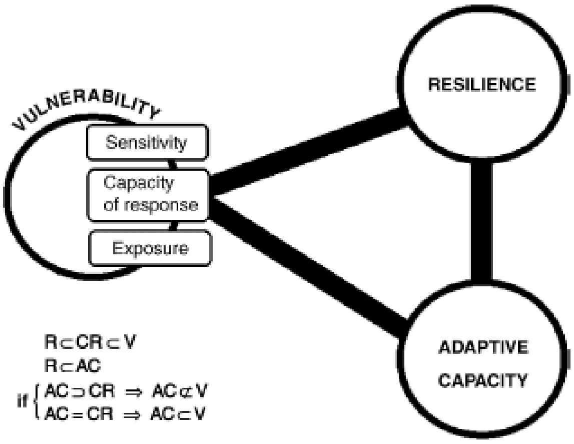


Fig. 3.8 A diagrammatic summary of the conceptual relations among vulnerability, resilience and adaptive capacity as described by Gallopín (2006). The signs represent relationships between sets: $\subset$ = 'subset of', $\not\subset$ – 'not a subset of'; R, V, AC and CR stand for resilience, vulnerability, adaptive capacity and capacity of response, respectively

Smit and Wandel (2006) portrayed the basic vulnerability relationships in a Venn diagram[9] format (Fig. 3.9). Here, the larger sets represent the broader stresses and forces that determine exposure and sensitivity and shape adaptive capacity at the local or community level, denoted by the smaller embedded sets. The interaction of environmental and social forces determines exposures and sensitivities; various social, cultural, political and economic forces shape adaptive capacity. The overlap recognizes that the processes driving three components of vulnerability – exposure, sensitivity and adaptive capacity – are frequently interdependent. The finer scale interaction represents local vulnerability; adaptations are particular expressions of the inherent adaptive capacity. Generally, a system (e.g., a community) that is more exposed and sensitive to an external stimulus, condition or hazard will be more vulnerable, and a system that has

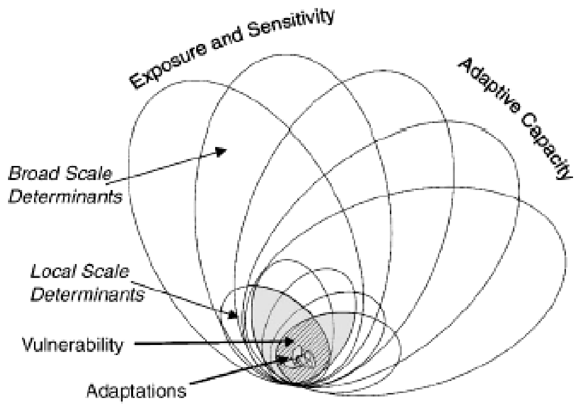


Fig. 3.9 Nested hierarchy model of vulnerability. *Source:* Smit and Wandel, 2006

[9] *Venn diagrams* or *set diagrams,* invented around 1880 by John Venn, are diagrams used to represent unions and intersection of a finite collection of sets (Upton, G. and I. Cook, 2002: *A Dictionary of Statistics*, Oxford University Press, p. 375)

more adaptive capacity will tend to be less vulnerable. That is why the term vulnerability has sometimes been used to describe the estimated net or residual impacts (initial impact costs minus net adaptation savings).

Although the viewpoint of Smit and Wandel relates mainly to climate change aspects, the proposed conceptualization indicates broadly the ways in which vulnerabilities are shaped in SESs on the whole. Vulnerability, its elements and their determinants are dynamic (vary over time), vary by type (from stimulus to stimulus), and are place- and system-specific. Even for a particular system, vulnerability is unlikely to be the same for all stimuli (e.g., for increasing temperature, floods or high-frequency droughts).

Farther, *exposure* and *sensitivity* are almost inseparable properties of a system and are dependent on the interaction between its characteristics and on the attributes of stimulus. The exposure and sensitivity to an environmental change risk reflect the likelihood of the SES experiencing the particular conditions as well as the occupancy and livelihood characteristics, which influence its sensitivity to such exposure. The occupancy characteristics (e.g., settlement location and types, land use, etc.) reflect broader social, economic, cultural, political and environmental conditions, usually called *drivers, sources* or *determinants* of exposure and sensitivity. Many of these determinants are similar to those that influence or constrain a system's adaptive capacity. One example is shown in Box 3.3 which is the projected population trends in countries with economies in transition that are important drivers of climate change but are also key to vulnerability and adaptation.

Box 3.3 The demographic future as a driver of vulnerability and adaptive capacity of transition countries

The 21st century is likely seen as the end of world population growth and the beginning of the century of population aging. At the global level the population proportion above age 60 is likely to increase from currently 10% to between 24 and 44% (95%-interval) by the end of the century. The situation in East Europe and FSU is shown in the table below. Such a massive change in demographic structure will have far reaching consequences for health, social and economic development and even for the environment. With respect to climate change this changing demographic outlook has implications for both the drivers of emissions as well as for the vulnerability of populations to global warming consequences and capacity to adapt. National policies must account for differential vulnerability within populations. Even within a household, the effects may differ by age and gender. Consideration of vulnerability must therefore focus not only on a country as a whole but also on the most vulnerable segments of the population within the country, and the elderly are among them.

Forecasted population sizes and proportion over age 60 *(in parentheses – 80% confidence intervals)*

Region	Population sizes (millions)					Share of population over 60		
	2000	*2025*	*2050*	*2075*	*2100*	*2000*	*2050*	*2100*
Eastern Europe	121	117 (109-125)	104 (86-124)	87 (61-118)	74 (44-115)	0.18	0.38 (.30-.46)	0.42 (.28-.57)
European part of FSU	236	218 (203-234)	187 (154-225)	159 (110-216)	141 (85-218)	0.19	0.35 (.17-.44)	0.36 (.23-.50)

Source: Lutz, 2006

3.2 Vulnerability to climate change

3.2.1 Interpretations of vulnerability in climate change research

Thanks to extremely fruitful IPCC activities, the term vulnerability has found its place in the climate change lexicon. Both natural and social scientists try to measure and assess vulnerability to climate change, whether from the perspective of regions, socio-ecological systems, or individuals. Different approaches to vulnerability in the frameworks of human-environment interactions, discussed in the previous sections, have penetrated into climate change research. Also, with the rapid growth of attention to climate change vulnerability, the concept itself has been re-defined. Climate scientists have developed their own interpretations and approaches, contributing significantly to the appearance of newly emerging systems of vulnerability analysis (Adger *et al.*, 2007; Burton *et al.*, 2002; Brooks, 2003; Brooks *et al.*, 2005; Füssel, 2007; Kelly and Adger, 2006; O'Brien *et al.*, 2007; Smit *et al*., 2001; Turner *et al.*, 2003; and other).

In a more recent work, McLaughlin and Dietz (2008) emphasize a need to understand not just the climate science but also to place climate projections in the context of human societies, political systems, social hierarchies, and underlying health profiles in order to appreciate the complex network of issues that may arise in different populations as a result of vulnerability to climate change. Unlike too much research on global climate change focused on climate change itself, these authors call to shift the research to their resulting ecological and social impacts. Based on the assessment of respective strengths and weaknesses of different theoretical perspectives, they consider such research as essential if we are to achieve a better understanding of the dynamics of vulnerability and to use that understanding for more effective target policies in relation to populations at the greatest risk.

Climate change represents a classic global problem that is characterized by infinitely diverse actors, multiple stressors and multiple time scales. As a result, research on vulnerability to this problem must address two important challenges: (1) to improve approaches for comparing and aggregating impacts across diverse sectors and populations, and (2) to model socioeconomic transformation in assessing the future significance of these impacts. Simultaneously, the research must account for multiple dimensions: the physical-environmental impact of changed climate; a region's capacity to recover from extreme events and adapt to change over the longer term; the degree to which international trade, international aid and other connections assist a region (country) in its coping and adaptive efforts (Moss *et al.*, 2001). The process of bringing climate change into mainstream development strategies and policies has also re-introduced some of the broader definitions of vulnerability, considering it as a function of the state of sustainability (EEA, 2006). Additionally, in climate change research the existence of competing conceptualizations and terminologies of vulnerability is particularly problematic since they are characterized by intense collaboration between scholars from different scientific schools of thought, including the physical science basis (IPCC, 2007b), risk assessment, sustainable development, economics, policy analysis, and so on.

Nevertheless, *"…this collaboration must be based on a consistent terminology that facilitates researchers from different traditions to communicate clearly and transparently, despite differences in the conceptual models applied"* (Füssel, 2007, p. 165).

The most widely used formulation of vulnerability to climate change identifies three dimensions: exposure to climate change stresses, sensitivity to those stresses, and coping capacity for dealing with the stresses. This vision bases the well-known IPCC (2007a) definition:

> *"Vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity, and its adaptive capacity".*

To date, extensive reviews of the use of the vulnerability concept in climate change research have identified two general and very different approaches to interpretations of the term and, hence, two very different purposes for using it, which are known as *'end-point'* and *'starting-point'* approaches (Füssel, 2007; Kelly and Adger, 2000; O'Brien *et al.*, 2004, 2007).

The first, more traditional approach considers vulnerability as "the end point of a sequence of analyses beginning with projections of future emission trends, moving on to the development of climate scenarios, and thence to biophysical impact studies and the identification of adaptive options" (Kelly and Adger, 2000, p. 326). Residual consequences that remain after adaptation has taken place define the levels of vulnerability that summarizes here the net impact of the climate problem and can be represented both quantitatively as a monetary cost or a change, e.g., in yield or flow, human mortality, ecosystem damage, and qualitatively – as a description of relative or comparative change (O'Brien *et al.*, 2004). A consideration of vulnerability in the '*end point'* of analysis understands it as 'a residual of climate change impacts minus adaptation'. Here, vulnerability represents the net impacts of climate change and serves as a means to define extent of the climate problem and provide an input into policy decisions regarding the cost of climate change versus the costs related to mitigation efforts (Kelly and Adger, 2000).

As an example, this conceptualization is captured in the model of vulnerability, proposed by Ford *et al.* (2006), where the system of interest is a community (Fig. 3.10). Here, vulnerability is expressed as a function of exposure-sensitivity of a community to climate change effects and its adaptive capacity to deal with that exposure. The authors don't see also exposure-sensitivity and adaptive capacity as mutually exclusive: an exposure to repeated climate-related conditions, for instance, can develop experience of how to manage them, enable a 'response with learning', and, thus, increase a system's adaptive capacity. In turn, the capacity to adapt also influences exposure. For example, the range of technologies available for adaptation may enable exposure to be managed, and, generally, more or less 'natural' ecosystems are more vulnerable than human-managed systems because they have a narrower range of coping mechanisms (Wilbanks, 2003). Under this interpretation and given the adaptation potential is realized, vulnerability really could be considered as the residual impacts of climate change after adaptation measures have been implemented.

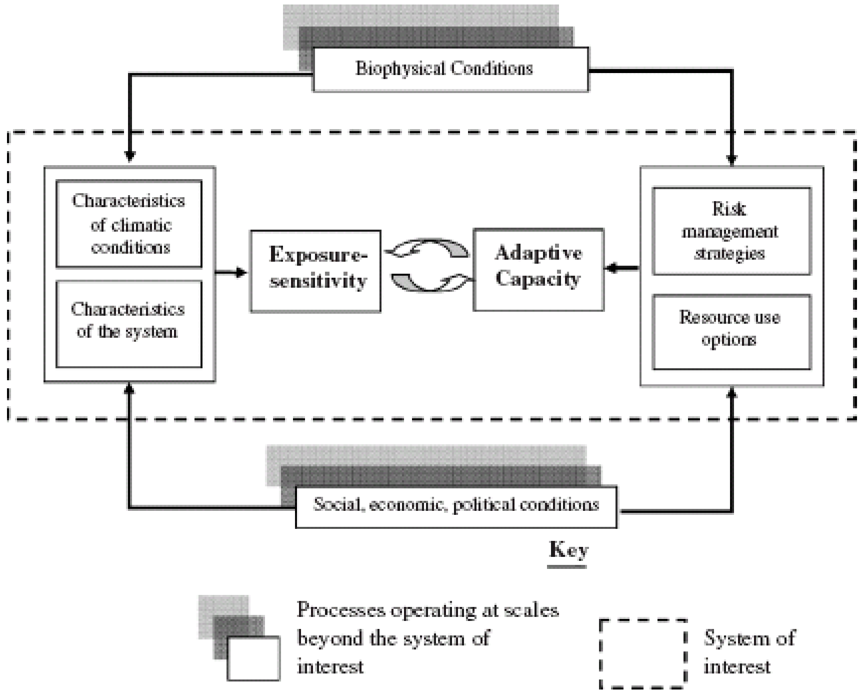


Fig. 3.10 A conceptual model of vulnerability with components of vulnerability identified and linked to factors beyond the system of study and operating at various scales. *Source:* Ford *et al.*, 2006

The *starting-point* approach, in contrast, considers vulnerability as an initial point for analysis. Rather than being defined by future climate change scenarios and anticipated adaptations, vulnerability represents a present inability to cope with external multiple environmental and social pressures, in this case – with changing climate conditions. Here, vulnerability is a characteristic of social and ecological systems that is generated by multiple factors and processes and as such provides a means to understand how the impacts of climate change will be distributed and how vulnerability could be reduced. A focus on prior damage assessment, referred by Kelly and Adger (2000) as a 'wounded soldier' approach, assumes that addressing present-day vulnerability will reduce vulnerability under future climate conditions (Burton *et al.*, 2002). A purpose of vulnerability assessments using this interpretation is, on the one hand, to identify policies and measures that reduce vulnerability and increase adaptive capacity and, on the other hand, to illuminate adaptation options and constraints. First and foremost, this is achieved by understanding the distribution and causes of vulnerability (Füssel, 2007; O'Brien *et al.*, 2004).

In particular, O'Brien *et al.* (2004) explain the differences between the two interpretations by their contextual backgrounds and the research purposes from which they originated. The *end-point* approach aimed at quantifying vulnerability to climate change and answering such questions as "Do the costs of climate change exceed the costs of greenhouse gas mitigation?" The *starting-point* interpretation has origins in assessments of social vulnerability with the purpose to identify the character, distribution and causes of vulnerability. This research includes such questions as "Who is vulnerable to climate change and why?" and "How can vulnerability be reduced?" Thus, critical to the starting-point interpretation is an understanding that vulnerability is a dynamic entity in a continuous state of flux because biophysical and social processes that shape local conditions and ability to cope are also changing (Leichenko and O'Brien, 2002). This understanding contrasts with that in the end point, which relies often on static quantifications reflecting the net difference of impacts and adaptations.

However, the most important difference between the two definitions is how they stand in direct relation to adaptation.

Most authors (Burton *et al*., 2002; Brooks, 2003; O'Brien *et al.,* 2004, 2007) are sure that interpretations of vulnerability are closely linked to differing interpretations of adaptive capacity, i.e. whether it refers to the ability to carry out specific technological adaptations to climate change or whether – to the ability to adjust to changing environmental and socioeconomic conditions. Viewing vulnerability as 'an end point' assumes that adaptations determine vulnerability, and adaptive capacity is a measure of whether technological adaptations can be successfully adopted or implemented. In the 'starting-point' interpretation, vulnerability determines adaptive capacity and hence adaptations. In other words, the adaptive capacity refers to the present ability to cope with and respond to stresses. Thus, in the first case adaptive capacity refers to future adaptations and vulnerability; in the second case it pertains to present-day vulnerability. Reversing the entire causal direction has serious implications for how both the problems and their solutions are viewed (O'Brien *et al.*, 2004).

Two roles of vulnerability research underlying these interpretations correspond largely with two types of adaptation research, distinguished by Smit *et al.* (2000) and Burton *et al.* (2002) and discussed in the next section. Here, we would like only to present Table 3.3, which summarizes the main differences between the two interpretations. According to the end-point interpretation, vulnerability is most relevant in the context of mitigation and compensation policy, for example, in technical adaptations. It is based on the integrated, or the risk-hazard framework of vulnerability research. According to the starting-point interpretation, vulnerability focuses on reducing internal socioeconomic vulnerability to any climatic hazards and addresses primarily the needs of adaptation policies and broader social development, being largely consistent with the political economy approach (Füssel, 2007).

In a second work, O'Brien *et al.* (2007), continuing their analysis of vulnerability in the climate change discourse (O'Brien *et al.*, 2004), show that the distinction between end-point and starting-point vulnerability studies, which reflects the differences between two conflicting interpretations of vulnerability, can be more succinctly summarized as *'outcome'* and *'contextual'* vulnerabilities.

Outcome vulnerability is considered as "a linear result of the projected impacts of climate change on a particular exposure unit (which can be either biophysical or social) offset by adaptation measures" (O'Brien *et al.*, 2007, p. 75). This is represented schematically in Fig. 3.11a where the result of an analysis is an outcome that can be attributed to climate change. Whereas positive outcomes are possible, it is the negative outcomes that are associated with vulnerability. Reducing outcome vulnerability involves reducing exposure through climate change mitigation, or developing adaptations to limit

Table 3.3 Two interpretations of vulnerability in climate change research

	End-point interpretation	*Starting-point interpretation*
Root problem	Climate change	Social vulnerability
Policy context	Climate change mitigation, compensation, technical adaptation	Social adaptation, sustainable development
Illustrative policy question	What are the benefits of climate change mitigation?	How can the vulnerability of societies to climatic hazards be reduced?
Illustrative research question	What are the expected net impacts of climate change in different regions?	Why are some groups more affected by climatic hazards than others?
Vulnerability and adaptive capacity	Adaptive capacity determines vulnerability	Vulnerability determines adaptive capacity
Reference for adaptive capacity	Adaptation to future climate change	Adaptation to current climate variability
Starting point of analysis	Scenarios of future climate hazards	Current vulnerability to climatic stimuli
Analytical function	Descriptive, positivist	Explanatory, normative
Main discipline	Natural sciences	Social sciences
Meaning of 'vulnerability'	Expected net damage for a given level of climate change	Susceptibility to climate change as determined by socioeconomic factors
Qualification	Dynamic cross-scale integrated vulnerability [of a particular system] to global climate change	Current internal socioeconomic vulnerability [of a particular social unit] to all climatic stressors
Vulnerability approach	Integrated, risk-hazard	Political economy

Source: Füssel, 2007

negative outcomes. Thus, viewing vulnerability as the outcome leads to the danger that adaptation will be reduced to building a local capacity to make sectoral and technological changes, rather than to address the fundamental causes of vulnerability, including the geopolitical and economic contexts (Brooks, 2003).

In contrast, *contextual vulnerability* (Fig. 3.11b) is based "on a processual and multi-dimensional view of climate–society interactions. Both climate variability and change are considered to occur in the context of political, institutional, economic and social structures and changes, which interact dynamically with contextual conditions associated with a particular 'exposure unit'" (O'Brien *et al.*, 2007, p. 76). Contextual conditions influence the exposure to climate variability and change, as well as potential responses.

Responses can affect both the processes and contextual conditions. Climate change is important because it modifies biophysical conditions, which alter the context for responding to other processes of change, e.g., economic liberalization or political decentralization. These other processes alter the context in which climate change occurs, and the reducing of vulnerability involves certain altering of this context, so that individuals and groups can better respond to changing conditions.

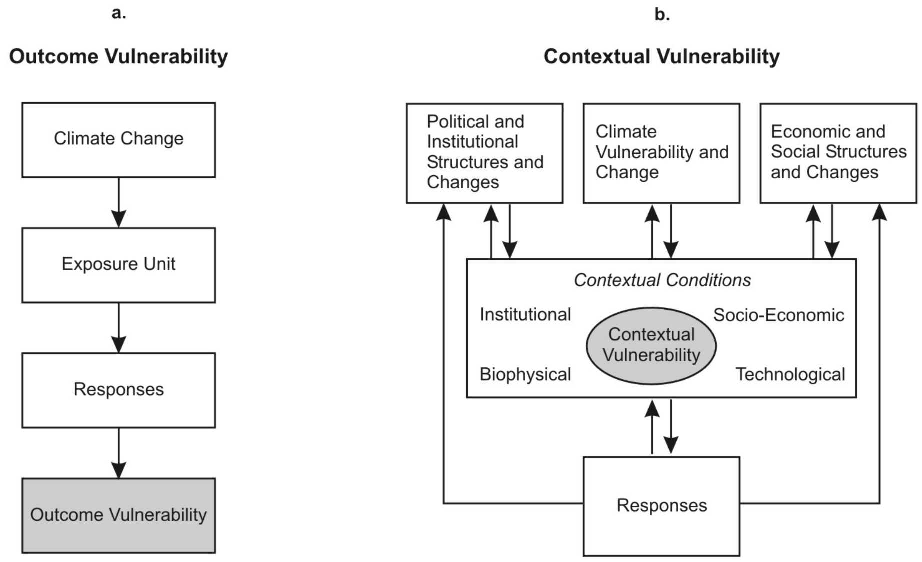


Fig. 3.11 Frameworks depicting two interpretations of vulnerability to climate change. *Source:* O'Brien *et al.*, 2007

However, O'Brien *et al.* (2007) consider the two representations of vulnerability as not simply its different interpretations, but as two fundamentally different frameworks of the climate change problem: its *scientific* and *human-security* framings.

The end-point or 'residuals' interpretation of vulnerability represents a strong scientific understanding of climate change (as well as of other environmental problems) where science plays a central role in both identifying and explaining ('diagnosing') these problems, and providing a basis for defining their solutions (recommending 'a cure'). Hence, ***scientific framings*** view climate change as a problem of human impacts on the global climate system. Research is focused on the changes that can be attributed to GHG emissions, with special emphasis on quantifiable impacts based on future climate change modeling scenarios. Firm boundaries are drawn between 'nature' and 'society', with disproportional focusing on nature as part of the Earth system. This framing tends to favor a physical-flows view that emphasizes the flow of matter and energy between systems' components (Füssel and Klein, 2006). An assumed knowledge of future climate is deeply embedded in the end-point analyses, both in terms of impacts and adaptations. However, if climate change manifests itself differently than was expected or projected, the predefined technological adaptations may become inappropriate.

Human-security framings view climate change as a transformative process that affects humans in different ways and focuses on the consequences of climate variability and change for individuals and societies. In this framing, nature and society are often considered as inseparable aspects of the same context, and nature–society relationships are conceptualized as mutuality, rather than duality. This sets much wider boundaries around the issue of climate change, emphasizing its interactions with multiple processes of change, and can be associated with an actor–system view that "emphasizes the flow of information and the relationship between different factors that determines social decision-making" (Füssel and

Klein, 2006, p. 311). Thus, vulnerability is considered to be influenced not only by changing biophysical conditions, but also by dynamic social, economic, political, institutional and technological structures and processes, that is, by contextual conditions.

As to the question *'Whether it is possible to integrate these two interpretations of vulnerability to climate change into one comprehensive and formal framework for understanding'*, – O'Brien *et al.* (2007) suggest that the differences may be too great to overcome. "Because merging two different framings involves different discourses and different actors, integrating the two interpretations of vulnerability into one unifying framework is not simply a matter of science, but of the politics of climate change" (p. 85). It may be possible to integrate across disciplines, but it is much more difficult to integrate across discourses, based on different models of causality. Outcome vulnerability and contextual vulnerability address two different, although interrelated questions that reflect two distinct framings of the climate change issue. The first question – *'Are humans changing the climate system?'* – is addressed through the scientific framing, which is embedded in institutions with strong influence upon climate-change debates and research, including such international bodies as the UNFCCC, IPCC and most global change research programmes. The second question – *'What are the differential implications of climate change for society?'* – has yet to be clearly articulated. The human-security framing is far less visible in formal international scientific and policy debates.

Thus, differing interpretations of the climate change vulnerability concept can be considered as an unsurprising outcome of the wide breadth and scope of climate change research, and the fact that diverse scientific communities representing physical, biological, and social sciences and humanities are involved in addressing this very complex issue. Further clarification of this concept is essential to designing and implementing future research, for presenting the issue to a broad audience, and to addressing it through concrete policies and responses. O'Brien *et al.* (2004) see understanding the biophysical, social, political and cultural factors that contribute to climate vulnerability as a critical prerequisite for taking actions to its reducing. Since the two interpretations of vulnerability differ so considerably in their content, origins, and assumptions about adaptation, they also differ in their using in practical research. The radically different definitions not only result in different 'diagnoses' of the climate change problem, but also in different kinds of 'cures'. The end-point approach originates from a perception that diagnosing climate change is the main problem, and the cures entail reductions of GHG emissions and sensitivity of various economic, social and environmental sectors and systems to projected changes in particular climate parameters. The starting-point approach diagnoses inherent social and economic processes of marginalization and inequalities as the causes of climate vulnerability and seeks to identify ways of addressing these.

These two framings of climate change can be considered as products of different discourses on *global environmental change* representing the distinct world views and approaches to science (Table 3.4).

A ***biophysical discourse*** emphasizes the importance of understanding the key processes in the integrated Earth system, and how human activities affect these processes. This supports the *scientific framing* of the climate change issue. The underlying logic of the *biophysical* approach to vulnerability is justification of continued investments in climate monitoring and modeling. *"In order to understand and reduce vulnerability, it is necessary to know where and how the climate will change"*, – Lövbrand (2004, p. 28) states.

Table 3.4 Discourses on global environmental change and their relationship to framings of climate change

Environmental change discourse	*Description*	*Framing of climate change*
Biophysical	• Takes the dynamic Earth system as a starting point and focuses on what humans are doing to biological and physical conditions and processes • Reflects the 'enlightenment' paradigm of positivist science, which is based on an understanding that more information and knowledge will enable society to better manage environmental problems	A scientific issue that requires a better understanding of key biophysical processes and impacts
Critical	• Emphasizes how social and political relations shape processes, responses, and outcomes from environmental change • Reflects social theory and poststructuralist and postmodernist approaches to knowledge. Many proponents question the rational, scientific paradigm that underlies the biophysical and human–environment discourses • Draws on the work of philosophers and post-modern theorists. Proponents argue that scientific enquiry, theories and hypotheses represent constructions of reality that are influenced by history and by the current cultural, political and economic context	A human-security issue that requires understanding differential capacities to respond to changing conditions
Human–environment	• Situates global environmental change within the context of interrelated human and environmental systems, where the natural environment is inseparable from human activities • Draws upon references to the 'coupled human–environment system', resilience, and adaptive management • Nature–society interactions are considered to operate at multiple scales, and interact with multiple stressors	Refers to both framings, but emphasizes the role of science in promoting sustainability

Source: O'Brien *et al,* 2007

A ***critical discourse*** emphasizes the role of social, political and economic relations in shaping the processes, responses and outcomes of environmental change, and as such it is in sharp contrast to the biophysical discourse. This discourse is closely associated with human-security framings of climate change. Here vulnerability is not only a function of the physical characteristics of climate events but, more importantly, is an inherent property of a society determined by such factors as poverty, inequality, gender patterns, access to health care and housing, etc. (Brooks, 2003). As was discussed earlier, through analysis of historic evolution of social systems in various regions, this approach tries to explain why certain groups are less able to adapt to environmental stresses on the whole and to climate change, in particular. Social vulnerability studies, as contrasted to impact studies, are therefore mostly bottom-up oriented.

A ***human–environment discourse*** relates to the coupled social–ecological systems and can be linked to both framings. Within this discourse, some research emphasize the role of science and technology for improving environmental management, while others emphasize the importance of location and context in generating vulnerability. From this discourse the greatest amount of efforts emerged to develop an integrative framework for vulnerability assessments (Turner *et al*., 2003). In particular, the top-down climate impact assessments and the bottom-up social vulnerability studies are bridged in the last IPCC assessment reports (IPCC, 2001a, 2001c; IPCC, 2007a, 2007d) where vulnerability is presented as a function both of the physical characteristics of climate change and of the social systems' inherent sensitivity and adaptive capacity. The attempts to bridge all approaches are especially advanced under the umbrella of 'sustainability science'.

Finally, somewhat earlier, Moss *et al.* (2001) proposed their vision of the dimensions of vulnerability to climate change. In their classification, the *physical-environmental dimension* "accounts for the harm caused by climate" and refers to the climatic conditions in a region and to the biophysical impacts of climate change, such as changes in agricultural productivity or the distribution of disease vectors. The *socio-economic dimension* refers to "a region's capacity to recover from extreme events and adapt to change over the longer term". The third dimension – *external assistance* – is defined as "the degree to which a region may be assisted in its attempts to adapt to change through its allies and trading partners, diasporic communities in other regions, and international arrangements to provide aid".

Thus, "…vulnerability is not simply the residual of impacts and adaptations, but a general characteristic generated by ongoing social and environmental problems that can be reduced by addressing current problems, irrespective of the exact direction or magnitude of future climate change" (O'Brien *et al.*, 2004, p. 6). And later these authors (2007, p. 85) concluded: *"Rather than being merely a question of definitions or semantics, the interpretation of vulnerability has consequences for how climate research is carried out within interdisciplinary research institutes, where scientists with differing backgrounds often use terminologies that are vaguely defined and lack shared meanings"*.

3.2.2 Interplay of risk and vulnerability

As was mentioned in the previous section, the *end-point* interpretation of vulnerability in climate change research can be based on the risk-hazard approach. This interpretation has been widely applied in different assessments of the expected damages caused by various kinds of hazards, including the climatic. The employment of a risk-based approach to portray vulnerability in terms of the likelihood of crossing specific thresholds was noted by Yohe *et al.* (2004). However, vulnerability is different from risk.

Let us remember, that definitions of risk are commonly probabilistic in nature, relating either to (1) the probability of occurrence of a hazard that acts to trigger a disaster or series of events with an undesirable outcome, or (2) the probability of a disaster or outcome, combining the probability of the hazard event with a consideration of the likely consequences of the hazard (Brooks, 2003; Brooks *et al.*, 2005). For example, in the second of these works (p. 152) a climate change risk is conceptualized "as relating to compound 'climate-related disasters', triggered by climatic or meteorological hazards (storms, droughts, extreme precipitation events, circulation changes and so on) but mediated by the sensitivity or vulnerability of the exposed systems". In other words, the authors view risk as a function of hazard and vulnerability and transform the relationship 'risk = hazard * vulnerability' to assess vulnerability, using the risk proxies in conjunction with a variety of socio-economic and other data.

Füssel (2007) differentiates the standard applications of *disaster risk assessments* (DRA) as primarily concerned with short-term (discrete) natural hazards, assuming known hazards and present (fixed) vulnerability, from the vulnerability assessment addressing climate change consequences (Table 3.5). Key characteristics of anthropogenic climate change are long-term and dynamical, simultaneously global and spatially heterogeneous. Moreover, climate change involves multiple hazards associated with large uncertainties and is attributable to human actions. In contrast to DRA, which traditionally sees hazards as stationary and assumes vulnerability to be constant, the long time scales of climate change shift the focus to future risks. This requires a dynamic assessment framework that accounts for changes in all vulnerability factors over time. The future climatic risks to a system are determined by its future exposure and future sensitivity to expected hazards that depends on the system's current sensitivity as well as on its current and future adaptive capacity. In turn, the adaptive capacity of the vulnerable system determines largely how its sensitivity evolves over time.

Table 3.5 Characteristic of vulnerability assessment addressing natural hazards and climate change

	Natural hazards	*Climate change*
▪ Hazards characteristics		
Temporal	Discrete events	Discrete and continuous
Dynamic	Stationary	Non-stationary
Spatial scope	Regional	Global but heterogeneous
Uncertainty	Low to medium	Medium to very high
Attribution	Natural variability	Natural and antropogenic
▪ System of concerns	Social systems and built infrastructure	All systems
▪ System view	Static	Dynamic and adaptive
▪ Targets for risk reduction	Exposure to hazards and internal vulnerability	Magnitude of hazard and internal vulnerability
▪ Analytical function	Normative	Positivist and normative

Source: Füssel, 2007

Thus, vulnerability is not a risk. The processes by which risk is converted into vulnerability, for example, at a national level are shaped by the underlying state of human development, including the inequalities in income, opportunity and political power that marginalize the poor, etc. Among the factors that create a predisposition for the conversion of risk into vulnerability, UNDP (2007a) see the following:

- ⇨ *Poverty and low human development;*
- ⇨ *Disparities in human development;*
- ⇨ *Lack of climate-defense infrastructure;*
- ⇨ *Limited access to insurance.*

As one example, insurance could be considered, which plays an important role in enabling people to manage climate risks without having to reduce consumption or run down their assets. Social insurance is a buffer against vulnerability that enables people to cope with risks without eroding long-term opportunities for human development.

Countries vary widely in their support for social insurance. In terms of the risk management of global climate change there is an inverse relationship between vulnerability, which is concentrated in poor countries, and insurance, which is concentrated in rich countries that spend a greater share of their average incomes on social insurance. Climate shocks affect livelihoods in many ways. They wipe out crops, reduce opportunities for employment, push up food prices and destroy property, confronting people with stark choices. Wealthy households can manage climate shocks by drawing upon private insurance, using their savings or trading some of their assets. They are also able to protect their current consumption without running down their productive capacities or eroding their human capabilities. The poor have far fewer options. With limited access to formal insurance, low income and meager assets, the poor households have to adapt to climate shocks under more constrained conditions. In an effort to protect current consumption, they are often forced to sell productive assets, thus compromising future income generation. When income levels fall from already low levels, they may have no choice but to reduce the number of meals they eat, cut spending on health care, or remove their children from school to increase labor supply. Those who reside in rural areas and whose livelihoods depend on smallholder agriculture, farm employment or pastoralism are especially vulnerable and subjected to climate change risks.

3.2.3 Assessment of vulnerability

The field of *vulnerability assessment* has emerged to address the need to quantify how communities will adapt to changing environmental conditions. Various researchers have tried to bridge the gap between the social, natural, and physical sciences and contributed new methodologies that confront this challenge (e.g., Hahn *et al*., 2009; Eriksen and Kelly, 2007; Fussel and Klein, 2006; Polsky *et al.*, 2007).

Multifaceted, interdisciplinary approaches to climate change vulnerability assessment are essential because of the policy imperative for an improved understanding of the factors that shape vulnerability. The assessment is also needed to develop measures aimed at increasing resilience and facilitating adaptation priorities and for improving the common understanding of the environmental, social, and economic effects of different stabilization targets for GHG emissions. Research on vulnerability seeks to address these issues in the frameworks for quantitative and qualitative assessing the interaction of environmental changes and socioeconomic conditions. It is important to recognize multiple dimensions of vulnerability and account for them in such methodological frameworks (Moss *et al*., 2001).

Eriksen and Kelly (2007), considering vulnerability assessment from a methodological viewpoint, emphasize three main implications for how vulnerability can be measured in the case of using a *'starting-point'* approach:

1. The state of vulnerability is closely related to the ability to respond.
2. When attempting to measure the ability to respond to adverse consequences, it is proposed to distinguish between the process of coping and the process of adaptation, although recognizing the two processes as related. An adaptation process consists of adjustments in practices, processes or structures performed in response to the actuality or threat of *long-term* climate change and leading to an *evolving change in state*, defined in terms of both physical and social conditions. On the contrary, coping refers to actions performed in response to the actuality of present climatic stress, often aimed at *restoring a previous state* and generally of a *short duration*.

3. A third implication of considering vulnerability as a pre-existing state is that not only is vulnerability a condition that cannot be measured directly, but that the consequences of this inherent inability to respond only materialize intermittently (for example, in a differential ability to secure well-being during extreme climatic events).

At the same time, vulnerability analysis is interdisciplinary work. Being a useful integrative and multidimensional conception for evaluating the potential effects of climate change, it is also a very complex issue that unlikely can be directly observed and measured. First of all, as it has been more that once emphasized in this discussion, due to complex interactions between socio-environmental systems and climate conditions, we cannot describe exhaustively the impact of climate change. There is also no consensus as yet even as to what indicators to measure.

Fortunately, some changes in the well-defined and measurable elements, which already demonstrate the significant impacts of climate change, can be used as *indicators* for changes in a system as a whole (EEA, 2004). Indicators do not tell the whole story, but they can give clear hints that the system is changing, in which direction it is changing and to what extent. In this quality, indicators help to assess the vulnerability of natural, societal or socio-environmental systems to climate change. Furthermore, they can help to show how distant the policy targets are. Searching the indicators and development of quantitative indices for vulnerability is an important part of the vulnerability assessment program (Baumert and Pershing, 2004; Eriksen and Kelly, 2007; Moss *et al.*, 2001). At the same time, the results of analysis carried out by Brooks *et al.* (2005) highlighted many caveats that must be in mind when we use spatially and temporally aggregated data. Vulnerability to climate change within regions or countries is geographically and socially differentiated, while the processes that mediate the outcomes of hazard events operate at the local scale. Ultimately, it is people and individual systems that are vulnerable, and the national-level indicators must be complemented by locally contextual indices to yield a full picture, including the identification of vulnerability 'hotspots'.

Some researches are focusing on quantitative estimates of vulnerability at the *national level.* This level is often the favored unit of analysis because it is believed (e.g., Brooks *et al.*, 2005; Eriksen and Kelly, 2007; Moss *et al.*, 2001) that the national level is an appropriate scale for information utilized by central governments in determination of policy, as well as for use in continent-wide or global comparisons, the calls for which have been largely policy driven. The nation state level is also still the main political unit through which emission targets and adaptation policies are formulated and the resources, such as development assistance, are assigned. This is the sovereign level at which international negotiations take place, and at which the ultimate responsibility lays for shaping the framework for policy formulation, instruments and institutional structures for executing measures. A need in objective comparison of levels of vulnerability between countries is a way of allocating priorities for funding and intervention, for example, in the context of the Adaptation Fund set up under the UNFCCC (2006). In political geography the national level is promoted as a middle category to separate conflicting interests, despite the fact that the global level is the level of reality where many influencing processes operate. Eriksen and Kelly (2007), who carried out the comparison of indicators used in national-level studies, add to this level's advantages the wide availability of reliable national indicators that are comparable across nations. Identification of particularly vulnerable nations or regions can act as an entry point for both understanding and addressing the processes that cause and exacerbate vulnerability, “although sub-national spatial and social differentiation of vulnerability, and the way in which the impacts of national-scale processes are mediated by local conditions, should not be downplayed” (Brooks *et al.*, 2005, p. 151).

One of the main challenges in selecting representative vulnerability indicators at the national level, and in conceptualizing vulnerability here, derives from the fact that the effects of climate-induced pressures are mediated by society. Consequences vary between communities, between social groups in a community, between households and even between people within a household.

Fussel and Klein (2006) divide available studies on this issue into the first generation vulnerability assessments, based on climate impact assessments relative to baseline conditions, and second-generation assessments that incorporate adaptive capacity. Of the second-generation studies, there are a multitude of interpretations about how best to apply exposure, sensitivity, and adaptive capacity concepts to quantify different vulnerability (O’Brien *et al.*, 2004; Ebi *et al.*, 2006; Polsky *et al.*, 2007). Key differences among studies include scale, methods used to select, group, and aggregate indicators, and methods used to display results. A common thread is an attempt to quantify multidimensional issues using indicators as *proxies*. These are often combined into a composite index allowing diverse variables to be integrated. The Human Development Index (HDI), for example, incorporates life expectancy, health, education, and standard of living indicators for an overall picture of national wellbeing (UNDP, 2007).

Several studies attempted to quantify national-level vulnerability by identifying (1) the sectors that are sensitive to climate impacts (such as agriculture, infrastructure, and ecosystems), and (2) resources available to cope with those impacts (economic, human, and environmental). For example, Moss *et al.* (2001) constructed a prototype computer-based methodology for assessing vulnerability and resilience to climate change. Their model, developed at the US Pacific Northwest National Laboratory (PNNL), calculates indicators of sensitivity to climate change and coping-adaptive capacity, and then aggregates these into the overall indicator of vulnerability. The difference between aggregated sensitivity (the negative value) and adaptation capacity (the positive value) yields a ***vulnerability-resilience indicator.*** If the indicator value is positive, we are dealing with resilience; when negative – the indicator denotes vulnerability.

The proxies were identified for two kinds of sectors (Fig. 3.12). The *climate sensitivity* sectors included settlement, food security, human health, ecosystems, and water. The *coping and adaptive capacity* sectors included economic capacity, human resources, and environmental/natural resources capacity. Each sector, in turn, was composed of one, two, or three proxies. The choices of sectors and proxies were determined by available data. Table 3.6 lists the indicators, sectors, and proxy variables used in the vulnerability-resilience indicator prototype (VRIP) model. This set of indicators and proxies illustrates also the sort of relationships that will need to be explored in greater depth in the process of moving from testing VRIP system to development of an expanded model.

The vulnerability-resilience indicator can easily be decomposed into its contributing aspects and therefore remains transparent to analysts. Those proxies that are the most important in determining the aggregate vulnerability-resilience indicator for a particular case are defined as dominant or *leading proxies*.

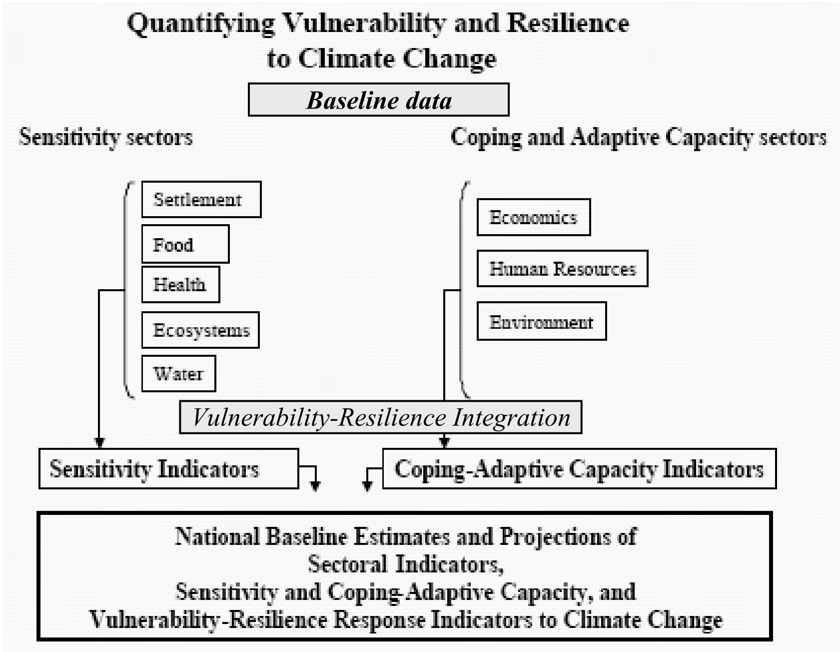


Fig. 3.12 Developing the quantitative vulnerability indicators: the structured relationships of model elements. *Source:* Adapted from Moss *et al.* (2001)

If to be guided by Moss *et al.* (2001) classification of the components of vulnerability (see Sect. 3.2.1), the *physical-environmental dimension*, which accounts for the harm caused by changes, e.g., in rainfall or water availability resulting in droughts or floods, can usually be measured, using available observation data. A *socio-economic dimension*, showing a capacity to recover from extreme events and adapt to long-term change, is more difficult for assessment and quantifying because it includes some cultural aspects, such as the strength of civil society and the societal view of nature, the diversity of a region's natural resources and sources of income, institutional development and political stability, and so on. A third dimension of vulnerability depending on the degree to which a region (nation) may be assisted in its attempts to adapt to climate change through external assistance is practically incapable to a priori quantitative measurement.

Practically the same types of indicators and sectors, but with slightly different proxies, used in developing 'vulnerability indexes', are presented in Table 3.7. In their comments to this set, Baumert and Pershing (2004) consider, for example, per capita income though crude but credible measures of a country's capacity to address either the causes or the consequences of climate change. Although in percentage terms, it is growing faster in developing and transition countries than in developed countries, the gap in absolute terms is evident and is widening. Some other measures, with bearing on a country's capacity to address climate change or other complex social challenges, include healthy life expectancy, educational achievement, and quality of governance (e.g., political stability or level of corruption). Such possible measures of capacity, as education and life expectancy, are similarly skewed.

Table 3.6 Indicators *(I)*, sectors, and proxies used in the vulnerability-resilience indicator prototype model

I	*Sectors*	*Proxy variables*	*Proxy for*	*Functional relationships*
Sensitivity	*Settlement and infrastructure sensitivity*	Population at flood risk from sea level rise	Potential extent of disruptions from sea level rise	Sensitivity ↑ as population at risk ↑
		Population without access to clean water/sanitation	Access of population to basic services to buffer against climate variability and change	Sensitivity ↑ as population with no access ↑
	Food security	Cereals production/area	Degree of modernization in the agriculture sector; access of farmers to inputs to buffer against climate change	Sensitivity ↓ as production ↑
		Animal protein consumption/capita	Access of a population to markets and other mechanisms for compensating for shortfalls in production	Sensitivity ↓ as consumption ↑
	Ecosystem sensitivity	% land managed	Degree of human intrusion into the natural landscape and land fragmentation	Sensitivity ↑ as % land managed ↑
		Fertilizer use	Nitrogen/phosphorus loading of ecosystems and stresses from pollution	60-100 kg/ha is optimal. X<60 kg/ha, sensitivity ↑ due to nutrient deficits and potential cultivation of adjacent ecosystems; X>100 kg/ha, sensitivity ↑ due to increasing runoff
	Human health sensitivity	Completed fertility	Composite of conditions that affect human health including nutrition, exposure to disease risks, and access to health services	Sensitivity ↓ as fertility ↓
		Life expectancy		Sensitivity ↓ as life expectancy ↑
	Water resource sensitivity	Renewable supply and inflow	Supply of water from internal renewable resources and inflow from rivers	Sensitivity calculated using ratio of available water to used: Sensitivity ↑ as % water used ↑
		Water use	Withdrawals to meet current or projected needs	
Adaptive capacity	*Economic capacity*	GDP(market)/capita	Distribution of access to markets, technology, and other resources useful for adaptation	Coping-adaptive capacity ↓ as GDP per capita ↑
		Gini index		At present Gini held constant
	Human and civic resources	Dependency ratio	Socio-economic resources available for adaptation after meeting other present needs	Coping-adaptive capacity ↓ as dependency ↑
		Literacy	Human capital and adaptability of labor force	Coping-adaptive capacity ↑ as literacy ↑
	Environmental capacity	Population density	Population pressure and stresses on ecosystems	Coping-adaptive capacity ↓ as population density ↑
		SO_2/area	Air quality and other stresses on ecosystems	Coping-adaptive capacity ↓ as SO_2 ↑
		% land unmanaged	Landscape fragmentation and ease of ecosystem migration	Coping-adaptive capacity ↑ as % unmanaged land ↑

Note: ↑, ↓ – increase or decrease of proxy and indicator
Source: Moss *et al.*, 2001

Table 3.7 Examples of proxy indicators used for development of vulnerability indexes

Sensitive Sector / Coping Capacity	*Proxy Indicators*
Food sensitivity	Population employed in agriculture (% of total) Rural population (% of total)
Ecosystem sensitivity	Water resources per capita
Settlement and infrastructure sensitivity	Population in flood prone areas Population without access to clean water/sanitation
Human health sensitivity	Fertility Life Expectancy
Economic capacity	GDP per capita Income inequality (Gini Index)
Human resource capacity	Dependency Ratio Literacy
Governance capacity	Political stability Regulatory quality
Environmental capacity	Population density Land unmanaged (% of total)

Source: Baumert and Pershing, 2004

However, while providing some indication of a country's climate risk and enabling cross-country comparisons, such indexes are rough approximations at best and fraught with difficulties.

The issue of how to develop credible indicators of vulnerability to climate change that can be used to guide the development of adaptation policies was also partially addressed by Eriksen and Kelly (2007). As a fundamental lesson they see the need to enhance the common understanding of the causes of vulnerability in order to develop indicators that can effectively aid future policy development. They also display a number of weaknesses that limit usefulness of indicators in developing adaptation policy because they

Box 3.4 Areas that need attention in the development of vulnerability indicators

- Given the differentiation of vulnerability at all levels, the scales issue is a critical concern in selecting representative indicators. However, the fundamental scale of vulnerability, due to differentiation within the community, is local, though processes operating at broader spatial scales do contribute significantly to patterns of vulnerability at this level. The need to aggregate up to, say, the national scale can lead to the loss of information about pockets of vulnerability and may distort overall conclusions as details are lost in the process of averaging or accumulation. Of course, this statement does not exclude the importance of national-level assessments, especially if to take into account political reasons for their being carried out.
- The selection of indicators must also be conditioned by the dynamic nature of vulnerability deriving from the interaction of many processes that determine vulnerability and the constant evolution of its levels as adaptation takes place. A wide-ranging set of required indicators must be updated regularly since reliance on a single-time snapshot could be seriously misleading. Any process-based study must consider change over time as a key diagnostic tool, and any attempt to 'understand' the causes of vulnerability must be undertaken with due awareness that understanding must evolve too as vulnerability itself changes.
- Indicator studies should be more transparent in defining assumptions and premises. While diversity in approaches is more than appropriate at a development stage, the increasing demand for objective analysis of vulnerability in order to support resource allocation and, ultimately, adaptive strategies warrants a clearer definition of where any study fits into the morphology of vulnerability assessment. Explicit statement of underlying assumptions and premises, and potential effects on research outcome is fundamental to the scientific method and is vital if the results are to be compared across different studies, thus leading to the development of a more thorough conceptual understanding.
- In addition to transparency, the verification of findings is that aspect of vulnerability indicator studies to which insufficient attention has been paid. The reliable, verifiable conclusions can only be drawn from the component of the complex of response patterns, namely, from the observed success in coping with short-term climate variability. Extrapolation to the longer-term process of adaptation can only be undertaken with caution and continual monitoring of any intervention strategy. Verification is absolutely essential if indicator studies are to generate findings that are credible both within the scientific community and before those responsible for the development and implementation of adaptation policies.

Source: Eriksen and Kelly, 2007

measure "aggregate conditions that provide static snapshots of population characteristics rather than guidance on societal processes that can be targeted to reduce vulnerability" (*Ibid,* p. 517). Eriksen and Kelly identified some areas as warranting serious attention in future studies (Box 3.4).

Fig. 3.13 – the 'crown' of this section – shows indexes of vulnerability to climate change of East European and FSU counties according to the World Bank (2009) vulnerability index. This index combines three sub-indices capturing a country's exposure, sensitivity, and adaptive capacity. The first, *exposure*, measures the strength of future climate change relative to today's natural variability and includes both annual and seasonal temperature and precipitation variables. The second sub-index, a country's *sensitivity* to climate change, is based on indicators likely to increase the impact of climate shocks. It includes physical indicators, such as the available water resources per capita and air pollution, the economic indicators capturing the importance of agriculture, the share of electricity derived from hydroelectric plants, the overall quality of infrastructure, and the share of the population over 65. *Adaptive capacity* is estimated by combining social (income inequality), economic (GDP per capita), and institutional measures. Combining these three components into a single index of vulnerability yielded the ranking of countries shown in Fig. 3.13 where different scales are used to demonstrate how each factor drives countries' vulnerability. In particular, the most vulnerable FSU counties are Tajikistan and Kyrgyz Republic, which have social and productive structures that are very sensitive to climate change impacts. Russia stands out for its high exposure and limited adaptive capacity, being offset by relatively low sensitivity.

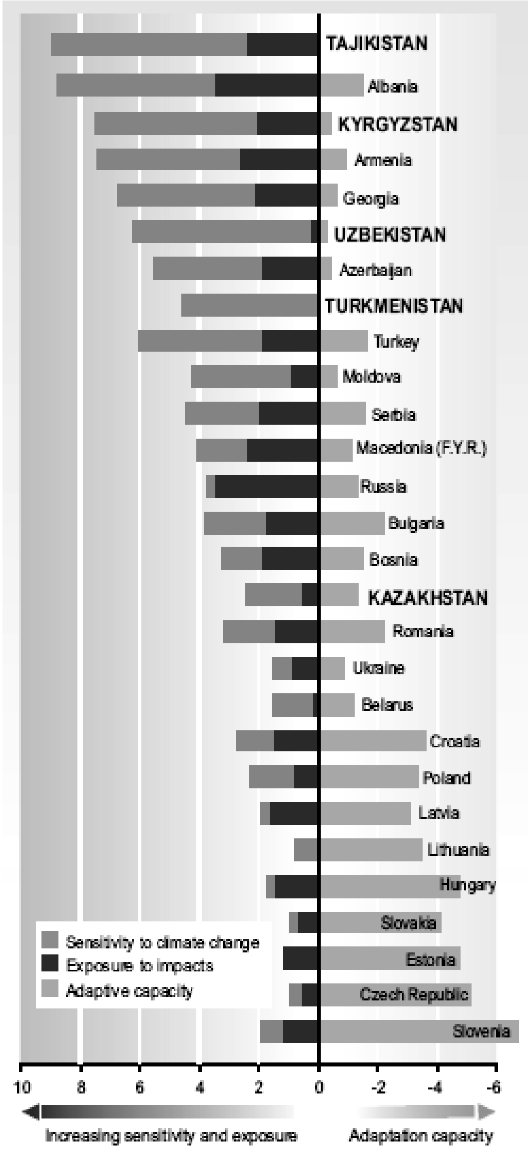


Fig. 3.13 Word Bank ranging of different countries by their vulnerability to climate change; in capital – Central Asian countries. *Source:* Word Bank, 2009; Zoï Environment Network, 2009

Table 3.8 Categorization of major components of a Livelihood Vulnerability Index (LVI) into IPCC contributing factors

Contributing factor	*LVI components*
Exposure	Natural disaster and climate variability
Sensitivity	Health Food Water
Adaptive capacity	Socio-demographic profile Livelihood strategies Social network

Source: Hahn *et al.*, 2009

Hahn *et al.* (2009) developed an alternative method for calculating a Livelihood Vulnerability Index (LVI) to estimate the climate change impacts on community levels that is also based on the IPCC definition of vulnerability through exposure, sensitivity and adaptive capacity. Their approach to construct the index differs from previous methods in that it uses primary data from household surveys. This helps to avoid pitfalls associated with using secondary, e.g., national data. The organization of seven major components in this framework is shown in Table 3.8.

3.3 Adaptation to climate change

3.3.1 Climate change adaptation as a concept

Adaptation is a rather vague term broadly defined as the process of modifying something to fit a new condition, and as such is a feature of human societies permanently adapting to social and environmental change. To a greater or lesser extent, all natural and social systems are also adapted to the climates they experience and have a capacity to adapt to a changing climate. Societies sustainable to climates exist in any part of the world, and relatively stable patterns of weather, influencing many aspects of economic and social life, create a certain way of life. Societies are also accustomed to dealing with the inherent variability of current climate, its extremes and weather-related disasters. However, climate change imposes new pressures on the systems and causes necessity to adjust in response. In natural ecosystems these pressures change the structure and dynamics of their populations; in social systems, where people and organizations try to remain sustainable, the scope for reflexivity, innovation and change appears (Berkhout, 2005; Thompson *et al.*, 2006).

It is also important to recognize that adaptation to changes in climate is occurring in the context of many other changes and 'adjustments', as well as in the context of many other, sometimes more significant social, political and economic discontinuities. The crucial question is whether social and natural systems can adapt in response to a changing climate in principle, implying both changes in its mean conditions and variability, and whether this can be achieved without suffering losses in overall social welfare or ecosystems functionality. While more flexible and fast-changing aspects of social and natural systems will adapt relatively quickly and possibly at low cost, the more long-lived and inflexible features are likely to be more difficult and costly for adjusting. Moreover, surprises with crossed thresholds and the sudden, much more rapid climatic shifts are unavoidable (IPCC, 2007a).

Yohe (2000, p. 372) identified a common theme that has emerged in each of the lines of adaptation research: *"Economically based adaptation tends to lower the expected cost of climate change along smooth and anticipated trajectories. In some cases, adaptation might prolong the lifetime of a system indefinitely. In other, more likely and more interesting circumstances, adaptation might extend a system's productive lifetime so that substitute structures and/or systems can be envisioned and created"*.

Analyses of adaptations in the climate change field emerged concurrently with the growing awareness of climate change itself and could be initially attributed to UNFCCC's Article 2. With time, the concept of climate change adaptation has deepened and widened. Burton *et al*. (2002) distinguished three stages in this process, defined as 'short term' *(Stage 1)* and 'medium to long term' *(Stage II and III):*

Stage I: Planning that includes studies of possible impacts of climate change to identify particularly vulnerable countries or regions, policy options for adaptation and appropriate capacity building;

Stage II: Measures, including further capacity building, which may be taken to prepare for adaptation as envisaged in UNFCCC Article 4.1(e);

Stage III: Measures to facilitate adequate adaptation, including insurance, and other adaptation measures as envisaged by UNFCCC Article 4.1(b) and 4.4.

One consequence of moving towards more comprehensive generations of adaptation studies has been the emergence of vulnerability as a central concept. As interest in climate change and its confronting developed, the emphasis shifted from an impacts-led approach to a vulnerability-led one (Adger *et al.,* 2004).

The ***impacts-led approach*** tends to concentrate on the evolution of physical hazards associated with climate variability and change. Typically, this approach examines future human exposure to climate hazards based on modeling studies and projections.

The ***vulnerability-led approach*** examines the underlying socio-economic and institutional factors, and to a lesser extent – political and cultural factors that determine how people respond to and cope with climatic hazards. Studies of vulnerability may be carried out without a detailed knowledge of how climate will vary over time. The vulnerability of a region, system or population group to a range of existing or hypothetical hazards may be assessed, based on the analysis of factors that determine how they likely to be affected in the face of the hazards in question. Such an approach is therefore a useful tool with which to assess people's needs in terms of adaptation or improvements in their ability to cope with existing threats. In this case, vulnerability assessments do not require detailed climate information generated by models, and adaptation policies may therefore be developed despite the uncertainties inherent in the science of climate change. While a detailed knowledge of likely or potential future climate would be desirable, a lack of it would not be an impediment to increasing the general resilience of societies to the types of threats they may be expected to face in the future.

At present, IPCC refers to adaptation to climate change as "adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities" (Parry *et al.*, 2007a, p. 869). On the other hand, the UNFCCC interprets it as "practical steps to protect countries and communities from the likely disruption and damage that will result from effects of climate change" (UNFCCC 2006a)[10]. The UNDP defines adaptation as "a process by which strategies to moderate, cope with and take advantage of the consequences of climatic events are enhanced, developed, and implemented" (UNDP 2006)[11].

Although the differences in adaptation definitions may seem small, the different stakeholders, as is noted by Srinivasan (2006), can interpret them to suit their own interests; this leads to widespread confusion. For example, community-based adaptation practitioners use a more technical interpretation of the term that focuses on actions, while adaptation policymakers use a broader definition and emphasize the institutional and policy sides of adaptation including building knowledge in support of policies and programmes, technologies, financing, capacity building, and other institutional arrangements. International negotiators face the dilemma to differentiate adaptation to long-term climate change from adaptation to short-term climate variability since the UNFCCC intends to support primarily the activities falling under the first category. Because the varied interpretations obviously have serious financial implications, it is important to promote a common understanding.

In particular, the Institute for Global Environmental Strategies (Srinivasan, 2006), based on Hay *et al.* (2004), interprets climate change adaptation as a dynamic and multi-dimensional process that integrates such components as planning, research, technologies, funding, training, capacity building, public awareness, and education (Fig. 3.14). In order to address adaptation comprehensively, the climate risks at local, national or regional levels must be assessed, using different decision support tools and methods involving data, information, knowledge, skills and so on.

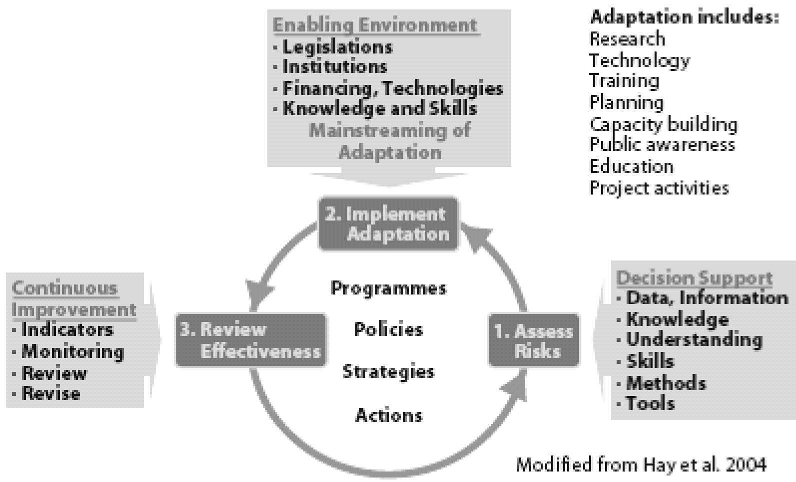


Fig. 3.14 Multi-dimensions of adaptation policies. *Source:* Srinivasan, 2006

[10] UNFCCC, 2006a. Adaptation (*http://unfccc.int/adaptation/items/2973.php*)

[11] UNDP, 2006. Adaptation-Definitions. UNDP, New York. Available online at *http://www.undp.org/gef/adaptation/climate/03b.htm*

To implement properly the various programmes, policies, strategies and actions, which can support mainstreaming adaptation concerns in development planning, a good enabling environment is needed, including supporting legislation and institutions. Effective implementation of adaptation actions, therefore, requires more than the mere output of climate change modeling. It is necessary to determine the effectiveness of the implemented activities through the development of reliable indicators and then to revise the existing practices. Successful adaptation requires also flexible institutional and policy processes, increased public awareness and dialogue, sharing of knowledge on adaptation measures, mobilization of tools and technologies, capacity building, appropriate monitoring and evaluation.

Smit *et al.* (2000) argue that the central theme of *'What is adaptation?'* is addressed, additionally to reviewing definitions, by considering three principal questions: *Adapt to what? Who or what adapts? How does adaptation occur?* (Fig. 3.15). Together, these three elements circumscribe, respectively, the climate-related stimulus, the system of interest, and the processes and forms involved. Thus, although in climate change adaptation discourse some definitions refer to adjustments in a system in response to (or in light of) climatic stimuli, they also indicate differences in scope, application and interpretation of the term. For example, the question '*adaptation to what?'* can refer to climate change, to climate change and variability, or just to climate (e.g., when a person gets into new climatic conditions). It can be in response to adverse effects, but can also be in response to opportunities, as well as in response to past, actual or anticipated conditions, changes or opportunities, and so on (Smit *et al.*, 2000).

Schneider *et al.* (2000) consider adaptation as an integral component of impact assessments that, in turn, are an integral component of the *policy analyze* of climatic changes. In addition to direct climate effects these authors see a host of other changes that adaptive agents need to anticipate in a dynamic world where many factors are changing simultaneously and not necessarily independently. These factors include degrees of belief that the climate is actually changing and knowledge about how it will change. As a result, most second generation studies include adaptation strategies where the complications implied by both climate natural variability and nonlinear behavior, or 'surprises', are considered. Variability can mask slow trends and thus delay adaptive responses or, in contrast, prompt 'a false

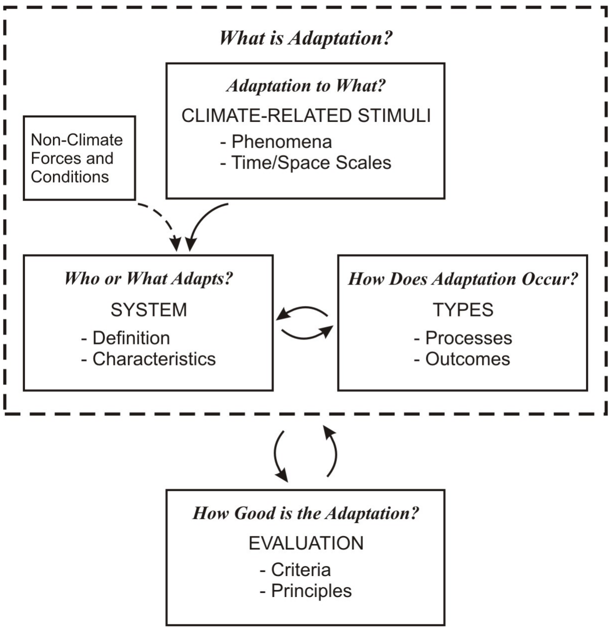


Fig. 3.15 Cross anatomy of adaptation to climate change and variability. *Source:* Smit *et al.*, 2000

start' leading to maladaptation. In addition, unforeseen non-linear climatic events can result in unwarranted placidity. Exposure to variability and to extreme events is an important source of vulnerability, and *"in fact, systems typically respond to variability and extreme events before they respond to gradual changes in the mean"*, – Yohe and Tol (2002, p. 25) noted.

On the whole, climatic conditions, the adaptations to which should been considered (either directly or indirectly), Smit *et al*. (2000) divided into three broad *temporal* categories:

- *global climate change,* as reflected in long-term trends, or in scenarios pertaining to, of mean temperatures and related climate 'norms' of other climatic variables;
- *variabilit*y in norms over periods ranging from a few years to several decades;
- isolated *extreme events* or catastrophic weather conditions, such as floods, droughts or storms.

Adaptations vary not only with respect to their climatic stimuli but also with respect to other, non-climate conditions, sometimes called *intervening conditions*, which influence the sensitivity of systems and the nature of their adjustments. For example, a drought may have similar impacts in two neighboring regions, but their differing economic and institutional arrangements may result in quite different impacts and hence in quite different adaptive responses, both in the short and long terms.

Berkhout (2005) considers the question '*adapting to what?*' from the viewpoint of the 'coping range' (*resilience)* of natural and human systems, or the range of *environmental variability* to which they are adapted. While it is often difficult to be precise about the real 'coping range' of any system, the general idea is useful in describing the discomfort, costs and risks that come with needing to cope with conditions that are outside common experience. The closer one gets to the edge of the coping range, the greater will be the effort to maintain welfare or function. Berkhout characterizes four features of responses to climatic conditions that stand out:

> ***First*****,** climate is multi-faceted, that is, experienced with more than just a single distinct phenomenon, such as temperature or precipitation change. Climatic conditions to which people or ecosystems respond and adapt are a combination of factors, and their particular effects are usually mediated by many other socio-economic factors.
>
> ***Second,*** the effects of changing or varying climatic conditions differ across different social groups. This means that in talking about impacts, care needs to be taken about identifying what group or system is being affected, and what range of conditions are being considered. Not all coping ranges will be equivalent, even within a similar sector, species or ecosystem, so that any given change in climate is likely to produce both winners and losers.
>
> ***Third,*** social systems will adjust to the direct experience of climate change, but also to a host of indirect consequences that may result.
>
> ***Fourth*****,** climatic factors may have their greatest influence as sequences of events or in the form of single catastrophic events. Natural and social systems are often resilient to cope with single events, but become more vulnerable to the compounding effect of a sequence of harmful events. A single event may place a system at the edge of its coping range, but a follow-up event may push it outside this range.

Answering the question *'Who or what adapts?'* is a second necessary step in any analysis or debate on adaptation – whether for impact assessment or for policy evaluation. It defines the system, to which the adaptations pertain, sometimes called 'unit of analysis' or 'exposure unit', 'activity of interest' or 'sensitive system' (Carter *et al.*, 1994). There are evident differences in how the definitions relate to this. It can be people, social and economic sectors and activities, managed or unmanaged natural or ecological systems, or practices, processes and structures of systems. Indirectly, these questions focus attention on the spatial scale of the process, but there is more in this question that relates to the nature or scope of a system: whether this is adaptation in a species, ecosystem, economic sector, across a social structure or a political entity. Dealing with instantaneous properties of a system or its variability over years or decades relates to the temporal scale of adaptation.

The nature of adaptation and its effects will vary not only according to whether the object is natural or socio-economic, small- or large-scale, a single sector, species or complex system, but also according to properties that relate to adaptation propensity such as adaptability, vulnerability, viability, sensitivity, susceptibility, resilience, and flexibility. Box 3.5 lists some terms commonly used to characterize the adaptive propensity to climate stimuli, although there is a considerable overlap in the basic concepts captured in these terms. Particular terms have been employed to distinguish natural systems from the socio-economic, or to differentiate between the pre- and post-adaptation conditions (Klein and

Box 3.5 Terms to describe characteristics of systems pertinent to adaptation*

Sensitivity	Degree to which a system is affected by, or responsive to, climate stimuli
Susceptibility	Degree to which a system is open, liable or sensitive to climate stimuli (similar to sensitivity, with some connotations toward damage)
Vulnerability	Degree to which a system is susceptible to injury, damage, or harm (one part – the problematic or detrimental part – of sensitivity)
Impact Potential	Degree to which a system is sensitive or susceptible to climate stimuli
Stability	Degree to which a system is not easily moved or modified
Robustness	Strength; degree to which a system is not given to influence
Resilience	Degree to which a system rebounds, recoups or recovers from a stimulus
Resistance	Degree to which a system opposes or prevents an effect of a stimulus
Flexibility	Degree to which a system is pliable or compliant (similar to adaptability, but more absolute than relative)
Coping Ability	Degree to which a system can successfully grapple with a stimulus (similar to adaptability, but includes more than adaptive means of 'grappling')
Responsiveness	Degree to which a system reacts to stimuli (broader than coping ability because responses need not be 'successful')
Adaptive Capacity	The potential or capability of a system to adapt to (to alter to better suit) climatic stimuli or their effects, or impacts
Adaptability	The ability, competency or capacity of a system to adapt to (to alter to better suit) climatic stimuli (essentially synonymous with *adaptive capacity*)

* These definitions of systems' characteristics are based on widely (but not unanimously) held conventions. They focus on the distinguishing generic properties, and do not include factors which might influence the state of a property or the forms it might take.

Source: IPCC, 2001c

Nicholls, 1999). These distinctions are important, but can be captured without narrowing the meaning of widely used terms.

Schneider *et al.* (2000) urged for foresight of how technology is changing the estimation of what will happen in competitive granaries and assumptions about what governmental policies will be in various regions and over time. The authors embed adaptive behavior for future climate change in the background of shifting market and social conditions, which may render it, and showed that adaptive behavior is much more multi-faceted than is usually assumed. Clearly, a transparent specification of such agent-based decision rules is essential to model adaptation explicitly in any impact assessment. Moreover, open recognition of the limited set of assumptions contained in an individual study demands clearly noting that it can represent only a fraction of plausible outcomes.

Reilly and Schimmelpfennig (2000) identified factors common to a wide range of systems that might be affected by climate change and used the term '*system portraits'* to describe combinations of characteristics that determine differences among systems. The term is used in the sense that 'a portrait' is a representation, but not reality itself. Understanding the elements of the portraits illustrate the conditions under which, for example, either warming or cooling can generate damages; when the rate of climate change matters; the potential effectiveness of R&D to reduce damages; and whether improved climate forecasting or better weather and climate data will reduce damages. The results suggest how greater adaptability and resilience to potential climate change can be fostered, depending on which 'portrait' represents the best system. The 'portraits' also have implications in research strategies for estimating adaptation and the biases that can result if underlying assumptions are not true. These authors identified ten unique combinations of characteristics considered as important when investigating the adaptation response, and grouped them into five broad categories: autonomous response; fast response with conscious action; people lack knowledge of what to do; adjustment costs are unavoidable, and no response. The intent in this identifying was to help shed light on the systems' adaptability. Whether systems can adapt has important implications for the extent of damages that would result from climate change; how they adapt has important implications for whether and what type of specific adaptation strategies would be useful to encourage adaptation.

The adaptation definitions also hint at the ways in which its forms or types can be distinguished, in other words, *"How does adaptation occur?"* Under this angle, adaptation refers both to the process of adapting and to the resulting outcome. Most definitions imply a change 'to better suit' the new conditions.

In practice, answering this question may include a series of adjustments that attempt to strike a balance between three broad objectives, or sides of adaptation (Berkhout, 2005; IPCC, 2001c):

→ *Minimizing sensitivity or exposure to risk*
→ *Developing a capacity to cope after damages have been experienced*
→ *Acquiring the means to exploit new opportunities that arise.*

Here, the difference between natural and social systems needs to be more sharply drawn.

In particular, for plants, animals and ecosystems any environmental changes impose new pressures that increase or decrease their ability to survive and reproduce, and their capacity to adapt will typically be quite limited. Biological systems are constantly responding to changing environmental conditions and to genetic variety, and over longer time periods they redistribute and evolve. Natural ecosystems may accommodate gradual changes in conditions, but more rapid changes can be disruptive, especially in already stressed environments. Climate change creates a new situation and adds another stress.

People and organizations, in principle, have the capacity to make conscious and planned adjustments to the way they respond to climate change risk, acting to reduce their vulnerability and making advantageous changes in their environment. Assessing alternatives, they can anticipate change or respond to impacts. Unlike policies and actions on climate mitigation, those related to adaptation often need to be sensitive to features at the micro-level of individuals, households, businesses and localities. Vulnerability to climate change may be universal, as is the capacity to adapt, but the gradients of vulnerability and adaptive capacity that exist between adapting agents tend to be steep. Variability and uncertainty that exist about the potential value of adaptation lead to great difficulties in searching for a 'best' adaptation strategy for any given adapting agent. Even where there is general awareness of climate change and its possible consequences, some agents will choose to adapt and will employ a range of strategies, while others will not. Both may be appropriate and well-founded responses in the context of uncertainty. The more is known on helping to evaluate climate vulnerability and the benefits of adaptation, the greater convergence in adaptive behavior can be expected (Berkhout, 2005).

Thus, in essence, "the problem in modeling adaptation rests on *how* to incorporate human behavior via a set of decision rules carried out by representative adaptive agents into the models' structure so as to make the models more *actor-oriented"*(Schneider *et al.,* 2000, p. 207). Decision-makers who use results from adaptation studies must be aware of the controversial nature of assumptions about adaptation behavior of various actors that often lurk invisibly in different impact assessment studies.

And, lastly, the measures of adaptation can be divided into two types: those of a more ***generic*** nature, which enhance adaptive capacity, and those that are ***specific*** responses to particular climate-related risks.

The performing of a national assessment for any country should proceed first by assessing that country's generic vulnerability and adaptive capacity in order to identify needs and options for increasing its ability to cope with a wide range of hazards, both of those that already have significant negative impacts on a regular basis, and potential future hazards that represent the most likely threats to human welfare and economic development (Adger *et al.*, 2004). As examples of generic adaptation measures, Anantram and Noronha (2005) named: investments in infrastructure, information, and communication technologies; control of population and population health status; strategies to address equity, access issues and gender empowerment; provision of education and housing; institutional/government policies, and any other measures aimed at sustainable development.

Certain factors make a system particularly vulnerable to specific types of hazard, while others might mean that a system has a high capacity to adapt to some hazards but not others. The identification of these hazards and of vulnerability to them is an essential exercise in the assessment of outcome risks. Specific 'interventions' linked to the management of climate risks may include, for example, short- and medium-term weather forecasts and disaster preparedness plans, research and development on drought- or flood-resistant crops, changes in farm practices or new techniques in agriculture, effective food insurance schemes, etc. Key findings on specific adaptation and adaptation capacities can be found in IPCC AR4 (Parry *et al.,* 2007).

This section's discussion can be summarized by the following discourse from Thompson *et al.* (2006). These authors believe that with reference to the human dimensions of climate change, the adaptation concept embraces any alteration of social, economic, or political systems to protect against climatic change and increased uncertainty or variability in the climatic system. As such, the concept has been harnessed to refer to social response behaviors, as *adaptations*, and to descriptions of dynamic systems and institutions in the form of *adaptive capacity*. As an additional step they suggest *adaptive management* – an often-cited approach for addressing complex and dynamic environmental problems that should be considered as a guiding concept for informing climate policy and management. Adaptive management is facilitated through multidisciplinary research and policy efforts; the implementation of adaptive management is needed in a coordinated framework for monitoring the outcomes of climate policies so as to inform future management decisions. This sort of interdisciplinary research is a bridge to *adaptive research and governance*.

3.3.2 Adaptive capacity to climate change

3.3.2.1 Capacity and the climate change problem

The concept of *adaptive capacity* is a central component of recent discussions regarding the human dimension of climate change. However, it was first brought to the attention of the climate change community in the IPCC's Third Assessment Report. Prior to this document, most analyses of human responses to climate change were limited to estimations of its specific impacts and proposals for mitigation and adaptation responses, rather than investigations into the socio-political and institutional precursors to these responses.

There are many definitions of adaptive capacity in relation to climate change impacts, but we settle on the definition, proposed by IPCC (Parry *et al.,* 2007, p. 869), namely: *"The ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences"*. Smit and Wandel (2006) noted also that adaptive capacity is context-specific and varies (not only in terms of its value but also according to its nature) from country to country, from community to community, among social groups and individuals, and over time. The scales of adaptive capacity are not independent or separate: the capacity, e.g., of a household to cope with climate risks depends to some degree on the enabling environment of the community, and the adaptive capacity of the community is reflective of the resources and processes of the region. In essence, adaptations are manifestations and reflections of adaptive capacity.

Usually, the term *'adaptive capacity'* is used to cover a multitude of factors, but there is no general agreement as to what these factors should be. Proceeding from the 'policy orientation' of this book, the social factors are seemed as a primary issue. Adaptive capacity studies recognize the path dependency and complexity of social, economic, and political change. Characteristics of communities, countries, and regions influence their propensity or ability to adapt (Haddad, 2005; IPCC, 2001). One direct effect of adaptation is to reduce social vulnerability. ***"****Given constant levels of hazard over time, adaptation will allow a system to reduce the risk associated with these hazards by reducing its social vulnerability. Faced with increased hazard, a system may maintain current levels of risk through such adaptation; reductions in risk in the face of increased hazard will require a greater adaptation effort"* (Adger *et al.,* 2004, p. 36). Adaptive capacity will be related to knowledge and awareness, access to resources, technology, social networks and attitudes towards risk (Smit and Pilifosova, 2003).

Adger *et al.* (2004) also argue that societies have inherent capacities to adapt to climate change because these capacities are bound up in their ability to act collectively. All decisions on adaptation are made by individuals and groups within society, organizations and governments on behalf of society, but any decision privileges one set of interests over another and creates winners and losers. The examination of social dynamics and outcomes of adaptation moves beyond a simple accounting for its economic costs and benefits. Further, although the capacity of individuals to adapt to climate change is a function of their access to resources, the adaptive capacity of societies depends on the ability to act collectively in the face of the risks posed by these threats. Thus, adaptive capacity, as an element of the overall vulnerability of a society, can be illuminated by examining its institutions for resource management, their effectiveness, efficiency and legitimacy.

Adaptation capacity encompasses a wide range of governmental and private-sector activities, all of which contribute to the achievement of measurable development goals (increased life expectancy, broader access to education, higher incomes, etc.). Here, as it was discussed earlier, all nations have *specific* adaptive capacities with respect to clearly understood challenges, and *generic* adaptive capacities – to respond to a wider range of uncertainty. There are also differences between capacity and actual results: the former is a pre-requisite for ongoing achievement of the latter. Focusing, for example, on generic adaptive capacity, the list of actors contributing to national adaptive capacity includes wealth, technology, education, information, skills, infrastructure, access to resources, management capabilities, and so on (Haddad, 2005).

The ***determinants of adaptive capacity*** exist and function differently in different context, and are generally not independent from each other (Smit and Wandel, 2006). Individual determinants cannot be isolated: adaptive capacity is generated by the interaction of determinants, which vary in space and time.

Yohe and Tol (2002) proposed to organize different thoughts about adaptive capacity around the list of underlying determinants (Box 3.6). Applying this structure, they went further (Tol and Yohe, 2007) and conjectured that the adaptive capacity of any system would be limited by the weakest of these (or from another alternative list) underlying determinants. The idea behind their hypothesis is that a significant weakness of any single critical component of a system's capacity to cope with the manifestation of an external stress, whether it worked to undermine the strength of a single element of the list of determinants or undercut the strengths of multiple determinants, would be the limiting factor of that system's ability to adapt. Although uncertainty regarding the elements on the list creates problems when it comes to empirical estimation of vulnerability, it does not

Box 3.6 Some determinants of adaptive capacity

- the range of available technological options for adaptation;
- the availability of resources and their distribution across the population;
- the structure of critical institutions, the derivative allocation of decision-making authority, and the decision criteria that would be employed;
- the stock of human capital including education and personal security;
- the stock of social capital including the definition of property rights;
- the system's access to risk spreading processes;
- the ability of decision-makers to manage information, the processes by which these decision-makers determine which information is credible, and the credibility of the decision-makers, themselves; and
- the public's perceived attribution of the source of stress and the significance of exposure to its local manifestations.

Source: Yohe and Tol, 2002

undermine the possibility that such a weakest link might describe much of reality. Based on the so-called '*weakest link*', the authors constructed a scheme that could be employed to judge the relative vulnerabilities to climate change of profoundly different systems.

Burch and Robinson (2007) consider the broad determinants of capacity as a part of a more general, development-related pool of resources called '*response capacity'*. According to this view, response capacity is time, context, culturally and regionally specific, and consists of a broad set of resources, many of which are described as determinants of adaptive and mitigative capacity. For instance, the elements of response capacity are stocks of human and social capital, or resources that may be used in a multitude of ways. The presence of technological innovation and economic strength of a nation also contribute to its store of response capacity. As a result, a response capacity is to some extent an approximation of a nation's development level, and thus is rooted in a nation's development path. A response capacity draws our attention to a very important set of processes and dynamic interactions between various technological, institutional and cultural trajectories which are fundamentally rooted in the underlying development path. In other words, the resources which contribute to response capacity represent potentially path-dependent systems of rules, institutional structures, and habitual practices, which may be the precursors of significant barriers to action. As such, the concept of response capacity allows for a greater specification of mitigative and adaptive capacity, and reveals the importance of deeper socio-cultural trajectories that form the context within which action may occur.

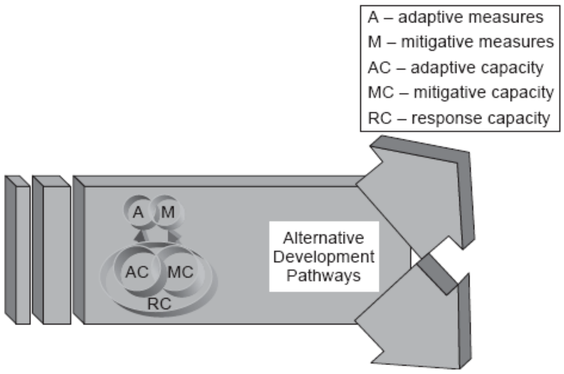


Fig. 3.16 The process of transformation of response capacity, which is a generalized set of resources rooted in the development, into mitigative and adaptive capacities, and finally into mitigative and adaptation actions. *Source:* Burch and Robinson, 2007

The ways in which response capacity is transformed into adaptive capacity are manifold, creating layers of interaction that lead to very different climate response outcomes. The relationship between response, mitigative and adaptive capacities, and real activities are illustrated in Fig. 3.16. This schematic shows that all factors that contribute to human responses to climate change are embedded in the underlying development path. Adaptive and mitigative capacities arise out of the response capacity resources in the form of institutions and policies that are geared towards one or both of these responses and, finally, are utilized to produce adaptation or mitigation in response to the climate change risks.

3.3.2.2 Adaptive capacity and vulnerability

It was shown above that any system's vulnerability to the impacts of climate change and climate variability could be described productively in terms of its exposure and baseline sensitivity to the impacts; both exposure and sensitivity can be influenced by the system's adaptive capacity (Smit *et al.*, 2001). Therefore, adaptive capacity is a component of vulnerability (Adger, 2004). There is much in the literature regarding the relationship between vulnerability and adaptive capacity, and the former is described as the inverse or as a function of the latter[12]. If to speak broadly, *"...the vulnerability of a system, population or individual to a threat relates to its capacity to be harmed by that threat"* or, in other words, *"...adaptive capacity may be described as the ability or capacity of a system to modify or change its characteristics or behavior so as to cope better with existing or anticipated external stresses"* (Adger *et al.* 2004, p. 28). However, the two concepts are often discussed without any explicit consideration of how they are mediated by the nature of climate hazards faced by a vulnerable system, and by the timescales over which these hazards operate. Moreover, *"...whilst the exposure and sensitivity elements have a history of research, adaptive capacity has only recently begun to be explored"* (*Ibid)*.

These authors also note that if a system's vulnerability to more gradual, longer-term change is a function of its ability to adapt incrementally and responsively, a vulnerability to discrete hazards occurring in the future will be a function of its ability to anticipate and pre-empt those hazards via appropriate planned adaptation strategies. The rate at which risk associated with a particular type of hazard will be altered (in other words, whether a system is likely to implement the necessary adaptation measures in available time and to reduce risk to a subjectively defined acceptable level) depends on the timescales of the implementation of adaptation measures (i.e. realization of adaptive capacity) and on the timescales associated with the evolution or occurrence of the hazard in question. Adaptive capacity is no more than *"a vector of resources and assets that represent the asset base from which adaptation actions and investments can be made"* (Adger, 2004, p. 49). As such, it has diverse elements encompassing the capacity to modify exposure to risks

[12] However, O'Brien *et al.* (2004) argue that considering adaptive capacity as the inverse of vulnerability may not only ignore the drivers of vulnerability, but also conceal differences in time scale and other assumptions underlying the two approaches. This confusion arises because many of the underlying drivers of vulnerability, such as poverty and economic marginalization, often coincide with the determinants of adaptive capacity. Different understandings of adaptive capacity are directly related to the dualism in understandings of adaptation. Again, as a consequence, different 'diagnoses' result in 'different cures'

associated with climate change, to absorb and recover from the losses stemming from climate impacts, and to exploit new opportunities that arise in the process of adaptation.

Another view, which addresses the important temporal issue, is linked with distinguishing between current and future vulnerability. According to Adger *et al.* (2004, p. 37), "Current vulnerability, determined by past adaptation and the current availability of coping options, provides a baseline from which a system's future vulnerability will evolve. This evolution will be mediated by the system's adaptive capacity and the extent to which this capacity is realized as adaptation". Here, one may speak in terms of the system's *current vulnerability* if the hazard is a particular type of discrete, transient, extreme climatic events. Such a 'snapshot' determines the extent to which the system would be damaged if the event in question occurred immediately. The system's *potential vulnerability* is a vulnerability that would take place at a specified point in the future to a specific hazard as a result of realizing (through anticipatory adaptation) this system's entire adaptive capacity. And, at last, if to assume that adaptation is a function of adaptive capacity only (all adaptive capacity of a system is realized as adaptation), we observe *actual vulnerability* that vary with time as a system's adaptive capacity fluctuates in response to changes in environmental, political, social and economic dimensions.

Thus, adaptation does not occur instantly; any system requires time to realize its adaptive capacity. From this viewpoint, adaptive capacity represents *potential* rather than actual adaptation, and its high level therefore reduces only a system's vulnerability to hazards occurring in the future (giving time to adapt in an anticipatory manner) or to hazards that involve slow change over relatively long periods, to which the system can adapt reactively.

The integration of information about climate-change exposure, sensitivity, and adaptive capacity provides insights into the set of conditions under which adaptive capacity may or may not be able to provide with all that is needed for societies to adapt in a timely fashion. Yohe *et al.* (2006) explored how variations in adaptive capacity and climate impacts influence the global distribution of vulnerability. They found that all countries will be vulnerable to climate change, even if they enhance their adaptive capacities. The developing nations are most vulnerable to modest climate change, and reducing GHG emissions would diminish their vulnerabilities significantly. Developed countries *vice versa* would benefit most from mitigation to moderate climate change. An extreme change would overwhelm the abilities of all countries to adapt.

Thus, as Yohe and Tol (2002, p. 25) summarized, "adaptive capacity has worked its way, as an organizing concept, into the research structures of those who contemplate the potential harm that might be attributed to climate change and other sources of external stress. As such, it holds the potential of being a point of departure for the construction of practical indices of vulnerability that could sustain comparable analyses of the relative vulnerabilities of different systems located across the globe".

3.3.2.3 Assessment of adaptive capacity

Tol and Yohe (2007) found that statistically significant determinants of adaptive capacity are different for the different measures of vulnerability that have led them to suggest that 'there is no such thing as a general adaptive capacity for all stresses'. Rather, the factors from which systems draw to create adaptive capacity are different for different risks. In this conclusion, they agree with Adger (2004) that adaptive capacity essentially describes the adaptation space within which decision-makers in any system might find feasible adaptation options and recognize that diversity makes it easier to anticipate changes in generic adaptive capacity rather than to foresee changes in adaptation. The linking of adaptive capacity determinants to available response levers can help to explain why certain responses to fundamentally identical stressors work sometimes in some places, but not at other times in other places.

In particular, there are favored national level assessments of adaptive capacity (Vincent, 2007), which providing information for governments to inform policies, provide also an input to assist the allocation of resources between countries to support international financial mechanisms. Comparing adaptive capacity across countries can identify leverage points in reducing vulnerability to climate change, at least in the short- to medium-term. Identification of nations with low adaptive capacity can act as an entry point for both understanding and addressing the processes that cause and exacerbate vulnerability. A widely used tool for empirical assessing the determinants of vulnerability and facilitating comparison of adaptive capacity between countries is national-level indices and indicators. Vincent (2007) demonstrates one of these indexes – the National Adaptation Policy Indicator (NACI) – an aggregate indicator of adaptive capacity in the face of climate-induced changes in water availability. NACI is calculated as the weighted average of five sub-indices: economic wellbeing and stability (20%), demographic structure (20%), institutional stability and wellbeing (40%), global interconnectivity (10%) and dependence on natural resources sensitive to water stress and water availability (10%).

Into typical categories for measuring national adaptive capacity to climate change, Haddad (2005) adds a nation's wealth, technology, education, information, skills, infrastructure, access to resources, and management capabilities. Simultaneously, he emphasizes that this approach is incomplete since it does not consider the motivational context of adaptation. Ranking the nation's adaptive capacities is scientifically altered when national aspirations, or broad self-defining attitudes and goals are made explicit. A model that sorts nations in terms of adaptive capacity based on national socio-political aspirations (e.g., seeking to maximize the welfare of citizens or to reduce the vulnerability of the most vulnerable groups) leads to the different weighting of the elements of adaptive capacity and to different rankings of the actual capacities of countries to adapt. In other words, a nation's adaptive capacity is determined also by purposes or goals to which it aspires. Economic and social priorities, while responding to contemporary circumstances, emerge from and are consistent with a broader national identity. Different aspirations will rank differently the nations' priorities. In particular, free market-oriented economic growth – the most common conception in developed countries – has aspirations significantly different from those of the former soviet system. The importance of national 'propensity' to adapt could be considered in terms of the extent to which a proposed action is consistent with long-term national goals.

As one example of the assessment of sectoral adaptive capacity, we can name the research of Alberini *et al*. (2006). These authors carried out the ranking of selected European and Central Asian countries by their adaptive capacity to certain effects of climate change on human health. Per capita income and inequality in its distribution, the health status of the population and type of health care system, and access to information were chosen as the most important factors enabling an effective response to climate change. This study showed tremendous variations in the response capacities (Fig. 3.17). The proposed *adaptive capacity index* varies from above four-five for nine developed countries to about two for FSU countries.

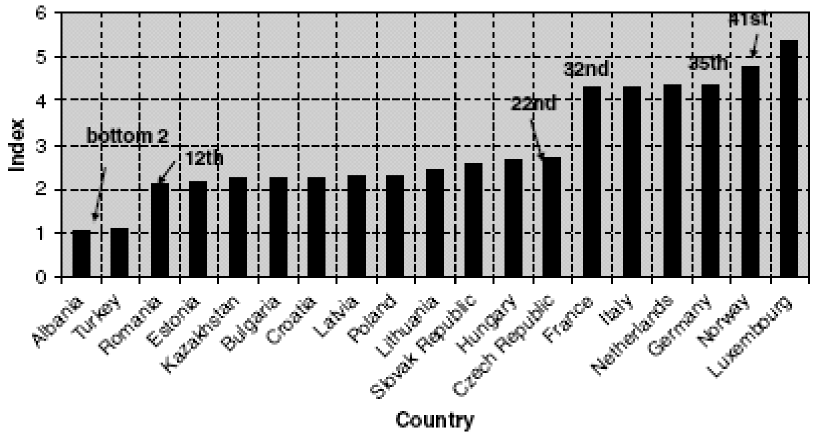


Fig. 3.17 Adaptive capacity index for some European and Central Asian countries. Higher index values mean higher adaptive capacity. *Source:* Alberini *et al*., 2006

3.3.3 The shaping of adaptation policy

In principle, as was mentioned above, adaptation to climate is not a new phenomenon, and throughout human history societies adapt to climate variability and natural long-term changes by altering settlement, economic production patterns and other facets of their lifestyles. Moreover, adaptation to climate has been remarkably successful, especially with regard to human – the most adaptable of sentient beings – which is attested to by the widespread distribution of human populations over the world. We should also take into account that climate varies much more over space than over time. With any change in the environment, all life adjusts, adapts, and evolves. Human life responds to such changes (and even in anticipation of these changes) in both conscious and unconscious ways (Burton *et al.,* 2006; Kates, 2000). Jerneck and Olsson (2008) listed several factors that make adaptation increasingly important nowadays. Among them they named accelerating climate change and increasing vulnerability of societies to climate variability (irrespective of climate change) due to multiple stressors, rising populations in climate-sensitive areas, deteriorating social conditions and health status, and so on. Certain 'innovation' is the idea of incorporating future climate risk into policy-making when fundamental adaptation planning occurs primarily through government decisions. When adaptation is unplanned it tends to be triggered by unexpected changes in natural or human systems (Lim and Spanger-Siegfried, 2004).

Equally important are fundamentally different views about how people are likely to respond to climate change (Reilly and Schimmelpfennig, 2000). At one extreme, these authors locate the response characterized as a 'dumb farmer' where an agent persists for a long time in an economic behavior that is revealed to be increasingly maladapted. Agents at the other extreme are characterized as adjusting to climate change with a foresight that eludes our current ability to forecast accurately weather events a few days into the future. The lack of climate change reliable predictability causes the more contentious analytical problems and political debate. Additionally, human-induced climate change has introduced a new dimension into adaptation process.

Burton *et al.* (2006) emphasize two important respects that distinguish adaptation to climate change from adaptation to historical climate variability and lend to this discourse a political aspect.

First, climate change results from human activity rather than pure forces of nature, and therefore the question of who pays for adaptation is more complicated and contentious. This question is especially relevant in considering adaptation efforts at the international level.

Second, in a world subjected to climate change, the historic climate records that have guided past adaptation are less reliable. Cropping patterns, engineering works, and other forms of adaptation have been designed with the expectation that general climatic conditions, as well as the frequency and magnitude of extreme events, will be largely consistent with those observed in the past. However, a stable, 'normal' climate can no longer be assumed, complicating not only successful management of the transition from one equilibrium state of climate to another, but rather adapting to a far more uncertain climatic future.

Nevertheless, "in the future as in the past, the success of human adaptation to climate will depend heavily on development options and choices: a higher level of development is likely to produce greater adaptive capacity, but certain patterns of development can undermine these advances by exposing populations to ever-higher levels of climate risk" (Burton *et al.* 2006, p. 5).

The slightly revised model for adaptation to climate change at an organization's level, proposed by Berkhout *et al.* (2003), has four basic elements:

1) Awareness of and concern about the potential impacts of climate change. Before an organization embarks on adaptation it must be first *aware* of the potential threat of climate change, and second – be *concerned* with potential impacts to its business. Without awareness there will be no concern, and without concern there will be no adaptation;
2) The adaptation strategy which defines *what* the organization is seeking to achieve by adaptation and *how* it intends to achieve it;
3) The concept of an *adaptation space* affecting the selection of an action and defined as the set of options which are potentially available to deal with possible climate and other changes. The adaptation space is dynamic, as new options become available through, for example, technological development, and as the understanding of the characteristics of change develops.

As the *fourth* basic element the authors consider a notion that there are three groups of factors which influence the awareness of threat, adaptation strategy, and what adaptation options are implemented:

- ✓ The *susceptibility to change* that defines the way in which the organization is susceptible to and impacted by changes in external conditions. These include changing patterns of demand, technological and regulatory change, and altered access to the natural resources needed to provide goods and services. Climate change is just one of these external drivers, potentially affecting both demand and availability of the resources. Susceptibility to climate change depends not only on the degree of climate change affecting the organization, but also – and probably more importantly – on how it uses climate resources, how it operates, and the time scales over which decisions are made and consequences of these decisions persist (the organization's 'sensitivity' to change);
- ✓ The *resources* and *capabilities* that determine how *an organization* responds to (or anticipates) challenges and pressures. Relevant factors include access to information and knowledge, management culture, access to resources (including funding) necessary to make changes, and external relationships with suppliers, customers, regulators and other stakeholders.
- ✓ The *regulatory* and *market context* that can both impose constraints on what an organization can do and act as a source or pressure for change.

To be most effective, adaptation must proceed at several levels simultaneously. Although it is inherently *local* in fundamental ways, as the direct impacts of climate change are felt locally, and response measures must be tailored to local circumstances, for these efforts to be robust or in many cases even possible, they must be guided and supported by national policies and strategies (Burton *et al.,* 2006). That is why, Burton and another team of co-authors (2002) referred to *climate adaptation policy* as actions taken by governments to mandate or facilitate adjustments in natural and socio-economic systems aimed at reducing vulnerability to projected or actual changes in climate. It was also implied that these adjustments should be made in practices, processes, or structures of systems exposed and sensitive to possible impacts. Here, as was discussed above, the impacts-led adaptation research debate results essentially in trade-offs between mitigation and adaptation, while the vulnerability-led approach relates mainly to development and corresponding policy problems.

To inform the policy process about adaptation in this second context, the emphasis shifts from fighting direct adverse impacts to questions about vulnerability and, correspondingly, how and where to deploy adaptation responses. Burton and colleagues consider these issues as especially important for developing countries[13] not only because they wish to reduce their vulnerability to climate change in the most effective way possible, but mainly because they essentially 'compete' for available international funds that help them in meeting the adaptation costs. Each country, therefore, should be able to demonstrate its vulnerability, adaptation policies, measures and their cost, where external assistance is needed and detailing donor funds can be effectively used.

Formulating ***the shape and content of climate adaptation policies***, Burton *et al.* (2002) emphasized several principles:

[13] Hereafter, as before, the arguments referred to *developing countries* may be attributed in most cases to transition countries as well

a) Policy decisions are made by governments, responsible for the success or failure of the policies they adopt, and as for other policy domains the purpose of policy-related research of adaptation to climate change is "not to decide or advocate policy, but to provide the policy-makers with policy choices, an analysis of the rationale of alternative policy choices, and additional information upon which they can base their judgments" (p. 156);
b) Effective adaptation policy cannot be made on a 'stand alone' basis, but has to be incorporated into other policies or be a component in different policy domains. There will also be special policies that are directed to one part of a country, such as regional development initiatives, or to an individual sector;
c) A crucial element in the formulation of current policy is the review and evaluation of adaptation practices already in use and the absence of those that might be used but are blocked or difficult to use for whatever reason. An assessment of the current 'adaptation baseline' can provide a benchmark against which to measure progress in the development and adoption of new policies;
d) The assessment of successes and failures of current adaptation policies promotes emergence of new ideas and proposals for strengthening adaptation measures in the future that leads directly to policy initiatives and alternatives. In many instances, improvements in adaptation or, contrary, the elimination of policies, which tend to increase vulnerability, will yield net benefits to the economy even in the absence of climate change. Policy innovations are especially desirable if they bring benefits under the present climate, serving as a 'guarantee' to be beneficial under a changing climate.
e) A critical question to be addressed concerns the quality and the rigour of the analysis. There is a sense of urgency, especially in the most vulnerable countries, that leads to demands for prompt action. In some cases, the needed adaptation policies and measures are very evident, and further delay in design and implementation caused by uncertainties may not be defensible. Even present day climate variability and extremes are exacting a heavy toll on development.

The summer 2008 extraordinary floods in Ukraine and Moldova, which caused significant destruction and impacted numerous victims, is a good example that confirms the urgency of a needed political response. This example is especially relevant if one takes into account the fact that flood in Moldova followed a record drought in the previous year, which nearly destroyed half the country's agricultural outputs. Given the sharp increase of the magnitude of these weather extremes, there is undoubtedly a need for more urgent anticipatory action both with and without regard to climate change.

On the other hand, the current situation in many transition countries demonstrates insufficient knowledge and information upon which to base good adaptation policy choices. Perhaps that is why the already quoted *'Rationales for adaptation in EU climate change policies'* (Berkhout, 2005) placed these factors as first in the identification of roles for policies pertaining to adaptation (Box 3.7).

Pelling and High (2005) see a potentially fruitful categorization of adaptations between those that reinforce existing organizational or system stability and those that modify institutions to add resilience through flexibility. The first category protects operating or management systems (such as a bureaucracy), the second – safeguards core functions (e.g., rural culture or livelihood) but not the system itself. The principal components of such '*resilient adaptation*' are shown in Box 3.8.

Box 3.7 Roles for EU climate change policy in adaptation

1. *Information, knowledge and learning. G*overnments play a major role in the sponsorship of climate science research and in the development of provisional tools such as global, regional and national climate scenarios. This informational role is being continually expanded. Experience shows that awareness of climate impacts and vulnerability assessment remains patchy, being well-developed in some sectors such as water services and insurance, and generally poor in many other sectors.

2. *Early-warning and disaster relief.* Available plans, organizations and resources to alert people to weather related disasters and to cope with their consequences need to be reviewed as their frequency, scope and intensity alter as a result of climate change.

3. *Facilitating adaptation options, guiding adaptation and enabling adaptive capacity.* There are strong 'public good' arguments for investing in scientific and technological resources that may be widely adopted in response to climate change. A standard response to greater uncertainty is to broaden the portfolio of adaptations that are available to vulnerable sectors. Beyond investing in innovations that may be applied by adaptors, there is also a clear role for regulators to signal the need to adapt to the private sector. The rationale for this is the potential for under-investment in adaptation by economic actors confronted by high uncertainty about the likelihood and consequences of climate change impacts.

4. *Regulating distributional consequences of adaptation.* It is likely that the most vulnerable social groups will end up bearing many of the new social and economic risks that arise as a result of climate change. As a simple example, one can name the proposed reduction (from three to two years) in the term of liability insurance covering new houses in the UK, partly as a response to heightened risks of storm damage. In this way the house-owner, rather than the house-builder's insurer, takes on an increased risk.

5. *Infrastructure planning and development.* Modification of infrastructure and of spatial plans in response to experienced and predicted climate impacts is another area in which Governments play a major role. Difficult trade-offs are likely to be necessary between conflicting social, economic and environmental objectives as a result.

Source: Berkhout, 2005

Box 3.8 Principal components of '*resilient adaptation'*

- some degree of overproduction or excess capacity
- overlapping functions
- rapid flow of materials, investment and information
- responsive decision-making at an appropriate subsidiary level
- diversification of inputs and an economic base
- alleviation of absolute poverty
- learning from past events
- mobilizing systems to redistribute costs including insurance
- active experimentation and support for innovation.

Source: Pelling and High, 2005

While opportunities for a more holistic account of adaptation were mostly emerging from ecological economics, Pelling and High (2005) have seen scope to draw on institutional and social capital theory to provide additional purchase on the behavioral elements that shape adaptive action. The importance of socio-economic context is not only in determining access to resources to undertake adaptation but also in stimulating adaptation to non-climatic stimuli that influence capacity to adapt to climate related stressors. The internal working of communities and organizations that may determine their choices of adaptive strategy will be partly a function of formal structure and resource distribution, but a large part can be attributable to informal social relations and values, or to *social capital*. Social capital offers a lens through which to study the co-evolution of social networks and norms in the production of adaptive capacity among collectives, communities, organizations and states.

All governments need to understand more about the ***social costs of adaptation*** and differential access to it because adaptation, even when driven by 'the invisible hand of the market', is not free and does not yield the same benefits everywhere (Kates, 2000). The 'price' of adaptation include not only economic and social costs of the effort required to adapt, but also the cost of adapting to the secondary effects of the adaptation, and the losses suffered by the groups and locations bypassed or marginalized by the ensuing changes. *"Serious study of the true costs of adaptation and the differential ability to undertake it should be a major focus in contemplating response to global climate change. However, designing good studies is difficult",* – Kates states (*Ibid,* p. 7). Common threats proceed from people's displacement from their lands, division of their resources, and degradation of their environment. Based on five case studies, Kates has tried to understand: could the global poor adapt to global climate change? His general conclusion is surely *yes*, but with great difficulty and much pain. Poor people everywhere cope with droughts, floods and storms, but the social costs of adaptation have been enormous – in the tolls of lives lost or diminished and in the direct costs of adaptation, the costs of adapting to the adaptations, and the costs of failing to adapt. A second principle of Kates' conclusion is: *"If the global poor are to adapt to global change, it will be critical to focus on poor people and not on poor countries as does the prevailing North-South dialog"* (*Ibid,* p. 16). The interests of poor people are not always the same as the interests of poor countries, since in the interest of 'development' they may, in reality, grow poorer. The last-decades sharp increase in the welfare span between rich and poor transitioning countries is a good illustration to this thesis.

Heller and Mani (2002) tried to answer the question what policy actions should policymakers take, keeping in mind that money spent on adapting to climate change may mean cutting back on investment that could lead to real income growth or decrease in poverty. By their opinion, crafting the fiscal stance, governments should take account of their countries' potential vulnerability to economic shocks arising from extreme weather events. Many developing countries will be increasingly exposed to the financial burdens of providing large-scale disaster relief and rehabilitation efforts as well as revenue losses caused by sudden drops in production and income. These countries cannot assume that international assistance will be sufficient to cope with all of the financial, fiscal, and real climate change shocks, and they should create a financial cushion, either by limiting overall debt or by creating contingency funds. Also, in many countries the insurance sector is still young, lacking the ability to optimize its risk coverage and premium terms and, therefore, these countries need to develop domestic institutions and instruments to improve risk management.

Governments also should create the right incentives and institutions, provide more information to the private sector and develop basic knowledge on adaptive technologies. Efforts to stimulate real growth should begin before economic losses start to mount. In particular, countries might want to:

⇨ *Assess the potential economic consequences of climate change and formulate multipronged action plans for informing the private sector and promoting adaptation.*

This could entail promoting, along with traditional measures, and in the most extreme cases, moving labor and capital out of, e.g., agriculture into more productive sectors with a greater comparative advantage;

- ⇨ *Ensure that price signals convey the correct incentives for adaptation.* This step may have implications for necessary fiscal measures, the regulatory and insurance environment (for example, elimination of insurance schemes promoting development in regions at risk of flooding) and the property-rights regime.
- ⇨ *Stimulate and encourage R&D to exploit existing technologies or develop new ones in the energy, water-supply, agricultural, forestry, and livestock sectors* through providing subsidies to universities and research organizations or secure funds from the international community.
- ⇨ *Invest in preventive infrastructure* for densely populated areas that are susceptible to coastal storm surges.

Finally, Heller and Mani argue that countries whose economies will be hurt by global mitigation efforts should craft macroeconomic policies to help them adapt. Countries have moved to adapt to the expected deterioration in their terms of trade; they should also begin to adapt their fiscal positions and incentives in the real sectors of their economies. A first step would be to cut energy subsidies and increase tax revenues derived from fossil-fuel products. Whatever role they play in global mitigation efforts, many countries will have no choice but to adapt to the anticipated adverse effects of climate change. They will need to ensure that their legal and economic structures and price signals encourage the private sector to take adaptive measures. They will also need to take into account increased macroeconomic vulnerability and to adjust current development paths to substantially decrease future costs.

Undoubtedly, for some countries adaptation efforts are needed in facilitating through ***international measures***. Collectively, these efforts must meet a wide range of interrelated needs that Pew Center briefly expresses as follows (Burton *et al.*, 2006):

Information—Effective strategies must rest on the best available data on the nature and severity of likely impacts over different timeframes in given locales, and on the cost and efficacy of possible response measures;

Capacity—An overriding priority is strengthening capacities in the technical and planning disciplines most relevant to understanding potential climate impacts and devising response strategies;

Financial Resources—Poor countries will require resources to improve capacity, undertake specific adaptation measures, and cope with impacts as they occur;

Institutions—While adaptation must be integrated across existing institutions, focal points are needed at the national and international levels to garner expertise, develop and coordinate comprehensive strategies, and advocate for broad-based planning and action;

Technology—Adaptation success depends in part on access to – and, in some areas, development of – technologies suited to the specific needs and circumstances of different countries.

In considering how best to address these needs, the international community faces a host of difficult issues stemming from the underlying characteristics of climate risk, the institutional contexts for adaptation decision-making and action, and inherent limits on available resources, all compounded by politically sensitive questions of responsibility and equity.

3.3.4 Adaptation policy framework

Developing an adaptation strategy for future climate change requires a set of key objectives. At the broadest level, these should fit within a nation's development priorities (e.g., poverty alleviation, food security enhancement, action plans under multilateral environmental agreements). At an operational level, Spanger-Siegfried and Dougherty (2004, p. 9) distinguish five important objectives:

- → Initiation of a process to reverse trends that increase maladaptation and raise the risks for human populations and natural systems;
- → Reassessment of current plans for increasing the robustness of infrastructure designs and long-term investments;
- → Improvement of societal awareness and preparedness for future climate change from policy-makers to local communities;
- → Increased understanding of the factors that enhance or threaten the adaptability of vulnerable populations and natural systems; and
- → A new focus on assessing the flexibility and resilience of social and managed natural systems.

Developing an adaptation strategy that can respond to these objectives requires a vision that balances the need to reduce climate change impacts with the constraints of national policymaking processes. Whatever adaptation options and measures emerge, packaging these decisions into an effective adaptation strategy will require increased policy coherence across economic sectors, societal levels and time frames.

The rationale for developing an adaptation policy framework was best described by Burton *et al.* (2002). Below we try to 'transmit' their arguments.

First of all, the adaptation research for policy is different in character from that of the impacts/mitigation framework. Although research for both were conducted in a policy context and are comparatively well supported for that reason, the latter includes more fundamental science, especially in biological and geophysical systems. This facilitates the development of common methodologies and tools, and common standards of measurement. In the case of adaptation research for the reduction of vulnerability and development of related policies, such a degree of top-down guidance is neither feasible nor desirable. Effective adaptation policy has to be responsive to a wide variety of economic, social, political, and environmental circumstances, and a different kind of creativity and ingenuity is required. To provide guidelines in a prescriptive style becomes inappropriate. "What is required is *a common framework of concepts*, linked together in a flexible manner that helps in the design and organization of research for adaptation policy to reduce vulnerability" (Burton *et al*., 2002, p. 154, italic added).

Second, the need for more policy-related results suggests many new requirements that are best characterized in terms of the previously discussed shift in emphasis of adaptation activities for coping with impacts to activities on diminishing vulnerability. This new accent in the approach leads to a series of questions related to the essence of vulnerability: What is its nature? How is it to be assessed? How can vulnerability best be reduced and what is involved in this process? What are the responsibilities of those considered to be most vulnerable, and those who intend to provide assistance for vulnerability reduction?

Third, the starting point of any 'excursus' into the future is usually the present. This should be 'self-evident', but in fact differs from the standard impacts/mitigation research paradigm that begins with the modeling of future climate.

Thus, the policy-making field began to recognize the need for innovation or changes in existed policies.

In particular, to ground adaptation in the present, we must start with an assessment of the current policies. Since human societies have always adapted to their climatic environment, the adaptation policies already exist, although they are rarely strictly recognized as such. A national government wishing to develop a policy for adaptation to future climate change might best begin by assessing vulnerability to present-day climate, including its variability and extremes, and the ways that existing policy and development practice use to reduce this vulnerability. The questions to be answered during this assessment are shown in Box 3.9. Answering these and related issues, which in summary synthesize the assessment of current vulnerability, provides a basis for compilation of *potential* adaptation policy initiatives and reforms. Their design, assessment and prioritization are the next step in the policy development process. The questions, to be asked and answered at this step in order to conduct this exercise, mirror largely those about current vulnerability (Box 3.9). Therefore, we won't repeat them but simply refer the reader to the original source (Burton *et al.*, 2002).

Box 3.9 Questions to be answered during the assessment of current vulnerability

- ? What has been the recent experience with climate variability and extremes?
- ? What economic damage has resulted and how has this been distributed spatially and among socioeconomic groups?
- ? What other non-economic impacts, such as social and environmental impacts, have occurred?
- ? Are there any trends in climate variability and extreme events, and if so to what can they be attributed?
- ? Are there trends in damages and other impacts, and if so how can they be explained?
- ? What adaptation policies and measures have been used to reduce vulnerability and how successful have they been used?
- ? What is the extent of adaptation in practice and what are the barriers, obstacles or incentives to adaptation?
- ? How does public policy (in any and all domains) affect impacts and adaptation?
- ? How does public policy with respect to climatic hazards relate to the economic and sustainable development policies and strategies in place?
- ? How do public policies with respect to climate hazards relate to policies for other atmospheric issues such as ozone layer depletion, acid precipitation, and air quality?
- ? How do public policies for atmospheric hazards relate to other natural resource management and environmental policies?
- ? To what extent have stakeholders (including those at risk) been involved in the policy development process, and how can this be facilitated?

Source: Burton *et al.,* 2002

In principle, the assessment of current and the design of future policy initiatives or alternatives ground the *Adaptation Policy Framework* because their realization provides input to the policy process. However, the formulation of any adaptation strategy operationally can pose a big challenge. It means situating the climate change issue in a policy world that is full of competing priorities, interest groups, election-driven stimuli, and a host of potential unpredictable events. Ultimately, whatever options and measures can be proposed to reduce the priority system's vulnerability to climate risks, packaging them into one adaptation strategy will require overcoming practical constraints (Spanger-Siegfried and Dougherty, 2004).

There are different methodological frameworks for adaptation process, for example, the IPCC's seven-step approach (Carter *et al.*, 1994) or UNFCCC Compendium of Decision Tools to Evaluate Strategies for Adaptation to Climate Change[14]. One of the most comprehensive is UNDP Adaptation Policy Framework for climate change (Lim and Spanger-Siegfried, 2004; NCSP, 2006) that will be used partly in the following discussion.

UNDP considers *Adaptation Policy Framework (APF)* as "a structured process for developing adaptation strategies, policies and measures to enhance and ensure human development in the face of climate change, including climate variability" (Lim and Spanger-Siegfried 2004, p. 248). The primary use of the APF is to guide – "a roadmap rather than a cookbook" – studies, projects, planning and policy exercises (collectively referred to as *project*) toward the identification of appropriate adaptation strategies, policies and measures. Within the framework, the assessment of future vulnerability and adaptation to climate change is grounded in the analysis of vulnerabilities and adaptation to current climate variability. The APF focuses on the scales at which adaptation occurs, places adaptation within the development context and includes stakeholder engagement as an integral process of V&A assessments. The APF is also designed to link climate change adaptation and other global environmental issues.

The APF is structured around ***four major principles*** that provide a basis from which actions to adapt to climate change can be developed (Lim and Spanger-Siegfried, 2004):

– *Adaptation to short-term climate variability and extreme events serves as a starting point and is included as a basis for reducing vulnerability to longer-term climate change.* As users seek to prepare for near-, medium- and longer-term adaptation, the APF helps them to firmly ground their decisions in the priorities of the present.
– *Adaptation policy and measures are best assessed in the developmental context.* By making policy the centerpiece of adaptation, the APF shifts the focus away from individual adaptation projects as a response to climate change toward a fundamental integration of adaptation into key policy and planning processes.
– *Adaptation occurs at different levels in society, including the local level,* combining national policymaking with a proactive "bottom-up" risk management approach.
– *Both the strategy and the process by which adaptation is implemented are equally important.*

The APF is comprised of five components (Spanger-Siegfried and Dougherty, 2004):

[14] Available at: ***http://unfccc.int/files/not_assigned/c/application/pdf/compendium.pdf***

Component 1: *Scoping and designing an adaptation project* involves ensuring that a project – whatever its scale or scope – is well designed and can be integrated into the national policy planning and development process. This is the most vital stage of the APF process. The purpose is to put in place an effective project plan so that adaptation strategies, policies and measures can be implemented.

Component 2: *Assessing current vulnerability* involves an assessment of the present situation, responding to such questions as: Where does a society stand today with respect to vulnerability to climate risks? What factors determine a society's current vulnerability? How successful are the efforts to adapt to current climate risks?

Component 3: *Assessing future climate risks* focuses on the development of scenarios of future climate, vulnerability, and socio-economic and environmental trends as a basis for considering future climate risks.

Component 4: *Formulating an adaptation strategy* in response to current vulnerability and future climate risks involves the identification and selection of a set of adaptation policy options and measures, and the formulation of these options into a cohesive, integrated strategy.

Component 5: *Continuing the adaptation process* involves implementing, monitoring, evaluating, improving and sustaining the initiatives launched by the adaptation project.

These components are supplemented by two cross-cutting processes:

- *Engaging stakeholders in the adaptation process* that involves creating and sustaining an active dialogue among affected individuals and groups.
- *Assessing and enhancing adaptive capacity* that involves the integration of activities to better cope with climate change into national capacity strengthening efforts.

Thus, APF is a flexible process that a project's teams use to formulate and implement climate change adaptation strategies either through policy options that enhance society's resilience or actions that expand the range of coping strategies. The policy focus may be directed at certain aspects of a national development strategy or at specific geographic areas, or at important sectors of the national economy. APF can be applied at various levels – policy development, project formulation, multisectoral studies, etc.

A well-implemented APF initiative can catalyze a policy process that extends well beyond the project's lifetime. To be effective over the long term, the adaptation process should lay the groundwork for similar efforts in the future in ways that support overarching national development objectives. To do so, the adaptation strategy must be effectively integrated with processes to update national plans, policies and programs. It is a challenging endeavor requiring cross-sectoral cooperation, interdisciplinary approaches and considerable political will.

The process of continuing the adaptation process involves generally three major tasks (Spanger-Siegfried and Dougherty, 2004, p. 23):

- *Incorporate adaptation policies and measures into development plans;*
- *Implement the adaptation strategy and institutionalize follow-ups; and*
- *Review, monitor and evaluate the effectiveness of policies, measures and projects.*

Fig. 3.18 illustrates the activities and feedback loops in continuing the adaptation process. The concept underlying this continuation reflects two approaches. On the one hand, countries can reorient existing policies and practices to make them more responsive to expected increases in climate variability and change (e.g., climate disaster management practices). Alternatively, countries can choose to address policy gaps regarding climate risks, while also enhancing the resilience of the priority system. These interventions remove existing barriers to the adoption of policies that are sensitive to climate change impacts. An adaptation strategy needs to be incorporated with key sustainable development policies, processes and plans; the integration can make its implementation more efficient. We should agree with the authors that *"... given the competitive nature of policy-making, a fledgling policy such as climate change adaptation may be unlikely to succeed if it is not integrated with other more familiar and established issues"* (*Ibid,* p. 25).

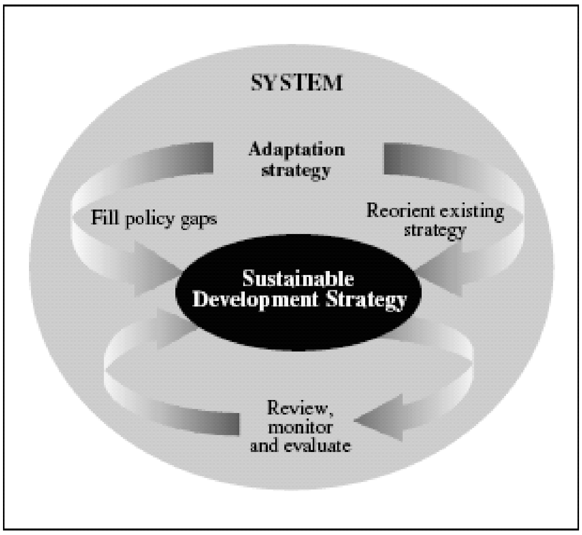


Fig. 3.18 Conceptualization of continuing the adaptation process. *Source:* Spanger-Siegfried and Dougherty, 2004

In response to the widespread need of non-Annex I Parties in methodological guidance on V&A assessment, the UNDP National Communication Support Programme (NCSP) summarized the purpose, tasks, inputs and outputs of each step within the APF as a practical guide on how to apply it in the assessment (Table 3.9).

3.3.5 Technologies for adaptation to climate change

3.3.5.1 The principal typology of adaptation

Adaptations come in a huge variety of forms and levels, and adaptation types (i.e. how adaptation occurs) have been differentiated according to numerous attributes.

In particular, Smit and Wandel (2006) listed the following ways of classification (here all original references have been omitted): *timing* relative to stimulus (anticipatory, concurrent, reactive); *intent* (autonomous, planned); *spatial scope* (local, widespread), and *form* (technological, behavioral, financial, institutional, informational). They also distinguish adaptations according to the degree of adjustment or change required from (or to) the original system (*mode* of implementation). For example, for an agricultural system facing water shortage exposures, a simple adaptation might be to use more drought resistant cultivars, the more substantial – to shift away from crop farming to pastoralism, the even more substantial – to abandon farming altogether.

Table 3.9 Steps for applying the UNDP Adaptation Policy Framework

	1. Scoping and designing the V&A assessments	*2. Assessing current V&A*	*3. Characterizing future climate risks*	*4. Developing an adaptation strategy*
Purpose	To develop a strategy for undertaking the V&A assessments	To gain an in-depth understanding of the characteristics of vulnerabilities within the priority sector/system under current climate conditions and of adaptive measures currently in place	To characterize the nature and scale of future climate risks in priority sector(s)/system(s)	To synthesize information generated from the assessment and to formulate an adaptation strategy for reducing vulnerability or harness benefits expected from climate change
Task	• Establish the core team; • Review existing information on ongoing V&A activities; • Identify relevant national, regional and sectoral development priorities; • Define the scope, objectives, activities, outputs and timelines of the studies; • Identify key stakeholders and specify their roles; • Select approaches, methods and tools; • Develop a strategy for communicating the results; • Prepare terms of reference	• Analyze recent trends in key features of priority sector/system and alongside the key climatic, socio-economic and institutional variables; • Analyze the contributing factors to current vulnerabilities; • Derive critical thresholds; • Review existing adaptive policies and measures and assess their efficacy	• Characterize future conditions of relevant climatic, socio-economic, and environmental variables; • Characterize the nature and scale of potential impacts of future changes in environmental and socio-economic conditions; • Assess the opportunities and barriers of priority sector/system to adapt to projected changes; • Characterize vulnerabilities of priority sector/system	• Synthesize information on current vulnerability, future climate risks, and opportunities for and barriers to adaptation; • Identify adaptation options; • Evaluate and prioritize options; • Elaborate the adaptation strategy
Inputs	• Literature on V&A; • Documents on national, regional and sectoral development priorities	• Observational records of relevant climate variables; • Records of key socio-economic indicators; • Characterization of institutional arrangements and social networks; • Records/descriptions of current adaptive policies and measures and their efficacy	• Characterizations of future climatic, socio-economic, sea level and other environmental conditions; • Inputs from stakeholders on indicators of adaptive capacity and vulnerability; • Methods and tools for impact assessment; • Indicators for adaptive capacity and vulnerability	• Outputs from steps 2 and 3; • Stakeholder inputs on the pros and cons of adaptation options

Table 3.9 (continued)

	1. Scoping and designing the V&A assessments	*2. Assessing current V&A*	*3. Characterizing future climate risks*	*4. Developing an adaptation strategy*
Outputs	• Technical team and stakeholder groups; • Well-defined scope; • Objective, methods, tools and data inventory; • Communications strategy; • Terms of Reference for different components of studies	• Vulnerability indicators; • Major contributors to current vulnerability; • Critical climatic thresholds for different sectors/systems; • Strength, weaknesses and lessons learned from existing adaptive policies and measures	• Potential impacts of changes in climatic, socio-economic, sea level and other environmental variables; • Opportunities for, and barriers to, adaptation of priority sector/system to potential impacts; • Vulnerability of priority sector/system to potential impacts; • Representation of uncertainties in the priority sector	• Prioritized list of adaptation policies and measures; • Adaptation strategy: a portfolio of policies, programmes, and projects

Source: NCSP, 2006

IPCC (2001c) also differentiates various types of adaptation according to *intention* (such as spontaneous or autonomous versus planned adaptation) and *time of action* (anticipatory versus reactive adaptation), but also to the *type of actors* involved (public versus private adaptation). Thus, IPCC broadens the definition of adaptation through focusing not only on technical measures but also on institutional responses. Although in the literature other typologies and classifications appear, the IPCC, in its last assessment (Parry *et al.*, 2007a), distinguishes three principal types:

Anticipatory adaptation that takes place before climate change impacts are observed. It is also referred to as *proactive* adaptation.

Autonomous adaptation that does not constitute a conscious response to climatic stimuli but is triggered by ecological changes in natural systems and by market or welfare changes in human systems. It is also referred to as *spontaneous* adaptation.

Planned adaptation that is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state.

Thus, autonomous adaptations are those that occur ‘naturally’, without interventions by public agencies, whereas public adaptations can be called ‘intervention strategies.’ As such, autonomous (natural system) and planned adaptations (human systems) largely correspond with private and public adaptation and could be correspondingly structured (Table 3.10).

Grothmann and Patt (2005) see principal distinctions between *proactive* vs. *reactiv*e adaptation, on the one hand, and *private* vs. *public* adaptation, on the other hand, in the following. The first dimension refers to the timing of the adaptation: whether it is motivated by predictions of an event occurring at an undetermined time in the future, or by the onset of the event itself. The second dimension refers to the actors and, therefore, to the question of who adapts. Thus, adaptation can be said to be *reactive* or *proactive* in two different senses.

Table 3.10 IPCC typology of adaptation to climate change

		Anticipatory (Proactive)	*Reactive*
Natural Systems			• Longer or shorter growing seasons • Migration of wetlands • Changes in ecosystems
Human Systems	*Private*	• Changing architecture of buildings • Buying hazard insurance • Devising new consumer products	• Moving home • Changing insurance premiums • Buying air conditioning systems
	Public	• Installing early warning systems • Establishing new building codes • Constructing dykes	• Offering compensation or subsidies • Enforcing building codes • Beach nourishment

Source: IPCC, 2001c; UNFCCC, 2006

Burton *et al.* (2006) also relate the first sense to stimulus for adaptation—whether an action is in response to observed climate impacts, or in anticipation of future climate change. In this sense, adaptation historically has been largely, if not entirely, reactive. However, for the first time, the human-induced climate change provides societies with the challenge of adapting to a climate forecasted but not yet experienced. As reactive adaptation is informed by direct experience, the resources can be targeted to known risks. In addressing future risks, however, uncertainties in the extent, timing, and distribution of impacts make it harder to determine the appropriate level of investment, exactly what measures are needed, and when. Typically, proactive adaptation requires a greater initial investment but is more effective at reducing future risk and cost.

As a general rule, adaptation strategies should give priority to proactive actions reducing future risk, but, insofar as significant risks will remain, should provide as well reactive approaches to help vulnerable populations recover from unavoidable impacts.

It is important to distinguish between *private* adaptations, done only for the benefit of the actor making the decision, and *public* adaptations where there are numerous beneficiaries.

Many ‘adjustments’ to new climate will be made *privately,* by individuals, households and businesses, and they are likely to yield principally private benefits. Private adaptation is a behavioral response by an individual or a firm to an environmental change for one’s own benefit and is expected to occur in most climate sensitive sectors of the economy. Thus, adaptation is private if the decision-maker is the only beneficiary. However, as Berkhout (2005, p. 380) guesses, *“…there are good reasons to believe that private adaptation, by itself, will remain at a level below what might be deemed socially or politically desirable”*. This is due to *spillover effects*, when certain benefits of private adaptation may be shared inadvertently with others, to uncertainty about the distribution of adaptation benefits and costs, and the mismatch between the distribution of climate vulnerability and the capacity to adapt. Self-interest will motivate most actors to engage in efficient private adaptation. Mendelsonn (2000) see as a principal doubt about private adaptation concerns how widespread *ex-ante* efforts will be. Private adaptation can be inefficient if it involves substantial externalities. A substantial uncertainty about the future benefits, while the current costs are reasonably evident, is especially clear with decisions where the adaptation cost has to be invested far before the climate change materializes. Since there is likely to be great uncertainty about future benefits from current actions, the people may hold back from choosing such adaptation options. Moreover, some climate changes will be more difficult to adapt to than others. For instance, adaptations against increases in climate variance are difficult to identify, and they are likely to have only modest net benefits.

Mendelsonn (2000) described three justifications for governmental ‘intervention’ in private adaptation.

First, governments could be helpful if there are externalities associated with an adaptation. Governments could subsidize important desirable changes and regulate undesirable actions to encourage individuals to incorporate the externalities into their decision-making. If it is demonstrated that private adaptations involve large new externalities, the governments should attempt to manage these situations efficiently.

A *second* justification for government action on private adaptation concerns information. In order to predict future benefits, the individual would have to be able to predict future changes in local climate, understand what impacts this would have, and comprehend what counteract actions could be taken. It is difficult to expect private citizens would be in command of this knowledge because the information costs could be too high for individuals to acquire. Governments could provide forecasts explaining: how the weather is expected to change over time, who are likely to be affected, and what they could do to adjust? Such actions are seemed especially justified with respect to *ex-ante* adaptations that need to be made well in advance of the actual manifestation.

A *third* justification for government involvement in private adaptation is equity. Even being efficient, private adaptation may not be considered just if governments will not promote to shift the burden of the costs from the victims to the polluter.

Political forces are likely to encourage governments to engage in private adaptation behavior.

In addition, there could be a range of adjustments that need to take place in the *public* sphere, for example, changes to major infrastructures, as well as changes in standards and regulations that will give private actors the framework and incentive to adapt. We think that as a public adaptation the *joint* adaptation (according to Mendelsonn’s definition) could also be considered, which involves responses with many beneficiaries to each action. As such, it resembles a ‘public good’. It is not an ‘aggregation’ of private adaptation responses; on the contrary, each individual action affects the benefits the other receives. Government intervention could solve the problem of joint adaptation by supplying protection levels based on an efficient allocation. Acting on behalf of society, the government would choose the level of adaptation that maximize the group’s net benefits and take into account externalities.

Risbey *et al.* (1999) suggested a four-stage process for public adaptation: signal detection, where it is decided what is adapted to and what is ignored; evaluation, where the signal is interpreted and foreseeable consequences are evaluated; decision and response, which results in an observable change in the behavior and performance of the system; and feedback, which involves monitoring of the outcomes of decisions to assess whether they are as were expected.

Two other important factors are also highlighted by the UNFCCC (2009). First, when designing adaptation measures, the tendency is often to focus on the *‘hard’* options, involving engineering solutions, but not to give enough attention to the *‘soft’* options involving policies and instruments that are designed to change behavior, for example

> **Box 3.10** Characteristic of *indirect* climate adaptation from a poverty perspective
>
> - Indirect adaptations are not a specific response to the impacts or risk of climate change for the poor. Without food or water, for example, a person is unlikely to prioritize climate risk or benefit fully from any other forms of intervention until these basic needs are met. Indirect adaptations may or may not increase the resilience of those experiencing chronic and absolute poverty to the additional pressures induced by increasing climatic hazards.
> - Indirect adaptations are effective in the short term as they more accurately reflect the immediate needs of poor people and communities.
> - Indirect adaptations can enhance the effectiveness of some forms of planned climate adaptation strategies, such as community-based disaster preparedness.
>
> *Sourse:* O'Brien *et al.,* 2008

through involving information and education, and include adaptive capacity-building through the use of insurance markets and other instruments at the national/local level. Second, it is important to keep options open and to design the programs so they can be modified in light of new information.

However, in spite of a great number of different classifications of the adaptation process, O'Brien *et al.* (2008, p. 198) are sure that "adaptation – and the broader climate change problematique – can be described as a 'wicked problem' where the answers are incomplete, contradictory and set against changing requirements. Climate adaptation is a problem where large groups of individuals have to change their mindsets and behavior. One consequence of this is that many of the adaptations must be seen as *indirect".* Some characteristics of indirect adaptations, on the example of climate adaptation from a poverty perspective, are listed in Box 3.10. It is obvious that indirect adaptations to climate risks are a programmatic rather than a project-based response, and although sometimes being, they are not a sufficient condition to move, for example, towards sustainable development or beyond poverty.

These and other conclusions mirror the common assumptions about the adaptation policy development process. An evident tendency to under- or maladaptation in the private sphere vs. the tough necessity of public adaptation, as well as insufficiency of indirect adaptations demonstrate a clear role of policy in motivating and shaping climatic change adaptation.

3.3.5.2 Role of policy in shaping adaptation

Burton *et al.* (2002, p. 147) refers climate adaptation policy "…to actions taken by governments including legislation, regulations and incentives to mandate or facilitate changes in socio-economic systems aimed at reducing vulnerability to climate change, including climate variability and extremes". Actions can be made in practices, processes, or structures of systems to projected or actual changes in climate.

For policy application the key question is: are adaptations advocated or recommended? Is this ultimately an advisory or prescriptive exercise, which requires information on possible adaptation strategies and measures, as well as principles to evaluate their merit? (Smit *et al.,* 2000). "Adaptation depends upon the capacity of systems to adapt, and also on the will or intent to deploy adaptive capacity to reduce vulnerability. The mere existence of capacity is not itself a guarantee that it will be" (Burton *et al*., 2002, p. 148). In concrete terms, adaptation to climate risks takes the form of *specific actions* or *projects,* e.g., establishment of the early warning systems about flooding or heat waves. Specific adaptations might also include correcting maladaptations—for instance, by no longer providing flood insurance in ways that encourage risky development in flood zones. A society's ability to undertake such actions is largely a function of its adaptive capacity (Burton *et al.*, 2006).

Adger *et al.* (2005) show that to be successful the adaptation can involve both building adaptive capacity, thereby increasing the ability of individuals, groups, or organizations to adapt to changes, and implementing adaptation decisions, i.e. transforming that capacity into action. Both dimensions of adaptation can be implemented in preparing for or in responding to impacts generated by a changing climate. Hence, adaptation is a continuous stream of activities, actions, decisions and attitudes that relates to all aspects of life and reflects existing social norms and processes. The next question, these authors try to answer, is: *Who makes adaptation decisions?* Adapting to climate change involves the cascading decisions of agents from individuals, firms and civil society to public bodies and governments at local, regional and national scales, as well as international agencies, with a broad distinction between actions that involve creating policies or regulations to build adaptive capacity and actions that implement operational adaptation decisions. In particular, actions associated with *building adaptive capacity* may include communicating climate change information, building awareness of potential impacts, maintaining economic growth and well-being, protecting property or land and exploiting new opportunities. The objectives associated with *implementing adaptation decisions* are more likely to focus on reducing the cumulative impacts of climate change, ensuring that adaptive measures taken by one organization do not adversely affect others, avoiding anticipated adverse impacts, and ensuring that the distributional impacts of adaptation are minimized. All these actions are often constrained and influenced by a higher-level adaptation framework as well as by the institutions defining all aspects of activity in that society.

For both public and private agents, where objectives of adaptation are explicit, they are often diverse.

Classifications of purposeful adaptations based on objectives of adaptation strategies focus frequently on measures that share the loss, bear the loss, modify the event, prevent effects, change use or change location. Adger *et al.* (2005) consider this classification as an expansion of three cornerstones of adaptation: reduce the sensitivity of the effected system to climate change; alter the exposure of the system to climate change; and increase the system resilience to cope with changes. Reducing the sensitivity occurs, for example, by planting drought-resistant crops. Altering the exposure of a system can be achieved, for example, by investing in heat-wave or flood preparedness. Increasing the resilience of social and ecological systems (see, e.g., Pérez *et al.,* 2010) can be achieved through generic actions that not only aim to enhance well-being or increase access to resources, but also include specific measures to enable specific populations to recover from loss.

A conceptual framework of the process of *planned adaptations*, aimed at changing existing management practices, was initially proposed by Klein *et al.* (1999) for coastal zones and then reproduced as one technology for adaptation to climate change by UNFCCC (2006). In this model (Fig. 3.19) the planned adaptation is shown as an idealized four-stage sequence or continuous and iteration cycle:

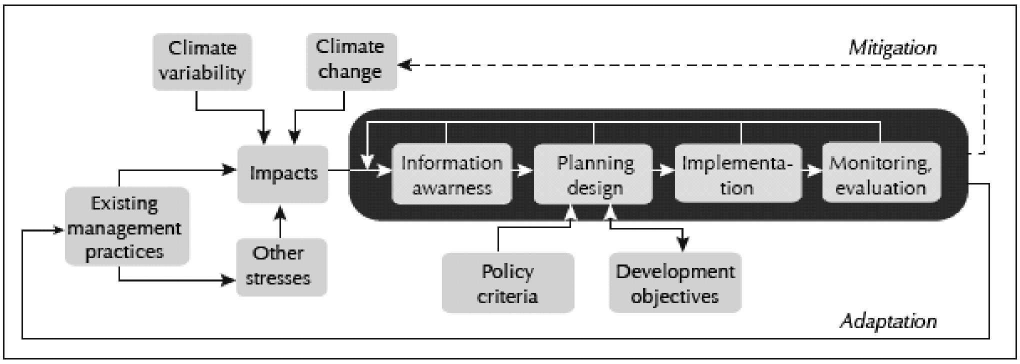


Fig. 3.19 Iterative steps in planned adaptation to climate change. *Source:* UNFCCC, 2006

1) *First,* information collection and awareness raising;
2) *Second,* planning and design of appropriate response that is not only technically feasible but also is consistent with the country's development objectives, as well as some key policy criteria;
3) *Third*, implementation, which in addition to installing systems means ensuring that these are actively supported by effective formal and informal institutions;
4) *Fourth,* continuous monitoring and evaluation of these technologies that allow for adjustments, course corrections, further innovation and feedback.

All dimensions of adaptation can be implemented at any scale. Here, Adger *et al.* (2005) described three major lessons based on the literature on cross-scale dynamics for implementing adaptation actions.

First, the issue of adaptation can become a crucible for amplifying existing conflicts over objectives between private and public agents. As it was discussed earlier, in some cases, reducing exposure to impacts and changing the impacts' physical characteristics may generate individual benefits if only others invest collectively in these adaptations too. In other cases, individual action will be adequate, and specific public policy intervention may not be required to generate individual benefits. Efforts to improve the ability of whole populations to recover from loss are, in general, more often tackled through public policy, or governmental intervention at the national scale (Mendelsonn, 2000).

Second, the institutional interactions in adaptation to climate change at different scales are not some natural patterns dependent on the physical risk, but are rather the outcome of interactions between the benefits of action or the costs of inaction. "Environmental issues are defined by society to be appropriately tackled at a particular scale; ultimately the choice of how an environmental governance problem is handled within a jurisdiction is a reflection of the strength of the interests and power of the actors who define the problem. Understanding adaptation therefore requires consideration not only of different scales of human action, but also of the social construction of appropriate scales by institutions to further their own aims" (Adger *et al.*, 2005, p. 80).

The *third* lesson is that adaptation across scales in ecological systems adds complexity, since at different levels the different biological and ecosystem processes dominate. The resilience of systems is defined by their ability in self-organization and is emergent from cross-scale and within-scale interactions. At the same time, cross-scale linkages are commonly asserted to be important in social processes. *"Yet in examining adaptation, the dynamic nature of linkages between levels of governance is not well-understood, and the politics of the construction of scale are often ignored"*, – the authors concluded *(ibid)*.

Specific strategies and policies for adaptation are as varied as the disciplines from which expertise is drawn. They vary in approach, time, financial investment, etc. Several adaptation options, offered by IPCC (2001c) and commented in USAID Best Practice Guide (Mintzer and Trexler, nd), are discussed in Box 3.11.

Box 3.11 A short guidance for selection adaptation options

Bear the losses as they occur. This approach is the simple baseline approach of 'doing nothing'. However, it could be the most costly approach in the end;
Share the losses. The effects of climate change can be distributed so no one sector or region is devastated by bearing the entire brunt of the problem. This distribution could be achieved by means of taxation and nationally funded relief and rehabilitation.
Modify the threat. The potential impact could be scaled back, for example, by constructing dams and dikes for flood protection.
Prevent the effect. All-out prevention could be pursued wherever possible. For example, crops could be managed so as to head off the possibility of experiencing the adverse effect.
Change use. Agricultural land potential could possibly be maximized, for example, by rotating croplands to pasture.
Change location. Communities and vulnerable assets could be relocated away from danger to avoid possible hazards (*see* Box 3.12 as an example).

Source: Adapted from IPCC (2001c), Mintzer and Trexler (nd)

3.3.5.3 Social vulnerability approach

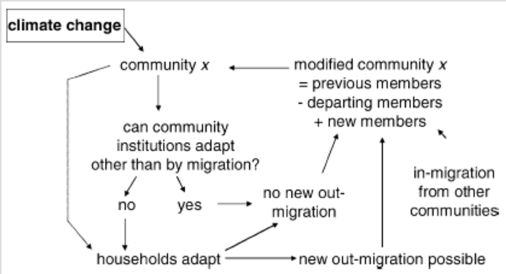
Adaptation should be discussed not only within the context of biophysical stressors, impacts, and prevention but also, or even primarily, be referred to as social vulnerability. The words of Nicolas Stern could serve as an epigraph to this section: "If people are well educated, have access to good basic services and can fall back on effective response systems in times of crisis they will be much less vulnerable to climate change. This is why I describe climate change adaptation as essentially *development in a hostile climate"* (ECA, 2009, p. 6).

Tschakert and Olsson (2005) see the advantages of a *social vulnerability approach* for adaptation policy as two-fold.

First, it allows focusing more consciously on people as agents of change who are constantly managing risk and adapting to some kind of stress, proceeding from their differential asset base or access to resources, and drawing upon a set of personal experiences. This implies that successful adaptation does not necessarily have to be planned at the top and be executed in a managerial way, but is carried out as individual and spontaneous action that can be reinforced through the enhancement of people's resilience to cope with an uncertain future. The authors provide some examples from soil and water conservation and agro-forestry projects that have succeeded because people's

Box 3.12 Model of migration as a climate change adaptation option

Historical evidence shows that lack of capacity to adapt to environmental risks or hazards is interconnected with population displacements, and migration can be seen as one possible outcome of adaptive capacity in light of exposure to some form of climatic stress. The conceptual model of the relationship between climate and human migration, developed by McLeman and Smit (2006), is shown in the figure below. This model focuses on differentiating the adaptive responses of individual households from those of community or higher-level institutions.



Let us assume that climate change stimulates some form of change in the environmental and/or socio-economic conditions of a given community *x*. In this case, if community institutions can adapt successfully, it is anticipated that no migration of the community would be as a consequence of a current change in climate. If the community's institutions are unable to cope with the changed environment, individual households remain vulnerable and may be obliged to implement their own adaptive strategies. For some of them, migration may be the only option. This would alter community membership, which in turn may alter the nature of community institutions. Attraction of migrants from other communities, who could not cope with environmental changes there, suggests a feedback cycle, that is, migration patterns begin to change in the given community and community membership; the community's coping capacity changes as well. However, there are historical examples where governments have organized, on behalf of their citizens, resettlement of people from areas of the environmental risk. So, in 1984–85 the Ethiopian government resettled tens of thousands of people from drought-stricken areas.

Source: McLeman and Smit, 2006

capacity and innovativeness were supported rather than pre-made 'one-size-fits-all' technical solutions.

Second, a 'pro-poor' and integrated approach, promoted by the UNDP, World Bank and other development institutions, places poor and vulnerable people at the centre of the analysis, where they are seen as part of the solution rather than the problem for simply improving environmental management or poverty eradication. Such an approach attaches a more active connotation to the concept of poverty eradication, dropping the still prevailing perception of large regions of the world as 'disease-ridden, poverty-stricken, and disaster-prone', with inhabitants incapable of removing themselves from danger and destitution. In fact, poor people tend not to use their livelihood strategies to 'escape' from poverty *per se* but rather to cope with risks and to address structural vulnerability.

Any adaptation action to climate change risks can also be argued to depend not only on its effectiveness in meeting defined goals, but also on issues of *equity* and *perceived legitimacy* of actions. Adger *et al.* (2005) noted that present-day adaptations are imposed on present-day society as a result of previous actions in perturbing the climate system. The whole issue of adaptation, due to intergenerational nature of the problem, begins therefore from a suboptimal and 'unfair' starting position. For adaptation, an equity in outcome means identifying who gains and who loses from any impact or adaptation policy decision, and the analysis of this nature often demonstrates that many present-day adaptation actions reinforce existing inequalities and do little to alleviate underlying vulnerabilities. On the other hand, anticipatory adaptation actions aiming to improve the ability to respond to climate impacts, such as reducing poverty and increasing access to resources, could reduce both present-day and future vulnerabilities.

In terms of *equitable* outcomes of climate change adaptations, the rules by which decisions are being made and implemented influence their legitimacy. Here, legitimacy is considered as "the extent to which decisions are acceptable to participants and non participants that are affected by those decisions" (Adger *et al.*, 2005, p. 83). Legitimacy can be gained as well as compromised through the evolution of adaptation strategies, although there are no universal rules for procedures that guarantee the legitimacy of policy responses. And, once again the social acceptability of the procedures for adaptation actions implementation, such as conversion of agriculture land use to crops for biofuel production, is an important characteristic. The legitimacy and trust are also scale dependent: *"While individuals consent to adaptation strategies and policies implemented by their governments for the public good, they are less likely to recognize the legitimacy of action by other countries to meet their own adaptation objectives"* (*ibid*).

3.3.6 Effectiveness and success of adaptation

3.3.6.1 Residual impacts as a measure of success

Arvai *et al.* (2006) consider climate change as an ideal 'test bed' for adaptive management of natural resources and see three reasons to believe *a priori* that adaptive management is a useful way to approach the climate change problem. First, any policy approach to global warming incorporates the interaction of human behavior with the natural systems, and vice versa; second, adaptive management is appealing because of the sheer complexity of the climate change problem coupled with the need to make management decisions under uncertainty; finally, adaptive management is inclusive and flexible in terms of the precise goals of climate change policy and the means used to achieve them.

Adaptation is one of the important links between an initial environmental change and final consequences to society. With respect to climate change, adaptation can either take the form of reducing damages that would otherwise occur or taking advantage of new opportunities that climate change makes possible. Thus, *effectiveness in adaptation* can either be gauged through reducing impacts and exposure to them or in terms of reducing risk, avoiding danger and promoting security. If adaptation is effective, it should reduce, by definition, the costs of damages experienced as a result of climatic change impacts and enable a system to take advantage of opportunities to improve performance that may arise from the changed conditions. Briefly, Adger *et al.* (2005) relate effectiveness in adaptation "…to the capacity of an adaptation action to achieve its expressed objectives". In turn, Reilly and Schimmelpfennig (2000, p. 255), also interpreting an adaptation as a response that improves the outcome, define *successful* adaptation as "…sometimes taken to eliminate all loss so that the status quo situation is retained".

Hanemann (2000) considers as the *normative statemen*t that public policy should encourage efficient adaptation, and as the *positive statemen*t – that adaptation tends to be efficient. He also thinks that "the real issue is not whether economic agents act optimally; it is whether they optimize in the specific manner assumed by the analysts" (p. 573). There are instances of *under(mal)-adaptation*, where individuals and organizations have failed to respond adequately to a change in their environment, as well as instances of *over-adaptation*, where they have over-reacted and magnified a problem out of proportion to its true significance. *"Judging adaptive capacity depends critically upon both defining a coping range and understanding how the efficacy of any coping strategy might be expanded by adopting new or modified adaptations"*, – Yohe and Tol (2002, p. 27) argue.

To assess climate impacts (either positive or negative), they must be defined. Many recent assessments have adopted a very similar definition. For instance, Parson *et al.*(2003, p. 11) say: "…*a climate impact* is the change caused by a projected change in climate, measured relative to a continuation of present climatic conditions". However, these authors discern also three especially prominent difficulties embedded into this concept that limit the power and utility of impact assessments: complex causal linkages between impacts, vulnerability, and adaptation; linkages between multiple domains of climate impact at various spatial scales; and multiple stresses, environmental and other, that are occurring in parallel with climate change.

A standard framework for understanding the linked concepts of impact, adaptation and vulnerability, widely employed today, distinguishes the *initial* or *first-order impacts* on a system, which result from a specified exposure to climatic change, from the *residual* or *net impacts* that remains following adaptation to the change (IPCC, 2007d). A community, region, or sector is vulnerable to climate stresses if these have a high probability of severe adverse consequences.

This framework grants a conceptual coherence to impact studies, but there are several complexities that obstruct its practical application. Parson *et al.* (2003) divided these complexities into three classes:

The first class of difficulties originates from the concepts of individual components of the framework themselves. Exposure, sensitivity, adaptation, and vulnerability must all be defined relative to multiple dimensions of climate – magnitudes and rates of change in numerous climate variables, both in their mean and extreme values, and variability. The response to a climatic change or event, observed in any system, is typically a combination of initial impacts and adaptive response. Since sensitivity and adaptation may be determined by totally different factors, impossible to be estimated separately, the observed responses to past climate variability or extremes may be highly misleading predictors of future responses.

A second class of challenges to residual climate impact assessment arises from linkages between impacts in different domains, locations, and spatial scales. Impacts on one system can modify impacts on others, through both biophysical and socio-economic processes. Separate assessments of sectoral impacts – which are at best aggregated, not integrated – still prevail. Similarly, impacts can differ strongly with the spatial scale at which they are described, and impacts in any location will reflect the interaction of the processes operating at multiple scales – from the local to the global. As a result, local impacts may be acutely sensitive to how the location is defined, but may also depend strongly on climate impacts or the processes operating elsewhere, e.g., changes in agricultural markets or human migrations.

*A third clas*s of complexities concerns above mentioned linkages between climate impacts and other stresses. Climate change occurs in conjunction with many other forms of environmental and non-environmental change causing multiple stresses that interact in complex ways, in both their biophysical aspects and their linkages to human impacts, posing the sharp problems for constructing useful scenarios of change and for analyzing systems' responses to change.

3.3.6.2 Efficiency of adaptation as its benefits

In the broadest terms, the success of an adaptation strategy or adaptation decision depends on how that action meets the objectives of adaptation, and how it affects the ability of others to meet their adaptation goals.

Actions to guard against real and imminent risks to national economies from climate are in many cases feasible, cost-effective and often constitute good economic development practice. It should therefore be a priority for decision-makers both to take early action to assess and address climate risks to their economies, and to overcome barriers to implementing adaptation measures. Poor adaptation to current climate already destroys considerable economic value – between 1 and 12% of the GDP annually, and the impact from climate is not just a future concern, although the scale of possible future climate change could dwarf these losses. However, Economics of Climate Adaptation Working Group (ECA, 2009) also shown that economies potentially are more adaptable than one might think. In the locations, studied by this research group in eight on-the-ground test cases[15], between 40 and nearly 70 percents of the expected losses by 2030 under high climate change scenarios can be averted through cost-effective adaptation measures that are already known and tested. Better policies and information on climate risk could strengthen incentives for an efficient adaptive response by actors across the economy.

Mendelsonh (2006, p. 204) defines *efficient adaptation* as "the set of adaptations that maximize the net benefits of adapting. In other words, an adaptation is efficient only if the benefit of undertaking it is more than the cost". Even if there is agreement on the threats ahead, decision-makers face an array of possible measures to guard against those threats, each with its own costs and benefits, and a set of competing priorities for limited resources. The costs of adaptation are any costs that must be borne to make this change happen.

In a financial or economic evaluation, the standard approaches compare the costs of options against the benefits and choose only those where the benefits exceed the costs (Fig. 3.20). This type of ***cost-benefit*** framework is widely applied to public expenditure allocations, but it is not the only criterion that is used. In the context of adaptation, the broad conclusion is that cost-benefit analyses are limited in their application both because

---

[15] The Economics of Climate Adaptation Working Group developed a detailed methodology for assessing the total climate risk in a target area (a country, region, or city), and to evaluate and prioritize the measures available to improve that area's climate resilience. The built quantitative decision-making framework included two sets of tools: (1) for quantifying a location's "total climate risk" as assessments of the expected annual loss to the location's economy from existing climate patterns and of incremental loss that could occur over a twenty-year period under a range of climate change scenarios, as well as a projection of the extent to which future economic growth will put greater value at risk; 2) for the fulfilment of a cost-benefit analysis spanning infrastructural, technological, behavioral and financial solutions in order to evaluate a selection of feasible and applicable adaptation measures. This methodology was applied in China, Guyana, India, Mali, Samoa, Tanzania, the UK, and the US (ECA, 2009)

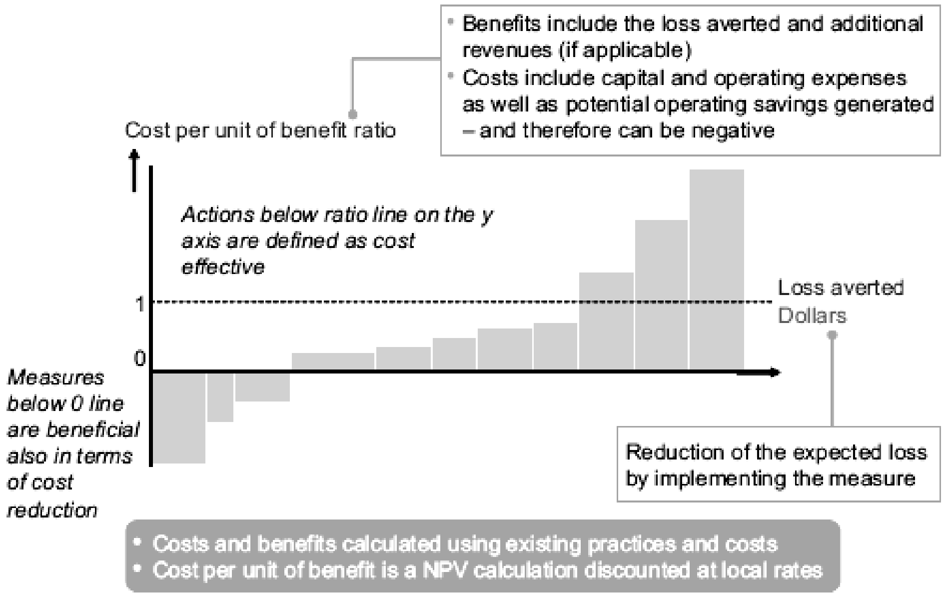


Fig. 3.20 Adaptation cost-benefit concept. *Source:* Economic of adaptation, 2009

of the partial availability of data on the costs and benefits of adaptation options, and because it should consider the distribution of impacts. There are issues relating to the valuation of non-monetary impacts (e.g., lives lost) that make it difficult to rely exclusively on that approach. As some limits of a cost-benefit analysis, ECA (2009) also notes a fact that it can accommodate only discrete adaptation options, rather than their full spectrum must be explicitly modified to take into account synergies or dis-synergies between different measures, and it necessarily represents a static view. Nonetheless, cost-benefit calculations are commonly used for local and national decision-making, and provide a useful starting point for a quantitative input into the decision-making process on adaptation.

In some cases, more can be achieved by using a ***cost-effectiveness approach***, i.e. selection of options that have the lowest cost for achieving a given physical target of supplying key services. Cost-effectiveness criteria are more likely to be of use for health, freshwater systems, extreme weather events, biodiversity, and ecosystem services. When cost effectiveness analysis is applied, it is done in conjunction with standards of acceptable risk. In other cases, a ***risk-based*** approach, in which policies that achieve an acceptable risk level at least are selected, may be more appropriate. Finally, for others a ***multi-criteria methodology*** may be adopted. Furthermore, while working at a sectoral level, the inter-sectoral linkages need to be recognized and taken into consideration (UNFCCC, 2009).

The UNFCCC emphasizes also that when considering the type of adaptation, it is important to take into account that different adaptation options have different characteristics, which facilitate analysis through different approaches. Assuming that early adaptation priorities could include a need to build adaptive capacity, to implement no-regret measures and investigate and manage longer-term issues, there are a number of different approaches/tools that will be suited to assessing each of these elements (Table

3.11). For example, while cost-benefit analysis may be well applicable for long-term priorities, it will be less suited to the analysis of adaptive capacity and no-regret options.

Table 3.11 Indicative mapping of the suitability of methods for assessing different adaptation priorities in an economic context

Options for assessing adaptation	Adaptation type		
	Adaptive capacity	*No regrets*	*Long-term priorities*
Formal cost-benefit analysis	✓	✓✓	✓✓
Non-formalized cost-benefit analysis	✓✓	✓✓✓	✓✓
Cost-effectiveness analysis	✓	✓	✓✓✓
Multi-criteria analysis	✓✓	✓✓	
Portfolio theory	✓	✓	✓✓✓
Pathway analysis			✓✓✓
Adaptive capacity assessment	✓✓✓		
Risk management method		✓✓	✓✓✓
Scenario-based approach		✓	✓✓
Technological assessment		✓	✓✓
Normative-policy assessment	✓	✓	✓
Participatory techniques	✓✓	✓	✓
Social learning	✓✓	✓	✓

Source: Adapted from Hunt and Watkiss (2009)

European Environmental Agency (EEA, 2004) links the success of an adaptation strategy with the combination of three factors:

- the flexibility or effectiveness of the adaptation measures, including their ability to meet the decision-maker's criteria under a range of climate and non-climate scenarios;
- their potential to produce benefits that outweigh their costs; whether they are consistent with, or complementary to, measures being undertaken in related sectors;
- the ease with which they can be implemented.

Mendelsonn (2000) believes that to be efficient the adaptation must maximize the net benefits to an individual. He distinguishes two sides in this statement. Because the individual receives the net benefits from engaging in private adaptation, the people tend to choose its efficient levels. As long as the costs and rewards are borne by the decision-maker, private adaptation will tend to be efficient. Under these conditions, the private calculus and the social calculus are identical. The private decision-maker can be left to her own devices to make an efficient choice, and no government policy is required to get private adaptation to be efficient. However, private interest will not lead ultimately to efficient levels of public adaptation that will be efficient only through government action. Additionally, an action that is successful for one individual, organization or level of authority may not be classified as successful by another.

Further, it is not at all clear whether efficient levels of joint adaptation will be undertaken because conflict is inevitable in collective action. *"The benefits and even the costs of engaging in a collective action are rarely the same for everyone. Some of the alternatives will benefit certain members of the group more than others. Individuals will naturally press for the choice that maximizes their personal benefits. These choices need* *not be the same ones that maximize group net benefits. It is consequently difficult for groups to make efficient collective choices",* – Mendelsonn (2000, p. 594) argues. He explains this situation by the fact that political processes do not appear to give efficiency a great weight. An efficient collective action implies that an activity maximizes the net benefits of the group, and this definition of collective benefit pays no regard to *who will benefit* or pay for the action, although most individuals are not indifferent to how the costs and benefits are distributed. "Given that the beneficiaries rarely are the same people bearing the costs of collective actions, individuals will often lobby for activities that improve their personal fortunes regardless of the effect on the group as a whole" (*ibid*). This is especially problematic when the benefits of an action are concentrated in the hands of a few, whereas the costs are dispersed across many. As a result, individuals from the public may not care which government action is undertaken as long as the costs per person are low. But powerful groups with concentrated benefits can reward themselves handsomely by swaying programs to meet their needs. The described situation is especially peculiar to transition countries where the former ideology of 'public property' is strong as before.

As it has been several times mentioned in this book, adaptations are not isolated from other decisions and occur in the context of demographic, cultural and economic change, transformations in information technologies, global governance, social conventions, globalizing flows of labor and capital, and so on (O'Brien *et al.*, 2004, 2007). It can be therefore difficult to separate climate change *adaptation decisions* from actions triggered by other social or economic events. Some adaptations can be clearly identified as being triggered by climate change, and those are often purposeful and directed. Other adaptations can arise as a result of other non-climate-related social or economic decisions. Irrespective of motivation for adaptation, both purposeful and unintentional ones can generate short- or long-term benefits. But they may also generate costs when the wider issues or longer timeframes are considered and, moreover, amplify climate change impacts by ineffectual and unsustainable anticipatory action. On the other hand, adaptations to non-climate drivers can increase vulnerability to climate change stress. The success of climate related adaptation actions may also be negated by reactive adjustments made by economic actors, governments or individuals as a part of the process of continual adjustment to social and ecological change driven by multiple factors (Adger *et al.*, 2005).

An important issue in assessing efficiency of adaptation relates mainly to decisions concerning the *non-market benefits.* Usually, adaptation costs are expressed in monetary terms, while benefits are typically quantified in terms of avoided climate impacts and are expressed in monetary as well as non-monetary terms – changes in yield, welfare, population exposed to risk, and so on (Parry *et al.*, 2007). Any efficiency assessment that incorporates only goods with market approximations (such as human health or economic production) risks to under- or to overestimate both costs and benefits.

Mendelsonh (2006) defines *market adaptation* to be private choices that individual firms and households make for their own benefit in response to climate change. Market adaptation therefore has three components: changes in supply, changes in demand, and changes in market conditions. An example of a supply response would be changes that farmers make on their farms in raising crops. An example of a demand response would be changes that consumers make in their energy consumption or conservation plans in response to climate. Finally, if either supply or demand shifts, trading will cause markets to adjust prices. To encourage efficient adaptation, the markets will encourage efficient adaptation in sectors whose goods are traded, such as agriculture, timber, and energy. The market will not be effective, encouraging adaptation for jointly consumed goods such as infectious diseases or biodiversity. Efficient adaptation in these sectors will require government support. Impacts in areas with both private and public involvement, such as water, coastal defenses, and heat stress, require a mixture of market (private) and governmental responses to be efficient. Finally, governments often play a role in encouraging or discouraging markets. For markets to be effective the governments have to provide efficient incentives, or adaptation may either not occur or become very costly.

In many cases, weather and climate affect people indirectly through their effects on physical/biological systems. If the latter have adaptive mechanisms that operate without human intervention, it is important for agents to seek to use and/or manage these systems for including such autonomous adaptations in evaluating the system they are managing. Reilly and Schimmelpfennig (2000) name this a *"human intervention to foster adaptation"*. So, any measure on protecting the biodiversity promotes undoubtedly to ecosystems autonomous adaptation. Moreover, such unintentional adaptation has the capacity to reduce the effectiveness of the purposeful adaptation.

3.3.6.3 Success of adaptation across scales

Success of adaptation depends on scale of implementation and the criteria used to evaluate it at each scale. Integration of adaptation actions and policies across scales remains a principal challenge to achieve effective adaptation in practice.

Adger *et al.* (2005) guess that defining success of adaptation simply in terms of the effectiveness of meeting its objectives is not sufficient by different reasons, two of which they state as:

1) Whilst an action may be successful in terms of one stated objective, it may impose externalities at other spatial and temporal scales, and what appears successful in the short term turns out to be less successful in the longer term;
2) Whilst an action may be effective for the adapting agent, it may produce negative externalities and spatial spillovers, potentially increasing impacts on others or reducing their capacity to adapt. Therefore, the definition of success of adaptation depends, clearly, on both the spatial and temporal scale, and should not simply be assessed in terms of the stated objectives of individual adaptors.

The ***timing*** of adaptation drew the attention of different analysts (Adger *et al.*, 2005; Hanemann, 2000; Mendelsonn, 2000). For example, Hanemann (2000, p. 574) thinks that "even if the level of adaptation is efficient, the *timing* could be sub-optimal, causing additional costs to be incurred. …the timing of adaptation could turn out to be a key determinant of the magnitude of the economic impacts associated with climate change."

More diverse arguments, presented by Mendelsonn (2000), can be summarized as follows. Adaptations that involve large capital stocks have important dynamic features. Climate change is a dynamic phenomenon, stretching over decades and centuries. On the other hand, many sectors can only slowly respond to desired change and so the process of adaptation is dynamic itself. Because the process of climate change may take a long time to unfold, the timing of the adaptations need to match these processes. Quick adjusting

Table 3.12 Speed of adoption for some agricultural adaptation measures

Adoption	*Time (Yrs)*
Transportation system	3-5
Opening new lands	3-10
Variety adoption	3-14
Variety development	8-15
Fertilizer adoption	10
Tillage system	10-22
Irrigation equipment	20-25
Irrigation infrastructure	50-75
Dams	75-100

Source: Adapted from Reilly and Schimmelpfennig (2000)

sectors, e.g., some in agriculture (Table 3.12), can adapt to climate as it unfolds, but more capital intensive sectors may need more time. As such, they are needed in climate change forecasts as well as in the corresponding plans to anticipate future climate. They are also more reliant on *ex-ante* decisions because choices, such as afforestation, have long-term implications and cannot be reversed easily.

The timing in relation to the climate change impact affects the perceived economic efficiency of an adaptation action, creating the distinction between *short-run* and *long-run* adaptations. In the first case, capital is largely fixed and most of the available adjustments are limited to changes in behavior. In the long run, all capital is replaced. Changes in residential buildings, factories, and transportation systems can all be made relatively cheaply over the long run. If the same changes were made in the short run, the vast amounts of existing capital would have to be prematurely abandoned. Where the planning horizons are short (less than one year), capital turnover rates are high and systems can readily adjust adaptation to short-term climate variability; this is all that is required to create an economically efficient response to climate change. On the other hand, where the planning horizons are long, capital turnover rates are low and systems cannot quickly adjust the longer-term climate changes have to be factored in order to avoid costly planning errors (Adger *et al.*, 2005; Mendelsonn, 2000).

The circumstances, where an anticipatory adaptation might be important, are situations when there are known climatic thresholds leading to the sudden appearance of a negative impact. In this case, it is possible to anticipate this event prior to observing it. For instance, one of the most important thresholds in natural systems is species extinction (Table 3.13). To reduce the chances of extinction, the private and public owners can take preventive actions to move threatened species to more secure habitats before they are lost.

Table 3.13 Ecological optimum of Moldova's forest species by mean annual air temperature and precipitation

Species	***Precipitation, mm***			***Temperature, °C***		
	Suboptimum	Optimum	Limits	Suboptimum	Optimum	Limits
Edificators						
Fagus sylvatica	600-1300	700-1200	500; 1400	4-10	6-9	3
Carpinus betulus	500-800	600-700	400; 900	6-11	8-10	5
Quercus petraea	500-900	600-800	1000; 1100	6-11	8-10	5
Quercus robur	450-760	600-700	440; 1000	7-11	8-10,5	6
Quercus pubescens	450	500-650	700	9-11	-	8
Co-edificators						
Tilia tomentosa	500	550-600	400	8,5-10,5	8,5-10,5	8; 11
Fraxinus excelsior	450-800	500-700	400; 1000	6-11	8-10	5
Beula pendula	600-1200	700-1100	500; 1300	3; 9	5-8	2; 10
Ulmus carpinifolia	600	450-550	400; 700	7	8-10	11
Acer pseudoplatanus	700	800-1100	600; 1200	4-8	5-7	11

Source: Shabanova and Izverscaia, 2004

Armed with advanced warning, a society could engage in preventive measures before the adverse impact takes place. In particular, this ideology supports development and implementation of early heat-waves and flooding warning systems (Menne *et al.*, 2008).

Thus, policy makers must be especially cognizant that adaptation to climate change must be frequently dynamic. The efficient response will be often a series of subtle changes over time, and the problem cannot be solved with a single one-time action. A dynamic policy is especially important in capital intensive sectors such as ecosystems, coastal protection or water supplies. *"Policy makers need to be able to think in long time horizons and pursue solutions as they are needed"* (Mendelsonn 2000, p. 598).

From the policy viewpoint, EEA (2004) named five key reasons why adaptation planning should begin as soon as possible:

(i) Anticipatory and precautionary adaptation is more effective and less costly than forced, last minute emergency response;
(ii) Climate change may be more rapid and more pronounced than current estimates suggest, creating the risk of under-adaptation and the potential for unexpected sudden events;
(iii) Immediate benefits can be gained from better adaptation to climate variability and extreme climatic events;
(iv) Immediate benefits can be gained by removing policies and practices that result in ineffective adaptation. An important aspect of adaptive management is to avoid the implementation of decisions that constrain or reduce the effectiveness of future options for adaptation;
(v) Climate change brings opportunities as well as threats. Future benefits can result from climate change, and these opportunities can be realized or increased by appropriate adaptation and awareness.

3.3.6.4 Measurement of adaptation effectiveness

As was shown above, adapting to climate change entails *costs* (at least those of implementation), but it should also yield significant *benefits* – those of reduced impacts or enhanced opportunities. The IPCC AR4 (IPCC, 2007d) defines adaptation costs as "the costs of planning, preparing for, facilitating, and implementing adaptation measures", while the definition for adaptation benefits is "the avoided damage costs or the accrued benefits following the adoption and implementation of adaptation measures".

Here, one should distinguish a very important difference between the financial and economic costs. *Financial costs* typically work within the budgetary framework of the adaptation strategy or intervention under consideration, while the *economic costs* require the consideration of all costs and benefits to society, such as those assessing significant distributional effects arising from most adaptation actions in favor of the less well-off. There are also other differences between the cost and benefit frameworks, in particular, with regard to whether they include or exclude such elements, as domestic taxes and charges, or net or gross revenues. If the economic benefit options outweigh the costs, then there are net benefits of adaptation. Otherwise, this potentially leads to maladaptation. If adaptation reduces impacts, but does not remove them completely, there will be residual damages, which also carry an economic cost. Therefore, there are different objectives of

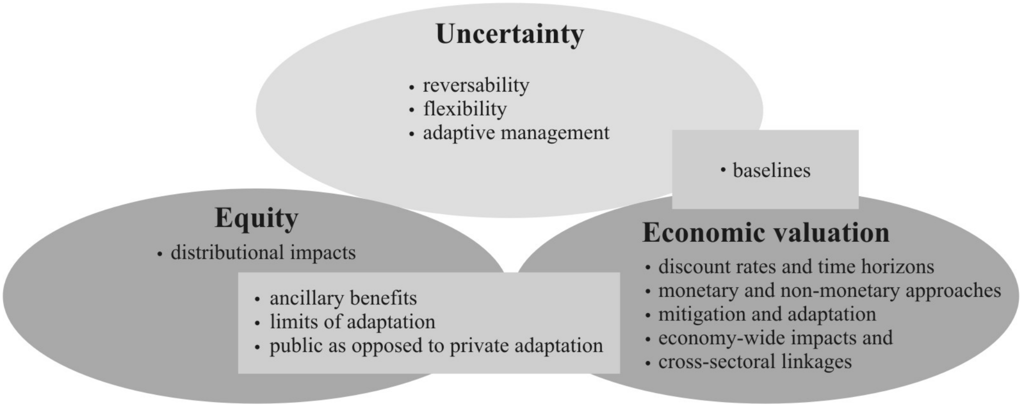


Fig. 3.21 Main methodological themes concerning cost and benefits of adaptation. *Source:* UNFCCC, 2009

adaptation options. For instance, they can (1) aim at avoiding all damages or at returning levels of welfare back to pre-climate change levels, or (2) at maintaining current levels of risk or reducing them cost-effectively within budgets or to pre-defined acceptable levels.

The literature on the costs and benefits of adaptation raises a number of methodological issues, which the UNFCCC (2009) grouped under the broad themes of uncertainty, economic valuation and equity (Fig. 3.21). Here, 'baselines' are items relating to both 'Uncertainty' and 'Economic valuation', while 'ancillary benefits, limit of adaptation and public as opposed to private adaptation' fall under both 'Equity' and 'Economic valuation'.

Although the effectiveness of adaptation can sometimes be directly measured, for example, by lengths of new flood-defensive dams, the adaptation benefits are often not easy to monetize, as they include non-market sectors, for example, ecosystem services. Adger *et al.* (2005) distinguished a number of issues surrounding this problem:

1) There may be uncertainty over how a particular adaptation option will work even under defined conditions as well as over the impact of an adaptation action. In some cases the impact will be clear and immediate, and past experience may be a very useful guide. In other cases, where the action is innovative, the consequences may not be known;
2) The effectiveness of an individual adaptation option may be reliant on actions taken by others;
3) The effectiveness of an adaptation action may depend on the future unknown state of the world: future climate, future social and economic conditions, and so on. Therefore, robustness to uncertainty and flexibility (an ability to change in response to altered circumstances) are two key indicators of effectiveness. Some adaptation measures are inherently more robust and less sensitive to changing conditions than others;
4) Whilst an adaptation measure may be effective at reducing the impacts of climate change or increasing opportunities in one location or in one time period, it may increase pressures or lessen the abilities to adapt to others. Potentially, any adaptation action can create unintended impacts on other natural and social systems. Measures to reduce exposure and sensitivity to a climate hazard have the greatest potential to

impact other elements of the physical and ecological environment; measures to increase resilience are less likely to have an environmental impact, however can clearly if are focused solely on achieving the short-term objectives, without taking into account wider sustainability considerations;
5) The assessment of the effectiveness of an adaptation action may be significantly dependent on the spatial and temporal scales over which the change is viewed.

In all cost-benefit analyses, there is also a gap if the prospective winners and losers from the proposed actions are not identified. As a rule, the damages caused by climate change disproportionately affect vulnerable populations, many of whom are poor. The costs of planned adaptation, on the other hand, are borne partly by national governments, spreading the burden across taxpayers n the country, or by global funds, in which case the burden is borne by the international community. That is why any assessment of the economic efficiency of adaptation actions requires consideration of (1) the distribution of their costs and benefits; (2) the costs and benefits of changes in those goods that cannot be expressed in market values; (3) the timing of adaptation actions (Adger *et al.,* 2005).

In this triad, the *distributional issue* has itself two specific dimensions: the balance between private and public costs&benefits of adaptation actions, and the regulatory system that determines the benefits. Some elements of adaptation response are, in effect, public goods (the conservation of nationally and internationally important habitats, the conservation of resources for future use, etc.). Other types of adaptation involve effectively private goods. At present, climate change planning tends to be concentrated on providing public goods such as scenario information, risk assessments in the public domain and public awareness campaigns. But public and private elements of responding to climate change are not fixed: they are shaped by institutional and regulatory features in every sector. Moreover, they can change from public to private and back again over time.

"Adaptation is efficient only if the cost of making the effort is less than the resulting benefits,"– is the opinion of Mendelsonn (2000, p. 585). Thus, if efficient adaptation responses can reduce the overall costs associated with climate change, the inefficient responses can actually increase costs. Total benefits and costs would be considered in every decision. In practice, however, governments may have difficulties in providing efficient levels of joint adaptation. Mendelsonn (2000) sees three forces that push them away from efficient outcomes: (1) Groups must perceive a collective gain; (2) The collective body must agree on the level of action; (3) Beneficiaries are often more interested in maximizing their private gain rather than maximizing the total value to society. Adger *et al.* (2005) add that from the diversity of development pathways it is clear the success and sustainability of future adaptations will depend on how institutions and social and cultural attitudes are changing as well as on the heterogeneity of adaptive capacity across different stakeholders.

Evaluating success of adaptation, Adger *et al.* (2005) see 'an ideal' in the adaptation that balances effectiveness, efficiency and equity through decision-making structures that promote learning and are perceived to be legitimate. The relative importance attached to each criterion varies between countries, between sectors within countries, and over time. Moreover, the relative weight placed on these values varies between actors engaged in adaptation processes, depending on their world view and perceived limits to responsibility (Haddad, 2005). Conflicts over the allocation of resources for adaptation and other purposes may reflect different perceptions of progress as a central dilemma of development. Equity of outcome and legitimacy of decision-making are both central to the resilience and, ultimately, to the perceived success of adaptation. Development which is inequitable, undermines the potential for welfare gains in the future, and development which lack legitimacy have less chance of the full implementation of adaptation actions.

However, there are no blueprints for successful climate change adaptation. Countries face different types and degrees of risk, start from different levels of human development and vary widely in their technological and financial capabilities. UNDP (2007) summarized the foundations for successful adaptation planning under four *'I'*s:

- ***I**nformation* for effective adaptation planning
- ***I**nfrastructure* for climate-proofing
- ***I**nsurance* for social risk management and poverty reduction
- ***I**nstitutions* for disaster risk management.

To differing degrees, the following chapters will attempt to uncover these positions. The available findings, e.g., of the UNFCCC (2009, p. 8), give some recommendations the most important of which is: *"…there are potential benefits in adopting multiple methods and approaches in an analysis of the costs and benefits of adaptation options, as linking these together would provide a greater evidence base. Indeed, it is almost impossible to see how one single approach could capture all of the complex methodological issues raised, or address different types of adaptation and/or different objectives"*. It is also clear that there is a lack of careful and detailed analysis of the economic costs and benefits of adaptation as well as of information from where estimates of public funding needs can be developed. However, knowledge in the area is still evolving, and there are a large number of research priorities that need to be investigated.

3.3.7 Key problems in adaptation research

European Environment Agency in its special Technical Report on vulnerability and adaptation to climate change (EEA, 2006) noted that although progress is being made in assessing vulnerability and adaptive capacity in Europe, several aspects have not been sufficiently studied, and a robust methodological framework for evaluating adaptation options is still to be developed. Although the need for adaptation is recognized by governments and organizations, work on adaptation is still at an early stage and has been predominantly of a preparatory nature. Drawing upon the insights and experience from member countries and climate adaptation literature, EEA highlighted the major challenges for climate change adaptation in Europe (Box 3.13).

To make progress on adaptation, efforts are needed to foster further research. Based on the UK Climate Impacts Programme (UKCIP)[16], the NCSP Workshop on vulnerability and adaptation to climate change (NCSP, 2006) identified some levers, triggers and barriers for adaptation that are important when moving from climate impact research to adaptation.

---

[16] See: *http://www.ukcip.org.uk*

Box 3.13 Key challenges for adaptation in Europe

As a relatively new issue, adaptation to climate change in Europe has been hindered by a combination of factors that include:

- significant uncertainties associated with climate and non-climate scenarios required for impact, vulnerability and adaptation assessments
- gaps in knowledge about the underlying causes of vulnerability and the theory of adaptation
- lack of policy guidance and institutional support
- insufficient coordination between sectors and countries
- there have not been many concrete adaptation actions, and hence there are not enough precedents to follow.

Source: EEA, 2006

Levers are identified as situations whereby small efforts can yield large change. They could include: 'tipping points'; regulation and standards; policies, strategies and guidance; investors and insurers; and education and training.

Triggers cause changes and/or actions for adaptation. They include: timely news on climate impacts; availability of more scientific evidence of climate change and its impacts; occurrence of climate extreme events and costs of recovery from them; legal liability; etc.

Barriers to adaptation action in financial, cultural and policy realms raise questions about the efficacy and legitimacy of adaptation as a response to climate leading to the lack of scientific interest and the misperception of climate change as a problem in the distant future. As such, IPCC AR4 discusses financial, informational, cognitive, social and cultural barriers (Adger *et al.,* 2007).

Jointly, these factors generate ***limits of adaptation***, which AR 4 (*Ibid*, p. 733) define "as the conditions or factors that render adaptation ineffective as a response to climate change and are largely insurmountable". These limits are subjective and dependent upon the values of diverse groups, being closely linked to the rate and magnitude of climate change, as well as to associated key vulnerabilities. The perceived limits to adaptation are likely to vary according to different metrics. IPCC also distinguish physical, ecological and technological limits.

Policy- and decision-makers (governments, organizations) are likely to play a number of roles in enabling, influencing and implementing adaptation to climatic change. But there is a range of other roles specific to adaptation that they can play, working independently and together through different international system. To understand what these roles will be, Berkhout (2005), in his rationales for adaptation in EU climate change policies, highlighted some key problems that have been identified in adaptation research thus far.

1. *Awareness of climate vulnerability.* Understanding the exposure, sensitivity and adaptability of a natural or human system to future changing climate is complex. Vulnerability assessment is a growing field and needs to provide practical tools and applications that can be used by people and organizations, as well in the management of natural ecosystems. Generally, private actors will not pay for the science needed for the assessment and management of vulnerability.

2. *Awareness of adaptation options.* Although organizations are continually under pressure to change the way they do things, the climate change risk has been integrated into innovation processes only in a few cases. This is at least partly because organizations are not yet aware of the measures (technological, institutional and so on) they could take to moderate climate vulnerabilities and risks.

3. *Uncertainty and motivation.* For many organizations there will continue to be considerable uncertainty about the precise nature and risks of changing climate and variability, about their vulnerability and about the benefits of adaptation. To some extent this uncertainty will remain irreducible, but there can be a role for better climate prediction and more tailored information, especially for smaller organizations. Anticipatory adaptation will become more likely with lower uncertainties about impacts and benefits of adaptation. There may also be the collective, broad-scale benefits from adaptation, which cannot be captured if private actors are not sufficiently informed.

4. *Adaptation spillovers.* As with many forms of innovation and change, the benefits of adaptation to climatic changes may not be appropriated entirely by the agent making the change. There may be other beneficiaries from actions, knowledge and experience that an innovator has invested in. These 'spillovers' can lead systematically to a collective under-investment in adaptation, generating a rationale for policy and legal interventions, much as with intellectual property rights and patenting regimes. In addition, climate adaptations, reducing the vulnerability of one agent, may generate either negative or positive consequences for others. Because vulnerability to climate change is likely to be unequally distributed across different groups in society, nationally and internationally, we would expect some groups and societies to be able to moderate their vulnerability more effectively, but often transferring risks onto others. Adaptation may therefore lead to a deepening of already existing inequities, pushing for the need for policies to protect both the innovative and the vulnerable actors.

5. *Constraints on adaptation* Much adaptation will draw on resources (including capital, knowledge, technology and consent) that are not held by the adapting agents themselves. While some of the resources will be made available through the market, there are also likely to be scarcities and constraints, partly as a result of the awareness problems discussed above. Policy has a role in modifying and perhaps moving some of the existing regulatory, market or infrastructural constraints. It is also likely that, giving adapting agents a greater scope to adapt (extending their adaptation 'space'), the new conflicts will be generated with other environmental, social or economic objectives. Along with 'win-wins' measures, the trade-offs, especially where new sources are required to modify vulnerability or improve adaptive capacity, should be expected.

In turn, Smit and Wandel (2006) distinguish four views on ***research studies*** in the adaptation field.

According to the *first view,* adaptations are considered as tools to assess the degree to which the systems can moderate and reduce negative impacts from climate change, or realize positive effects to avoid danger. When analyzed for this purpose, adaptations are conventionally assumed or hypothetical, and their effect on the system of interest is estimated relative to the estimated impacts. Thus, for this use, the focus is on the effect of assumed adaptations with a purpose to estimate impacts of climate change as well as to estimate the difference adaptation could make. Studies of this kind neither empirically investigate adaptations, examine the actual processes of adaptation or adaptive capacity nor explore the conditions or drivers that facilitate or constrain adaptations. They take certain assumed or hypothetical adaptations and then estimate the effects they would have on the calculated impacts of conditions captured in the specified climate change scenarios.

A *second* body of scholarship focuses on specific adaptation options or measures, for a particular system subject to climate change stimuli. These analyses address directly

UNFCCC Article 4.1 that commits countries to "formulate and implement… measures to facilitate adequate adaptation to climate change" and aim to assess the relative merit or utility of alternative adaptations in order to identify the 'best' or better ones.

A *third* group of studies focuses on the relative adaptive capacity of countries, regions or communities and involves comparative evaluation or rating based on criteria, indices and variables typically selected by the researcher (e.g., Alberini *et al.*, 2006; Vincent, 2007). Vulnerability, taken here as a 'starting point' rather than the residual or 'end point', is assumed to be measurable based on attributes or determinants selected a priori. The expected application is that adaptation efforts should be directed to areas with the greatest exposures or least adaptive capacity. The authors again relate this work to UNFCCC Article 4.4, which commits developed country to assist developing ones that are particularly vulnerable to the adverse effects of climate change. The main purpose of these studies is to provide an evaluation of the relative vulnerability (and/or relative adaptive capacity) of the countries or regions, usually using some kind of indicator, scoring, rating or ranking procedure. The intent is to provide information for targeting the adaptation initiatives for scarce resources (see, e.g., Sect. 3.2.3). This research does not aim to identify the processes, determinants or drivers of adaptive capacity and vulnerability as they function in each system—they are taken as given, and used as a basis for the rating or ranking analysis. This analysis also does not substantively address the policy and decision-making processes that deal with the conditions that can alter adaptive capacity and vulnerability. It is implicitly assumed that the output – indications of the relative vulnerability or adaptive capacity – will have application in policy and decision-making, by identifying the countries, districts or areas with the greatest vulnerability or the least adaptive capacity.

The purpose of the *fourth* type of analysis is to contribute to practical adaptation initiatives where under 'practical application' there is meant research that investigates adaptive capacity and adaptive needs in a particular region or community in order to identify means of implementing adaptation initiatives or enhancing adaptive capacity. Such a research enables identification and development of particular adaptive measures or practices tailored to real needs of that community. The aim is not to score adaptations or measure relative vulnerabilities, nor to quantify impacts or estimate effects of assumed adaptations. Rather, the focus is to document the ways in which the system or community experiences the changing conditions and processes of decision-making in this system (or that influence the system) that may accommodate adaptations or provide means of improving adaptive capacity.

In their analysis of the available body of work in the climate adaptation field, Smit and Wandel (2006) also identified several distinctive features that are important to facilitate ***adaptation initiatives***:

- To tend not to presume the specific variables that represent exposures, sensitivities, or aspects of adaptive capacity, but seek to identify these empirically from the community.
- To focus on conditions, which are important to the community rather than on those assumed by the researcher or for which data are readily available.

- ➲ To employ the experience and knowledge of community members to characterize pertinent conditions, community sensitivities, adaptive strategies, and decision-making process related to adaptive capacity or resilience.
- ➲ To identify and document the decision-making processes into which adaptations to climate change can be integrated.
- ➲ To use a *bottom-up* approach in contrast to the scenario-based *top-down* approaches.

The distinctive motivation here is to identify what can be done in a practical sense, in what way and by whom in order to moderate the vulnerability to the conditions that are problematic for a community.

Significant outstanding research challenges in understanding the processes, by which adaptation is occurring or will occur in the future, and in identifying areas for leverage and action by governments are noted in IPCC AR4 (Adger *et al*., 2007). In particular, further research is especially needed to monitor progress on adaptation and to assess the direct and ancillary effects of such measures. There is also a need for research on the synergies and trade-offs between various adaptation measures as well as between adaptation and other development priorities. It is also not well understood what impact human intervention to manage the process of adaptation in biological systems will have, although research on the resilience of socio-ecological systems as well as on the economic and social costs and benefits of adaptation measures is also required. Sufficient information is lacking on the economy-wide implications of particular adaptations on economic growth and employment.

Thus, it is possible to agree with Schneider *et al.* (2000) that adaptation strategies can significantly affect (and usually, but not always, reduce) climate damages that are likely without adaptive responses. But they also added that "perfect adaptation by agents with perfect foresight of slowly and smoothly occurring climatic trends is an unrealistic exaggeration of more likely realistic adaptive responses" (p. 217).

Chapter 4
Adaptation Politics and Regulations in the Administration of Climate Change Regime

4.1 Dichotomy of climate policy: adaptation and mitigation

4.1.1 Avoiding the unmanageable and managing the unavoidable

As everybody knows, UNFCCC identifies two responses to global warming: mitigation of climate change and adaptation to its impacts. IPCC (2007a) defines *mitigation* as "implementing policies to reduce greenhouse gas emissions and enhance sinks" and *adaptation* – as "initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects". In a wider interpretation, mitigation means an anthropogenic intervention to reduce the anthropogenic forcing of the climate system through strategies to reduce GHG sources (emissions) and enhance their sinks; in turn, adaptation means adjustment in natural or human systems in response to actual or expected climatic stimuli and their effects in order to moderate harm or exploit beneficial opportunities. It follows that mitigation reduces all climate change impacts (both positive and negative) and thus reduces the adaptation challenge, whereas adaptation is selective, taking the advantage of positive impacts and reducing negative ones (Klein *et al.*, 2007).

An effective policy, aimed at reducing the risks of climate change, has to involve a portfolio of both adaptation and mitigation actions. On the one hand, current global warming is the consequence of emissions decades ago, and this process will continue. Owing to the lag time in responses of the global climate system, no mitigation efforts, no matter how rigorous and relentless, will prevent climate change from happening in the next few decades, thus making adaptation inevitable. According to the latest estimations (Parry *et al.*, 2009, p. 1102), "even the most restrictive emissions policies proposed to date leave a sizeable chance that significant climate change will occur over the next several decades, probably surpassing the 2°C warming target adopted by the European Union and held by many as a dangerous limit beyond which we should not pass. We must therefore complement a strong emissions policy with a plan to adapt to major environmental, social and economic changes in the lengthy period during which we will overshoot safe levels of climate change. This will require much more investment in adaptation than is currently planned".

Shalizi and Lecocq (2009) see three reasons to treat adaptation as the primary rather than the secondary concern when addressing the climate change challenge. First, some countries have very limited mitigation opportunities, but all face adaptation needs. Second, there have been delays in coming to an effective agreement on mitigation, and these delays are expected to continue. Lastly, the early impacts of climate change are being observed (in part, a consequence of the delayed action of the past two decades), and there is already a need for adaptation to deal with these initial stages. In particular, Hallegatte (2009) proposes a list of sectors in which decisions should already take into account climate change, because they involve long-term planning, long-lived investments and are already exposed to changes in climate conditions (Table 4.1).

Table 4.1 List of sectors in which climate change should already be taken into account because of their investment time scales (years) and their exposure to climate conditions

Sector	*Time scale*	*Exposure*	*Examples*
Water infrastructures	30–200	+++	dams, reservoirs
Land-use planning	>100	+++	flood plain, coastal areas
Coastline and flood defences	>50	+++	dikes, sea walls
Building and housing	30–150	++	insulation, windows
Transportation infrastructure	30–200	+	port, bridges
Urbanism	>100	+	urban density, parks
Energy production	20–70	+	plant cooling systems

Source: Adapted from Hallegatte (2009)

On the other hand, there are limits and barriers to effective adaptation. Moreover, even if these limits and barriers were to be removed, reliance on adaptation alone is likely to lead, in the long run, to a magnitude of climate change, which makes adaptation impossible for some natural systems and involves very high social and economic costs for most human systems. Therefore, it is a generally accepted conclusion that there is "…no longer a question of whether to mitigate climate change or to adapt to it. Both adaptation and mitigation are now essential in reducing the expected impacts of climate change on humans and their environment" (Klein *et al.*, 2007, p. 748). It is also clear that mitigation and adaptation are not alternatives; both need to be pursued actively and in parallel. The UN Scientific Expert Group on Climate Change (SEG, 2007) expressed figuratively these two indissolubly united strategies of confronting climate change as '*avoiding the unmanageable and managing the unavoidable'*.[1] Mitigation is essential because without firm actions now, future generations could be confronted with climate change on such an overwhelming scale that adaptation might no longer be feasible, or become unmanageable. However, because mitigation is not enough on its own, to manage inevitable, or unavoidable, becomes essential. Thus, historically, the awareness has grown that mitigation and adaptation were erroneously regarded as two fundamentally different approaches to the same problem, thereby largely ignoring possible synergies and trade-offs between them. This resulted in what can be described as the mitigation–adaptation dichotomy – a separated approach to combat climate change (Klein et al., 2007). The

[1] Much earlier, Nordhaus made the point regarding these choices as 'Mitigate we might; adapt we must' (Nordhaus, W.D., 1994: *Managing the Global Commons: The Economics of Climate Change,* Massachusetts Institute of Technology, p. 189. Quoted by Schipper (2006)

potentials of combining both approaches have only recently been picked up and discussed within the scientific community (see, e.g., Biesbroek *et al.*, 2009; Klein *et al.*, 2007; Swart and Raes, 2007).

However, the primary focus on mitigation created a view of adaptation as almost an opposite response from mitigation, to be employed only when mitigation failed to prevent impacts. To a large extent, this underestimation of adaptation still persists. Knowledge of past adaptation and research into the processes and techniques of adaptation still continue to be neglected (Burton *et al.*, 2007). Moreover, Swart and Raes (2007, p. 2890) state: “Until recently, mitigation was considered to be a problem of developed countries, which had caused the problem and not only had the responsibility but also the resources to do something about it. Adaptation was more a problem of developing countries, where per capita emissions were low and vulnerability high. Gradually, it has become clear that climate change, with its roots in the fundamental requirements of societies for energy and food, may rather be framed as a development issue rather than as an environmental problem. But even if developing countries may be more vulnerable, climate change also affects developed countries. Mitigation and adaptation both aim at reducing risks of negative climate change impacts, and are obviously closely linked in different ways”.

Thus, policy-makers should acknowledge the fact that both mitigation and adaptation are a part of the portfolio of responses to climate change, and they will have to confront decisions about how to incorporate them both into a coherent and balanced strategy (Burton *et al.*, 2007; IPCC, 2007d; Swart and Raes, 2007). The acceptance that a mix of short-term adaptation actions is needed to support long-term mitigation strategies is an urgent policy issue that provides more efficient and effective use of financial and human resources instead of formulating separate climate policies for each sector. In order to foster these two types of actions, research has to take an interdisciplinary approach, and links need to be made between the socioeconomic dimensions of impacts and responses, which would subsequently challenge institutional settings and a potentially broaden policy-makers’ dialogue.

4.1.2 Conceptual history of adaptation as a policy approach

Although mitigation and adaptation have the same purpose – reducing undesirable consequences of climate change – and are both set out as responses to anthropogenic climate change, for historical reasons the two have been separated both in science and in policy. Even if nowadays mitigation and adaptation have become ‘equal in rights’ items in the climate policy agenda, this was not always so. Moreover, in the opinion of Schipper (2006), the dichotomy between the two strategies, though now less visible, continues to exist in the UNFCCC process. The separation of mitigation from adaptation in thinking and practice is well documented and is evident in the treatment of these two issues in scientific literature, generalized in four successive IPCC Assessment Reports.

A dichotomy between adaptation and mitigation as *policy approaches* also has its own history. Schipper (2006, p. 82) notes: “…debates on merits of each approach with respect to the other have been ongoing among negotiators, policy makers and scholars since the inception of the dialogue on climate change”. In particular, she describes three schools of thought: the ‘limitationist’ view where action to reduce GHG emissions (mitigation) is the core of efforts; the 'adaptationist' view where no explicit action is required since the 'invisible hand of either natural selection or market forces' will ensure that societies will adjust to the changes (Kates, 2000), and the more recently expressed 'realist' view where climate change is considered as a fact, and adaptation – as a crucial and realistic response option along with mitigation, although available uncertainties are acknowledged (Klein *et al.*, 2005, 2007).

In the late 1990s, Cohen *et al.* (1998) stated, as an important characteristic of climate change literature, the strong separation between analysis of mitigation and analysis of impacts and adaptation. Although the policy debate was framed as a choice between mitigation and adaptation, an emphasis, both in research funding and policy attention, has been upon the former, and 'skewness' in favour of mitigation activity characterized the discourse. The reason behind this distinction has much to do with the way the climate change problem had been defined at that time.

Initially, in order to reverse trends of changes in climate, the scientists agreed predominantly that anthropogenic sources of GHG emissions must be limited. In other words, climate change was still considered to be merely an environmental problem that could be addressed in a fashion similar to that of acid rain and stratospheric ozone depletion, with a targets and timetable approach aiming at mitigating the impacts (Munasinghe and Swart, 2004). In acknowledgement of this need, in 1992 the international community adopted the UNFCCC as the global legal policy framework for doing this. Moreover, this was the main reason why the Convention did not reflect a great emphasis on adaptation, and the climate change policy has primarily emerged as mitigation policy, focused particularly on energy use. The original intention of the UNFCCC process underscored that the treaty should focus on reducing the source of climate change, rather than on adapting to the changes. Anthropogenic climate change has traditionally been conceptualized in terms of a chain of causes and effects from socio-economic driving forces to impacts, with a strong emphasis upon the science of atmospheric processes. Contributing to climate change impacts assessment, the social sciences have focused on the topic of mitigation: how best and at what cost to limit global climate change by reducing emissions. Adaptive capacity was considered to be an indicator of the extent to which societies could tolerate changes in climate, and was seen as one policy objective. Naturally, this led to a conceptual separation of mitigation issues from those of adaptation. However, the more attention, which has been given to mitigation, proceeded not only from a political choice, but because reducing emissions was considered more important. Numerous scientists and policy makers overlooked adaptation as 'a cousin of greenhouse gas mitigation', and adaptation was considered only as a secondary response (Schipper, 2006). Schipper, for the best illustration of this point, named the fact that the Convention had no article solely on adaptation, and the term was mentioned directly only five times in its text. The UNFCCC's principal statements relating to adaptation policy are shown in Box 4.1. This situation has resulted in different amounts of research (and, hence, literature) on each of the two responses, creating a lack of understanding and consensus about adaptation.

Such an understanding of the climate change problem has also led to an institutional separation, with important socio-political implications. With the most attention being focused on mitigation, the public policy debate has turned almost entirely on energy policy and emission reduction issues, despite the fact that in terms of value of information the

Box 4.1 UNFCCC *articles referring to* ***adaptation***

Article 4.1(b): All Parties are to "formulate, implement, publish and regularly update national and, where appropriate, regional programmes containing measures to … facilitate adequate adaptation to climate change".

Article 4.1(e): All Parties shall "Cooperate in preparing for adaptation to the impacts of climate change; develop and elaborate appropriate and integrated plans for coastal zone management, water resources and agriculture, and for the protection and rehabilitation of areas … affected by drought and desertification, as well as floods".

Article 4.1(f): All Parties shall "Take climate change considerations into account, to the extent feasible, in their relevant social, economic and environmental policies and actions, and employ appropriate methods … formulated and determined nationally, with a view to minimizing adverse effects on the economy, public health and the environment".

Article 4.4: "The developed country Parties … shall also assist the developing country Parties that are particularly vulnerable to the adverse effects of climate change in meeting costs of adaptation to those adverse effects".

Article 4.8: "The Parties shall give full consideration to what actions are necessary under the Convention, including actions related to funding, insurance and the transfer of technology, to meet the specific needs and concerns of developing country Parties arising from the adverse effects of climate change and/or the impact of the implementation of response measures".

Article 4.9: "The Parties shall take full account of the specific needs and special situations of the least developed countries in their actions with regard to funding and transfer of technology".

Source: UNFCCC, 2007c

society stands to gain a much larger return by investing more in the impacts and adaptation component of climate change; these issues are connected to a much broader spectrum of actors and interests (Cohen *et al.*, 1998).

The focus on mitigation rather than adaptation in both scientific and policy forums, objectively, could not last forever, and a shift has begun in the direction of increasing the role of adaptation in climate policy. It became as essential to include adaptation in the assessment of climate change impacts. The scientists have understood that by making certain assumptions about how people and societies will respond to climate change, and incorporating these responses in the assessment of damages, the economists could more accurately compare the costs and benefits of particular mitigation policies (Grothmann and Patt, 2005). Given the challenges of promoting the adaptation policy, the adaptation discourse was strongly influenced by a need to justify equal treatment of both approaches as well. Moreover, due to some delay and uncertainties in the implementation and success of the Kyoto Protocol, adaptation began to be seen as the only viable option for furthering climate change policy, and the original suggestion that there could be a choice between whether to mitigate emissions or to adapt to the changes has largely disappeared from the mainstream (Schipper, 2006).

In 2001, the agreement on the UNFCCC Marrakesh Accords, which focused on adaptation as a policy response, crowned the shift from solely looking at mitigation. The COP7 has adopted a vital work program on adaptation (see, e.g., UNFCCC, 2002) that can be considered as the highest pinnacle of adaptation policy thus far. Since COP 7, the political emphasis on adaptation has steadily increased to complement work on mitigation and culminated in the adoption of the Buenos Aires program of work at COP10. This program emphasized implementation of activities, identified in the context of national communications, and foresaw further action on vulnerability and adaptation, including information gathering and methodologies.

Table 4.2 indicates the shifts in thinking in the climate change debate and reflects how the understanding of adaptation has altered since the 1970s; it also reflects how different approaches for responding to climate change were questioned by various groups over time. Fig. 4.1 indicates the differing conceptual pathways to adaptation that were considered by these groups.

Table 4.2 Historical framing of climate change debate and adaptation thinking

Time frame	*Forum*	*Main questions*	*Strategies*
		Climate change debate	
1960s–1970s	WMO Climate scientists	Is climate change an issue we need to worry about? How will climate change affect the weather?	Weather modification Monitoring
Mid-1980s–early 1990s	IPCC International Negotiating Committee (INC) UNFCCC COP	Is climate change occurring? How will climate change affect global ecosystems and humanity? Who should be responsible for reducing emissions?	Global emissions reductions regime, activities implemented jointly/joint implementation
Late 1990s–early 2000s	UNFCCC COP Regional decision makers	What are the relative costs of mitigation and adaptation? How vulnerable are communities to variability and its consequences?	Planned adaptation strategies
		Adaptation thinking	
1970s–early 1980s	Club of Rome Academics	What are the ecological limits to human development and growth? How can we respond to climate change? What sort of impacts can systems sustain? Will systems adapt automatically?	Individual adaptation
Late 1980s	Advisory Group on GHG IPCC	What will the impacts be? How much adaptation are society and ecosystems capable of? How much can ability to adapt offset need to mitigate?	Ecosystem adaptation
Early 1990s	IPCC INC	Is mitigation more important than adaptation for responding to climate change? Mitigation and adaptation as alternatives to responding to climate change.	UNFCCC
Late 1990s	UNFCCC COP Research bodies	How can policy support adaptation? Who is vulnerable to climate change and why? Climate change will occur – adaptation will be necessary. Close link between adaptation and development.	Vulnerability and impact assessments Adaptation policy
Early 2000s	UNDP/GEF WB and donor agencies Research bodies IPCC TAR	What constitutes adaptive capacity? How can adaptation be integrated into existing sustainable development plans? What is needed to mainstream adaptation? How can adaptation policy be designed?	Development policy programs and projects by multi-lateral and bi-lateral donor agencies

Source: Schipper, 2006

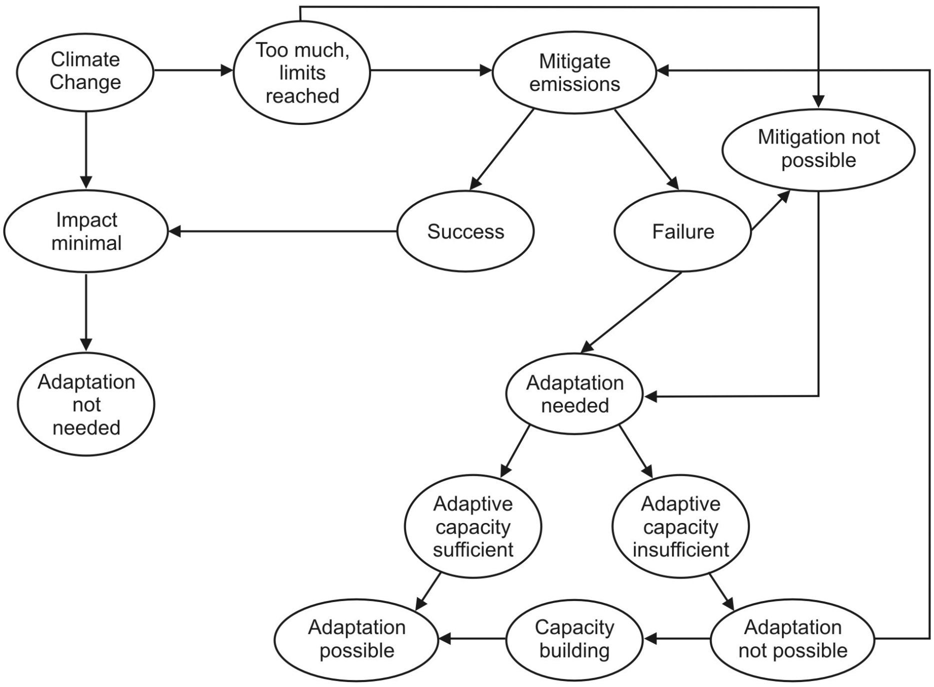


Fig. 4.1 Pathways for responding to climate change. *Source:* Schipper, 2006

Thus, undoubtedly, one reason for increasing interest in adaptation to climate change relates to the global discussions on its role as an alternative to mitigation, although this issue is sometimes framed as whether adaptation can substitute for mitigation and provide more 'breathing space' for global emissions trajectories, rather than in placing risk management as central to the global problematic and recognizing the joint determinants of the ability to adapt and to mitigate (Adger *et al.*, 2005). A second reason for increasing interest in adaptation, as these authors see, lies in the reality that adaptation is occurring today. Decisions are being made about how to adapt to current changes in climate – from premiums by insurance companies to decisions to engineer buildings. The imperative to adapt has already been recognized by rich countries, and many are investing heavily in the development of climate defense infrastructures. For example, the UK is spending US$1.2 billion annually on flood defenses; in the Netherlands people are investing in homes that can float on water (UNDP, 2007a). The adaptation decisions and processes often proceed even without explicit recognition that the faced changes in weather variability are consistent with or attributable to human induced climate change.

Again, adaptation is unavoidable. This conclusion, which for the first time was made by Martin Parry with colleagues in 1998[2], has received the heaviest recognition in IPCC AR4 (IPCC, 2007). Evidence from this assessment indicates that the problem is bigger than we thought, and, squaring up to reality, Parry *et al.* (2008) caution against a curious

[2] Parry, M., N. Arnell, M. Hulme, R. Nicholls and M. Livermore, 1998: Adapting to the inevitable. *Nature*, **395**: 741

optimism — the belief that one can find a way to fully avoid all serious climate change threats. The sooner humankind recognizes this delusion, confronts the challenge and implements both stringent emissions cuts and major adaptation efforts, the less the damage that we have to live with will be. Even with an 80% emissions cut, damages will be large, and any impact that occurs below a temperature rise of 1°C is likely to be unavoidable, even under the most stringent mitigative action. Residual damage will be great unless we invest in adaptation now, and although much of the damage could be avoided by adaptation, this would require a much larger effort than is currently planned.

It would be a good thing to finish this discourse by Parry *et al.* (2008, p. 69–70) commentary: *"We now have the knowledge to make a more informed choice regarding the optimal balance between mitigation and adaptation, and we know that immediate investment in adaptation will be essential to buffer the worst impacts. This does not mean that mitigation can be delayed, but quite the opposite: the longer we delay mitigation, the more likely it is that global change will exceed our capacity to adapt"*. "For the first half of the 21st Century there is no alternative to adaptation to climate change", – UNDP (2007a) echoes. If the first stage of the international climate effort was focused predominantly on reducing GHG emissions to prevent dangerous climate change, the next stages require effort to deal squarely with coping with those impacts that cannot be avoided. It also may be a condition for further progress on mitigation. New mitigation commitments may be politically feasible only if accompanied by stronger support for adaptation because any ambitious mitigation efforts can only lessen, but not prevent, future climate change (Burton *et al.*, 2006).

Thus, "…within the policy context of negotiations and the UNFCCC, adaptation has gone from being understood as a spontaneous adjustment that would determine the limits of how much climate change could be tolerated, and hence how much mitigation was necessary, to being seen as a fundamental policy strategy to promote the attainment of sustainable development", – Schipper (2006, p. 91) summed. "…the question is simply whether capacity is sufficient to undertake the necessary adaptation" (*ibid*, p. 86). In both areas of concern – effective adaptation decision-making and global mitigation response – issues of future adaptation, its social and institutional organization as well as technical and social limits are critical.

4.1.3 Nexus of adaptation and mitigation: links and distinctions

In spite of a common agreement on the importance of both adaptation and mitigation, there is still much uncertainty about how they can be combined successfully in policy measures (Winne *et al.*, 2005). Numerous opportunities exist to integrate adaptation and mitigation into broader development strategies and policies, and policy makers express an interest in exploring interrelationships between the two responses as well as the need to explore trade-offs and synergies between them. Such researches are faced with an array of questions that are raised and partly disputable in AR4 (Klein *et al.*, 2007). Whereas a wide discourse on this issue is outside the objectives of this book, some themes will be highlighted here as being of certain interest.

The general relationships between climate change, mitigation and adaptation were illustrated diagrammatically in the IPCC TAR (Fig. 4.2). Such a representation is

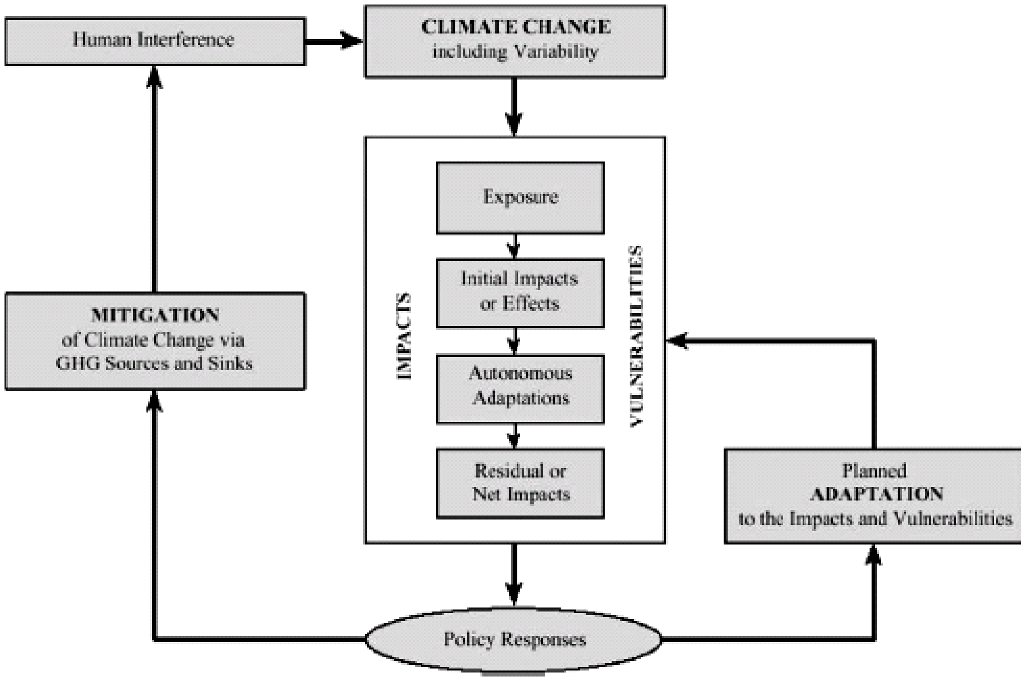


Fig. 4.2 Mitigation and adaptation responses to climate change. *Source:* IPCC, 2001

important in conceptualizing the problem, identifying important feedbacks, and communicating between disciplines (Barker, 2003). A growing interest in developing synergies between mitigation and adaptation is supported by considering it as a cross-cutting issue in the IPCC AR4 (IPCC, 2007a).

Schipper (2006), resuming numerous works, suggests that since 2002 a complementary approach between adaptation and mitigation has gained support; she also acknowledges that they are not alternatives, but rather ‘two sides of one coin’, or the ‘balanced portfolio of responses’. Adaptation has greater prominence on the political and research agendas, and there is no longer any need to justify its importance now.

However, the approach to adaptation needs, in principle, to be different from the way mitigation has been handled. These issues are very different: mitigation represents activities to *protect nature from society*, while adaptation constitutes ways of *protecting society from nature* (Stehr and Storch, 2005). In other words, while mitigation focuses on the *source* of climate change or seeks to reduce the principal cause of the problem, adaptation addresses its *consequences* or seeks to protect from the impacts of the problem. In the words of Swart and Raes (2007, p. 289), “mitigation aims at reducing the climate change effect; adaptation aims at reducing vulnerability to these effects”. In this ‘cooperation’, the relationship between adaptation and mitigation is such that, theoretically, the more mitigation takes place, the less adaptation will be needed, and *vice versa,* less effort on mitigation will imply a greater effort on adaptation over the long term. Thus, at an aggregate level, mitigation and adaptation can be viewed as being partial substitutes for each other (Berkhout, 2005). The diagram in Fig. 4.3, borrowed from IPCC

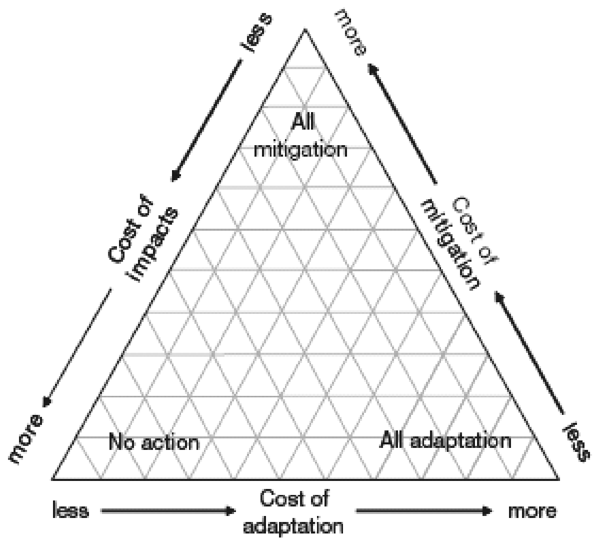


Fig 4.3 A schematic overview of inter-relationships between adaptation, mitigation and impacts, based on Holdridge's life-zone classification scheme. *Source:* Klein *et al.,* 2007

AR4, confirms this statement: the greater the effectiveness of adaptation in reducing vulnerability to climate change, the less the urgency to reduce GHG emissions. Adaptation cannot prevent economic and other losses from climate change, but it can reduce and delay them. Both adaptation and mitigation efforts determine the level of climate-change impacts, and whether or not this level is dangerous (Smith *et al.*, 2001). Thus, adaptation can be seen as direct damage prevention, while mitigation would be an indirect one.

The potential for developing synergies between climate change mitigation and adaptation has become a recent focus of both climate research and policy. Strategically, it is clear that mitigation and adaptation are bound together, at least over the long term. Presumably this interest in synergies springs from the appeal of creating win–win situations by implementing a single climate policy option. Identifying different synergies where adaptation results also in mitigation, and *vice versa,* might be an effective way of promoting new responses. This leads one to consider the potential for synergies between the *practical implementation* of adaptation and mitigation. Many opportunities for synergies exist and these need to be exploited. However, institutional complexity, insufficient opportunities and uncertainty surrounding mitigation and adaptation present major challenges to this widespread synergies development (Klein *et al*. 2005; Tschakert and Olsson, 2005).

While there are many opportunities for linkages between mitigation and adaptation actions, it is also recognized that some basic features of the two are divergent, and the 'problem structure' of adaptation appears significantly different from that of mitigation (Berkhout, 2005). Hypnotically, adaptation and mitigation are policy-substitutes or policy-partners because both reduce the impacts of climate change. As such, they should be analyzed together. However, analysis of the trade-offs between adaptation and mitigation is hampered by a number of fundamental differences between two sets of response strategies. The most prominent response strategies are distinguished by their *nature, focusing* and *limits*, *temporal* and *spatial scales, associated costs* and *benefits*, the *types of actors* and *policies involved,* and *where the measures are implemented* (Biesbroek *et al.,* 2009; Klein *et al.,* 2007; Tol, 2005; Wilbanks, 2004). In brief, these linkages can be reduced to the following:

a) ***Geographical patterns of the effects.*** In addition to the problems, which are addressed by adaptation and mitigation, the sectoral focus of their responses is different: mitigation focuses on GHG emitters and sinks; adaptation focuses on sectors and activities sensitive to climate impacts. The scale at which responses to climate change might take place is one of their central differences (Adger *et al.,* 2005; Klein *et al.,* 2007). There are diverse ways in which adaptation and mitigation are related at different governance levels of decision-making, and these relationships exist within and across each of these levels – from individual households, farmers or private firms to national planning agencies and international agreements. Thus, in order to be effective, the geographic scope of mitigation activities must be global because any effective mitigation requires the participation of major greenhouse-gas emitters globally, and the climate benefits of mitigation are global. By contrast, the services, provided by adaptation measures, can take place at a number of scales, from local to global, addressing climate-related problems at any of these particular levels and making use of capacities available to that group of factors. Typically, adaptation works on the scale of an impacted system, which is regional at best, but mostly is local. Its costs and ancillary benefits accrue locally and nationally, although some adaptations might result in spillovers across national boundaries. As an exception, Tol (2005) names facilitative adaptation (enhancing adaptive capacity) that like mitigation requires long-term policies. Facilitative adaptation and mitigation not only both reduce impacts, but also compete for resources. Additionally, money spent on mitigation contributes to a global public good with few tangible effects here and now, while money spent on adaptation is restricted to only a local good, with important tangible local effects for specific beneficiary groups (Tschakert and Olsson, 2005).

b) ***Temporal dimension.*** The difference in temporal dimension between mitigation and adaptation is conditioned by the effectiveness of measures over time and in the timing of efforts. In general, adaptive measures are short-term investments with short-term solutions to the impact of climate change and natural variability, whilst mitigation strategies are short-term investments for long-term climate results (Goklany, 2007). The numerical findings of de Bruin *et al.* (2009) show that adaptation is a powerful option to combat climate change, as it reduces most of the potential costs of climate change in an earlier time period, while mitigation does so in a later time period. In addition, the nature of adaptation and mitigation decisions may change over time influenced by, for example, technological development, innovation, and scientific progress.

c) ***Cost and benefits of response measures.*** Berkhout (2005), considering the rationales for adaptation in EU climate change policies, notes that part of the justification by some countries for not incurring high mitigation costs in the short term draws on the expectation that adaptation costs in the medium and long term will be lower. This expectation is based on the 'optimistic' assumptions that overall welfare will have improved with economic growth, and technological and institutional change over time will make adaptation relatively easier and cheaper. On the contrary, one of the arguments for accepting the costs of substantial mitigation efforts in the short term is based on the recognized uncertainty that exists around the costs of adaptation to more rapid and damaging climatic change. Summarizing different views, Berkhout structured them into three premises, which with some additions from other works are as follows:

1. First, while mitigation will mostly bring 'common good' benefits and typically at an international level, the benefits of adaptation actions will often be private or localized. For example, mitigation investments in renewable power generation capacity will contribute to lower GHGs concentrations over the long term, with gains in terms of

reduced global climate change. Adaptation investments, for example, in new defensive flood or sea level infrastructures, will bring benefits only to directly protected settlements. Therefore, many adaptation actions at a more local scale will be implemented because they are expected to generate private benefits.

2. The benefits of mitigation activities will not be immediately evident, just as the full effects of current GHG emissions will not be experienced, as was more than once mentioned, for many years due to the inertia in the global climate system and the long residence time of GHGs in the atmosphere. On the contrary, adaptation measures, since they may be in response to already experienced changes in climate and depend on the type of services they provide, would yield benefits (both intended and ancillary) that may become apparent by those bearing the costs over the short run. The time-profiles of mitigation and adaptation are therefore likely to be often difficult to reconcile. Mitigation is also slow due to lags in the implementation of effective policies, including delays in the entry into force of the Kyoto framework for emissions reductions. On the other hand, the results of adaptation efforts will have near-term visibility because of strong links with development initiatives (Schipper, 2006).
3. Because mitigation can be achieved through technological as well as behavioral means, the *measure of effectiveness* is unitary – lower GHG emissions. The emission reductions obtained through mitigation options are expressed as CO_2-equivalents, and cost-effectiveness *vis-à-vis* other mitigation options and associated implementation costs can be determined. In the case of adaptation, however, it gets more complex since the benefits are the reduction in climate-related damage costs for both natural and human systems by undertaking adaptation measures. Reduced vulnerability (or greater resilience) will tend to be multidimensional and usually hard to measure at local or broader scales (Adger *et al.*, 2005). Also, local/regional nature of adaptation implementation signifies that benefits will be largely valued based on political, ecological, cultural, and behavioral contexts.

d) ***Actors and policies.*** Mitigation is concerned with the relatively more bounded problem of emissions, and the focus of its activities has been primarily in the energy, transportation, forestry, and agricultural sectors. These sectors are usually and comparatively well organized and closely linked with national planning and policy-making. In contrast, adaptation is concerned with multiple adjustments related to numerous direct and indirect interactions between climate and human activities or natural ecosystems services. Adaptation involves the interests of numerous actors – agriculture, urban planning, water supply, tourism and recreation, human health, etc. – and is occurring in a number of different sectors and systems, many of which are not substantial contributors to GHG emissions. Albeit all these sectors are potentially impacted, the decisions whether to adapt or not are taken at different levels, ranging from individual farmers to national planning services. For most, climate change is not an immediate concern. Early research on adaptation show that the assessment of climate vulnerability, as with many risk assessments, can often be an open-ended process involving many aspects of individual and organizational activities (Berkhout *et al.*, 2004). Thus, enforcement of mitigation, treated as "*facilitating the coordination for reduction of emission"* (Anantram and Noronha, 2005), is easier in comparison with ensuring the adoption of adaptation measures that are likely to intrude in the lives of millions of people and require careful multilayered assessments. Wilbanks (2004), considering mitigation and adaptation as parts of an integrated portfolio of strategies, policies and actions, sees one more complexity of adaptation as to mitigation in the fact that it can be both anticipatory and reactive, depending often on a mosaic of local circumstances, while mitigation is always anticipatory.

Because for several years the research community and policy makers have used different research strategies and political agendas on mitigation and adaptation, leading to highly specialized knowledge development, the two approaches to confront climate change have involved different types of stakeholders, each of which have specific desires and capacities.

Table 4.3 Differences and similarities between adaptation and mitigation

	Mitigation		*Adaptation*	
Issue	Dominant factor	Examples of exception	Dominant factor	Examples of exception
		Differences		
Causes/effect	Primary addresses causes	Urban design with low energy requirements and low vulnerability	Primary addresses consequences	Drought-resistant biofuels can address vulnerability and emissions
Spatial scale	Main objective: avoiding global changes	Cost-benefits for short-term local air pollution, energy security, jobs	Main objective: local damage avoidance	Adaptation of farmers may have global consequences
Sectors	Mainly energy, transport, building and industry sectors	Mitigation options also available in water and land management	Mainly urban planning, water, agriculture, health, coastal zones	Renewable energy solutions can be vulnerable
Time scale	Long-term benefits from avoided climate change	Co-benefits for short-term local pollution, energy security, jobs	Often short-term benefit due to reducing vulnerability to current climate	Preparing for long-term impacts
Beneficiaries	Mainly benefits others *(altruistic)*	Co-benefits for mitigating actors, local air pollution, energy security, jobs	Mainly benefits those who implement it *(egoistic)*	Some adaptation may have wider benefits
Incentives	Usually incentive needed	No-regret options (e.g., energy efficiency)	Often incentives not needed	Anticipatory actors without immediate benefits may need incentives
Urgency	Lower political urgency/legitimacy	Short-term co-benefits, local air pollution, energy security, jobs, enhance urgency	Higher political urgency/legitimacy	Proactive adaptation with high costs and uncertain effect can have low urgency
		Similarities		
Goal	Aiming at reduction of climate change risks			
Benefits	Having ancillary benefits that may be as important as the climate related benefits			
Drivers	Driven by availability/penetration of new technology & societal ability to change			

Source: Adapted from Swart and Raes (2007)

e) ***Difference in and between administrative scales*** that follows from the previous thesis (Füssel, 2007; Klein *et al.*, 2007). Adaptation measures are generally local whilst mitigation is predominantly (inter)nationally orientated (Klein *et al.*, 2007; Schipper, 2006; Wilbanks *et al.,* 2007). It is challenging to coordinate mitigative and adaptive measures with other sectors and disciplines *(horizontal)*, other scales *(vertical)* and between different sectors and disciplines at different scales *(diagonal)* (Biesbroek *et al.,* 2009).

Swart and Raes (2007) who presented their vision of differences and similarities between the two policies (Table 4.3) also added that, while the determinants of adaptive and mitigative capacity are overlapping and mutually supportive, they differ in application.

4.1.4 Integration of adaptation and mitigation policies

Climate change matters to policymaking only if its potential ultimate damages are expected to be significant, i.e. only if the expected business-as-usual scenario with climate change differs markedly from the expected laissez-faire scenario without climate change. A converging set of data and projections suggest that such significant difference is in fact likely (IPCC 2007a, 2007b). Shalizi and Lecocq (2009) use the term '*ultimate damages*' when referring to damages that would be incurred in the absence of any policies—even if some private adaptation is implemented—and *'residual ultimate damages'* to those ones that remain after all mitigation and adaptation expenditures have been incurred because they are technically irreversible (for example, lost species) or economically irreversible, that is, reversibility may be feasible technically, but is considered too costly, for example, the full restoration of the Aral Sea. Further, these authors distinguish four main options for reducing the ultimate damages of climate change: mitigation (*ex ante*), proactive adaptation *(ex ante)*, reactive adaptation *(ex post)*, and accepting residual damages. As mitigation and adaptation are not perfect substitutes for each other, "an integrated portfolio of actions that encompasses simultaneously some mitigation actions, some proactive adaptation actions, some reactive adaptation actions, and explicit acceptance of residual damages will be superior to any individual type of action alone in minimizing the total climate bill. Because of the inertia in the climate system, there will always be a lag between *ex ante* actions and their effects, so one needs to schedule *ex ante* actions well in advance. This implies that a portfolio of action is needed at any given moment in time", – Shalizi and Lecocq (2009, p. 10) concluded.

An increasingly dominant perspective that adaptation is not an alternative to mitigation, but presents a necessary objective, should be supported by explicit adaptation policy, on par with mitigation. However, despite the higher scientific and political profile given to climate change adaptation in recent years, most policy discussions and dialogues continue to focus disproportionately on the new mitigation commitments. This situation for selected Asian countries, expressed as the pages coverage of adaptation and mitigation policies and measures in the National Communications to UNFCCC, was examined by Srinivasan (2006). Analogous comparison for FSU countries is shown in Table 4.4.

Table 4.4 Coverage of adaptation and mitigation policies and measures (strategy) as reflected by number of pages in the FSU countries' National Communications

Country and *No* of Communication	Number of pages						
	Total	*Mitigation*			*Adaptation*		
		Total	GG inventory	Strategy	Total	Impacts and vulnerability	Strategy
Armenia, *first*	57	21	8	13	21	16	5
Azerbaijan, *first*	88	21	12	9	15	13	2
Belarus, *second-fourth*	131	50	27	23	31	~20	
Estonia, *fourth*	168	87	47	40	2	15	
Georgia, *first*	137	39	20	9	48	32	4
Kazakhstan, *first*	75	26	12	14	12	4	4
Kyrgyzstan, first	98	19	11	8	20	10	3
Latvia, *fourth*	162	96	40	56	6	3	
Lithuania, *fourth*	117	39	15	24	15	12	3
Moldova, *first*	86	26	18	8	13	11	2
Russia, *fourth*	164	34	21	13	10	10	
Russia, *Progress Report*	56	36	5	31	6	6	
Tajikistan, *first*	112	30	25	5	27	23	4
Turkmenistan, *first*	89	27	20	7	20	4	10
Ukraine, *second*	83	43	13	14	4	2	
Uzbekistan, *first*	120	52	23	15	14	10	4

Implementation of the UNFCCC's adaptation commitments and provisions, in the opinion of Yamin (2005), has been impeded by different procedural and political complications, along with some objective factors, for example, by limited institutional capacity to undertake vulnerability assessments and adaptation planning. In particular, international discussions about the balance between mitigation and adaptation, and the role of adaptation in reducing vulnerability to existing climate variability and non-climatic risks have been constrained by the fragmentation of policy due to the lack of a single COPs' agenda item to address these issues. Global climate policies have traditionally focused either on adaptation or on mitigation, without considering potential links. Nevertheless, as Yamin suggests, because adaptation will be a major concern for all developing countries for decades to come (we are sure that for transition countries as well), it should be a core issue in the policy discussions. A deeper focus on adaptation provides better balance in the adaptation-mitigation nexus, while fusing adaptation and mitigation debates may considerably influence future policy responses.

There are various reasons to make *integrated* adaptation and mitigation policie*s* more attractive. First of all, many climate policy options might have significant impacts both on adaptation and mitigation. It is also important to recognize that combining adaptation and mitigation perspectives makes participation in international climate cooperation much more attractive for transition and developing countries (Halsnæs and Shukla, 2007). There is also a growing recognition that development through its common determinant of mitigative and adaptive capacities can be a framework for integrated policies. Further building up of these capacities can be an important element in meeting countries' demand for supportive measures to adaptation. The introduction of the twin concepts of 'adaptive' and 'mitigative' capacity is considered as a novelty (Schipper, 2006).

Biesbroek *et al.* (2009) believe that in order to formulate effective measures, such integrated response is desirable which leaves little room for strict dichotomies between mitigation and adaptation. They argue that "the dichotomy is mainly constructed in the minds of politicians and scientists, and is strengthened by the traditionally different ways in which knowledge is produced, and the different approaches and strategies that are used" (p. 231). In turn, Swart and Raes (2007) suggested five pragmatic ways of broadening climate policy, while taking into account the linkages between adaptation and mitigation: (1) *avoiding trade-offs* when designing both policies (2) *identifying synergies*, (3) *enhancing response capacity*, (4) *developing institutional links*, e.g., in national institutions and in international negotiations, and (5) *mainstreaming* adaptation and mitigation considerations into broader sustainable development policies.

Different studies have proposed the policy frameworks for harmonizing climate change mitigation and adaptation responses (Burton *et al.*, 2002; Halsnæs and Shukla, 2007; Klein *et al.*, 2007; Srinivasan, 2006; Wilbanks, 2004). They show that besides general relationships between two sets of response strategies, the mitigation or adaptation may interact with each other in *action-specific* ways, in some cases offering alternatives, but also possibly reinforcing each other. In either case, they both relate complexly to different aspects of sustainable development choices. Significant conjoint adaptation and mitigation opportunities, whose benefits can be realized by integrated policies and actions, exist in land-use, protection of biodiversity and watershed, soil conservation, water and energy sectors. For example, in the forestry sector opportunities for linking mitigation and adaptation exist through their sustainable management in af(re)forestation projects, agro-forestry, forest protection and conservation. Joint adaptation and mitigation policies accrue developmental benefits. *"Novel attempts to create synergies between mitigation and adaptation policies and to integrate climate change measures and policies more efficiently into sectoral decision-making and development planning ('mainstreaming') have considerably transformed the climate change – sustainable development debate"*, – Schipper (2006, p. 338) states. The debate has shifted, as is shown in Chapter 5, from seeing sustainable development as a simple add-on, or even competitor to climate change, to a 'development-first approach' – a broader focus on development with climate mitigation and adaptation, and other environmental goals as desirable ancillary benefits.

Schipper also suggests that an 'optimal mix' of adaptation and mitigation could exist in the context of discussions on the ***costs*** of optimization of adaptation and mitigation measures. The goal would be to assess how a country or organization could best invest money, but also to identify individual projects that would contribute to both adaptation and mitigation components. Such solutions would have an extra advantage of being eligible for funding under both mechanisms. Certain policy measures may already fall under the category of both, for example, agriculture projects with a focus on adaptation, which include carbon sequestration components. In part, this moment is the focus of Wilbanks (2004) who states that progress with either adaptation or mitigation reduces payoffs from investment in the other. Mitigation targets and adaptation potentials are related: if the fundamental objective of climate change policy is to limit impact costs rather than to limit atmospheric concentrations, then a highly adaptive world can live with a higher stabilization level if necessary. Adaptation can cope, at least to a considerable degree, with many impact costs at a moderate rate and level of climate change but not at the more massive ones. On the other hand, if mitigation can be successful in keeping impacts at a lower level, adaptation can be successful in coping with more of the resulting impacts.

Investment in mitigation will provide high returns for ***human development*** in the second half of the 21st Century, reducing exposure to climate risks for vulnerable populations (UNDP, 2007a). It also offers insurance against catastrophic risks for later generations, regardless of their wealth and location. International cooperation on adaptation is the second part of the climate change cost-benefits and insurance strategy. It represents an investment in risk reduction for millions of the world's most vulnerable people. While the world's poor cannot adapt their way out of dangerous climate change, the impacts of global warming can be diminished through good policies. Adaptation actions taken in advance can reduce the risks and limit the human development damage caused by climate change.

And, at last, adaptation policies are both more complex and less well-understood than mitigation policies. Wilbanks (2004) sees the causes of this situation in the following factors:

- Attention to adaptation was discouraged for decades because it might reduce the urgency of mitigation;
- Adaptation can include both anticipatory and reactive actions, unlike mitigation, which must be anticipatory by definition;
- Valuations of adaptation costs and benefits tend to be very place- or context-specific;
- Potential of adaptation is much clearer than costs, unlike mitigation where costs have often received more attention than potentials.

Thus, adaptation cannot be treated in the same way as mitigation. Adaptation thinking needs to be sensitive to the fact that vulnerability is different at different levels and for different actors, and that climate change impacts are closely interlinked with development issues. Adaptation needs to be viewed through a gender and equity lens, and the collective action and responses is the key to resilience (Anantram and Noronha, 2005). The increasing calls for research to define the optimal mix of mitigation and adaptation options are based on the misguided assumption that there is one single optimal mix of these options for all possible scenarios of climate and socio-economic change, notwithstanding uncertainty and irrespective of the diversity of values and preferences in society. In the face of current uncertainty, Klein *et al.* (2005) raised three research questions:

- To provide guidance on how to develop a socially and economically justifiable mix of mitigation, adaptation and development policy, as well as on which elements would be part of such a mix;
- To establish the conditions under which the process of mainstreaming can be most effective. Rather than actually developing and implementing specific mitigation and adaptation options, the objective of climate policy should be to facilitate such development and implementation as part of sectoral policies;
- To focus on the optimal use and expected effectiveness of financial instruments, taking into account the mutual effects between these instruments, on the one hand, and national and international sectoral investments and official development assistance, on the other.

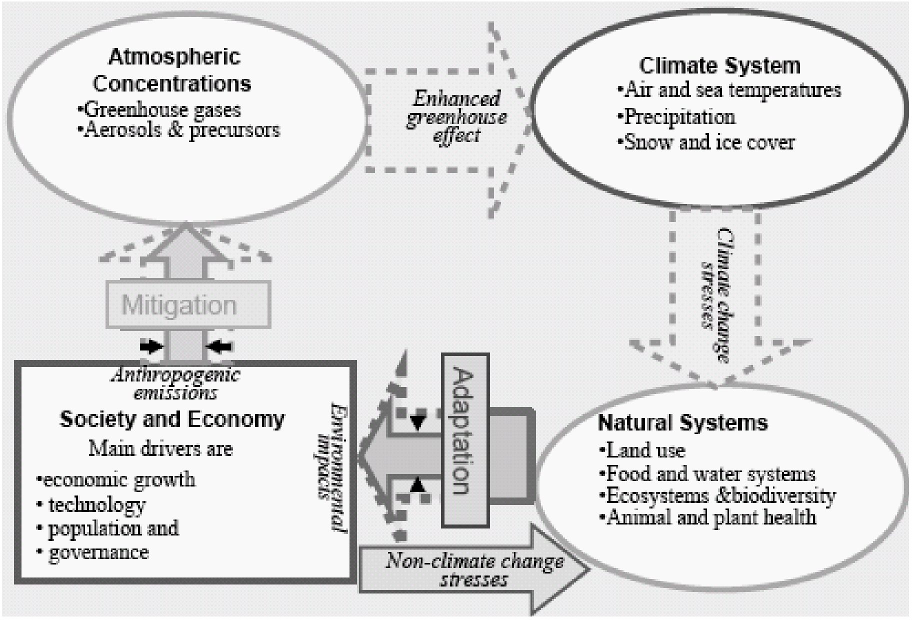


Fig. 4.4 Integrated assessment framework for considering climate change with adaptation and mitigation. *Source:* Barker, 2003

As one example of integrated mitigation-adaptation research, we would like to present the integrated assessment framework (Fig. 4.4), proposed by Barker (2003). His approach was developed through focusing on *stocks* and *flows* in interacting systems, with adaptation and mitigation measures affecting certain flows. Each system or domain in the framework contains complex interactions and feedbacks, with the possibility of extreme events, critical thresholds and shocks. The arrows show the main ways in which the systems affect one another in a clockwise flow. However, we have no intention of discussing or commenting on this framework here. It is presented only to show the inexhaustibility of the adaptation-mitigation discourse.

Yohe *et al.* (2006) offered suggestive illustrations of potential synergies within the adaptation/mitigation portfolio, i.e. complementarity in the economic sense that one makes the other more productive. As it has already been mentioned in this book, they found that all countries will be vulnerable to climate change, even if their adaptive capacities are enhanced. Developing nations are most vulnerable to modest climate change, and reducing GHG emissions would diminish their vulnerabilities significantly. For moderate climate change, developed countries would benefit most from mitigation, while extreme climate change overwhelms the abilities of all countries to adapt.

Finally, the integration of adaptation and mitigation will have advantages over other approaches if causes and impacts of climate are addressed in close coordination and coherence with other approaches and policy domains. For example, Biesbroek *et al.* (2009) discuss addressing the relationship between climate change responses and spatial planning, considering it as a switchboard for mitigation, adaptation and sustainable development objectives (Box 4.2).

Box 4.2 The river basin approach for integrating mitigation and adaptation of water resources

In line with the general concept of the ecosystems approach, water management tries to integrate the land, water and living resources objectives and promotes sustainable use of water resources. The impact of climate change on water will have great effects both on socio-economic and biogeophysical processes and have to be addressed in an integrated manner, including coordination and coherence between mitigation and adaptation. The following are reasons why this coordination at the river basin scale can have an added value for dealing with climate change:

- Water management contribute to both mitigation (e.g., hydropower) and adaptation (e.g., water retention);
- Holistic approaches stimulate trans-disciplinary research and policy making; as a result, there is no dichotomy of mitigation and adaptation, and only practices will determine if integrated responses between them are relevant;
- The river basin approach allows assessing a possible synergies and trade-offs of mitigative and adaptive measures in an integrated manner;
- Climate change as captured in a river basin approach forces local decision makers to broaden the context of their planning and investment decisions;
- Adaptation and mitigation strategies can be integrated more easily into the (local) planning process;
- The river basin approach can have an added value to reduce the impacts of climate change and overcome the negative effects of the dichotomy between mitigation and adaptation.

In order to utilize the full response capacities of mitigation and adaptation measures in water resource management, socio-economic processes such as technological development, knowledge production and economic development should be included.

Source: Biesbroek *et al.*, 2009

4.2 International efforts in confronting climate change within environmental impact assessment

4.2.1 Rationale for collective actions

Biesbroek *et al*. (2009) compare developing coherent climate change policies with "…a complex puzzle of coordinating institutions, developing policy strategies and searching for feasible conceptual frameworks, from the international to the local level, to mainstream climate policy into sectoral and cross-sectoral policies" (p. 231). Here, Young (2002) identifies two dimensions of cooperation: *horizontal interplay* or the relationship between policies at the same level of governance, e.g., international, European, national, subnational, etc.), and *vertical interplay* or interaction between policies located at different spatial scales of governance. The vertical interplay determines the transition from strategic objectives to concrete solutions. Each tier has its own policy architecture of objectives and strategies; it also places climate policy in new political and cultural contexts.

The last three decades have seen an increasing importance of multinational and global environmental problems for the policy agenda and of the international agreements to manage them. The transboundary qualities of these problems motivate all to cooperate because each party benefits from a successful solution. Active participation in the agreements is stimulated by a desire to improve the environment for domestic as well as international benefit. The lack of participation of any country can reduce or negate the ability of the others to solve the global problem. As a result, "environmentalists have long championed the idea to think globally, act locally…Deciphering the differing needs of global and local problems in terms of both responses and incentive structures is a current challenge to the sustainable development community" (Hale and Mauzerall, 2004, p. 220).

Wilson (1973)[3] distinguished three types of reward for acting collectively: material (economic), solidary (social) and purposive (doing the right things). That is why collective actions have been of interest to both economists and sociologists, although in the opinion of Harrison and Easton (2002, p. 145) "there is no general theory of collective action, rather a number of models and concepts". In general terms, the answer to a question '*Why does it take place in the context of international environmental issues?*' is seen in certain driving forces that can lead to collective action under certain conditions. So, Olson (1965)[4] assumed that the primary reason for collective action is to produce public goods whose key aspect is that they are *non-excludable,* i.e. all participants must have access to them.

Addressing climate change is both the problem of the provision of a global common good ('tragedy of the commons'), and the 'free-riding'.

We would remind that '*tragedy of the common'* is a type of social traps, often economic, that involves a conflict over finite resources between individual interests and the common good. This allegory derives from the medieval right of private individuals to graze animals (as many as possible) on common land. But if all owners behave similarly, the result is over-grazing and, ultimately, the destruction of the common land – the evident parallel with over-use of the atmosphere's capacity to absorb carbon (Llewellyn, 2007).

The '*free-rider"* problem arises because some individuals can obtain the benefits of a public good without contributing to its production. Given the possibility of free riding, no rational actor would join a collective action until he is sure that the personal costs of contributing to a public good would not exceed his benefit. In this situation, actors wishing to use a common but finite resource will always tend to want to consume more, at the expense of others, thus leading to a vicious circle (Harrison and Easton, 2002). Again, the parallel with international agreements to limit emissions is clear. The immediate consequence of free-riding is over-exploitation of the common good that in the case of climate change mitigation would mean a sub-optimal level of emissions reduction.

The costs that a party might incur as a result of collective action can be considered in the terms of a *cost–benefit* approach. Llewellyn (2007) presented an example of pay-offs for two countries that have to decide whether or not to cooperate (Table 4.5). The calculations were based on the following assumptions. The cost (damage from climate change) of doing nothing is taken to be -3 for each country; the cost of implementing the optimal policy is -12. The benefit from implementing the policy is +8 if one country acts alone, but +16 if both countries act in concert. Hence, if only one country cooperates, its pay-off is (-12+8) = -4, while the pay-off for the other not-cooperating country is a net benefit of +8 (0+8). If both countries cooperate, each has a net gain of (-12+2*8) = +4.

[3] Wilson J., 1973. *Political Organizations*. *Basic.* New York

[4] Olson M., 1965. *The Logic of Collective Action*. Harvard University Press: Cambridge, MA

Table 4.5 Cooperation vs. non-cooperation: pay-offs for two countries

Country A/Country B	*Cooperation*	*Non-cooperation*
Cooperation	+4/+4	-4/+8
Non-cooperation	+8/-4	-3/+3

Source: Llewellyn, 2007

Thus, if a country judges that the other will cooperate, its optimal strategy is to not cooperate, and thereby free-ride on the benefits of the others' action. The equilibrium (-3/+3) therefore is for the countries not to cooperate, which is not optimal. However, in a multi-round exercise, it is generally not in the interests of participants to cheat for very long lest they be excluded from participating in international treaties and agreements.

A climate-smart world is within a reach if we will (World Bank, 2010):

Act now, because of the tremendous inertia in both climate and socioeconomic systems. *Inertia means that today's actions will determine tomorrow's options.*

Act together (or globally) for equity and efficiency; it is also essential to keep costs down and facilitate adaptation, notably through better risk management and safety nets to protect the most vulnerable.

Act differently, because a climate-smart world requires a transformation of energy, food production, and risk management systems. Rather than being optimally adapted to the climate of the past, decisions will have to be robust to the variety of climate outcomes we could face in the future.

The nature of the climate change problem demands a coordinated approach among the world's countries. Governments resist to act alone to rein in their emissions, given that the rising GHG output in other countries could undermine their own potentially costly efforts (Baumert and Kete, 2002).

The effectiveness of international cooperation in the frames of environmental organizations can be assessed along three dimensions (Biermann and Bauer, 2004):

- the *output*, that is the actual activity of an organization;
- the *outcome*, that is the change in the behavior of societal actors (such as governments, nongovernmental lobbyist groups, scientists, the mass media, or individual actors); and
- the *impact* that changes in regard to policy targets, such as quantifiable improvements in the natural environment.

A main problem with the assessment of policy outcomes is the need to separate the influence of specific policies of the specific international environmental organization from the background noise of general political developments, such as economic or transitions changes. Additionally, some academics and policymakers argue that because national governments maintain their sovereignty when they establish international institutions, the design of policy architectures should focus on national and—in some cases—regional institutions. Top-down architectures, such as those based on multilateral agreements on targets and timetables, may not provide robust incentives for participation and compliance (Aldy and Stavins, 2008).

In this context, Biermann and Bauer (2004, p. 190) define *international environmental organizations* "…as agencies that have been set-up by national governments with some degree of permanence, that are beyond the formal control of national governments but are controlled by multilateral mechanisms through the collective of governments, and that serve environmental protection as a specific policy purpose". Thus, they distinguish international environmental organizations from *ad hoc* agencies, such as temporary conference secretariats, purely national agencies, transnational non-state actors, and so on. They also distinguish this term—a hierarchically organized group of international civil servants with a given mandate and resources within the context of a given policy area—from both international institutions and international regimes in political science, as well as from the term 'international organization' as it is used in international law. At the same time, the proposed definition covers the United Nations and its specialized agencies, as well as some of its semi-autonomous sub-bodies, such as treaty secretariats.

In recent decades the world has been very active in the creation of international regimes for environmental protection. As of the beginning of this century there were over 500 international treaties and other agreements related to the environment, of which over 320 were regional[5]. However, Runnalls (2008) consider as 'bad news' the situation that most of these agreements are supported by small secretariats with inadequate budgets, and none have effective compliance regimes, being cursed by a lack of accountability. Moreover, although these are legal agreements, most governments seem signed up to a whole series of commitments with little intent of honoring the majority of them.

International cooperation in climate protection is the most important – and the most challenging – between rich and poor countries. Industrialized countries are concerned that current lack of emission control commitments for developing countries leads to a lack of environmental effectiveness. This concern is due to rising GHG emissions in some developing countries (first of all, in China and India) as well as the possibility that, given the asymmetric emission control commitments, energy-intensive industries might migrate to countries where emissions are unconstrained (Baumert and Kete, 2002). Industrialized countries also argue that while they have made commitments under UNFCCC and the Kyoto Protocol to curb their GHG emissions and provide financial assistance to developing countries, there is a small promise of future action from the developing world. For their part, many developing countries believe that industrialized countries lack credibility on the issue of international cooperation to curb GHG emissions, having done little to address a problem they largely have caused.

Disparities in emissions also reflect an uneven distribution of energy resources when some countries depend on coal, whereas others rely on less carbon-intensive energy sources, such as natural gas or hydropower. Based on these discourses, all countries agreed formally that the first round of the Kyoto Protocol, legally binding emission controls, should not include developing countries, reflecting an understanding that the wealthier countries have greater financial resources and technological capability to put them on a sustainable course, while developing countries face more urgent priorities, such as poverty alleviation and public health.

Nevertheless, despite differences in the roles in the climate change problem's history, the current disparities are not the largest barrier to cooperation. Baumert and Kete (2002) tried to explain what could constitute a more potent obstacle in the enduring and growing

---

[5] UNEP, 2001: *International Environmental Governance: Multilateral Environmental Agreements*: *Full version.* UNEP/IGM/1/INF/3_MEA_Add. Available at: ***http://www.unep.org/ieg/Meetings_docs/index.asp***

lack of trust. Industrialized countries have legitimate concerns that developing countries never come into a climate protection regime or may commit only to limit their emissions at some remote future date. GHG emissions are intimately linked to essential aspects of economic development, and addressing climate change for the developing and transition world is more an issue of basic economic development than urgent environmental protection.

Llewellyn (2007) emphasizes the role of international diplomacy and negotiation in the design a policy that is capable of producing an optimal outcome in the interests of all countries taken together and to provide a credible punishment for any participant who tries to be a free rider. Typically, such international cooperation occurs when five conditions have been met:

- ☑ *The proposed policy is in the perceived national interest of the countries in question;*
- ☑ *There is a common recognition the solution has to be international to avoid the problem of free-riding;*
- ☑ *Each country knows that no gains can be expected from free-riding because if it does not participate, neither will the others;*
- ☑ *There is in existence a well designed and workable policy proposal; and*
- ☑ *A major country is committed to, and actively pushing, the policy.*

In 'summary', it would be correct to use the UNDP principle of "human solidarity in a divided world" (UNDP, 2007a). Under the UNFCCC broad 'umbrella' and call for international cooperation, rich countries are required to support developing and transition economies that are particularly vulnerable to the adverse effects of climate change by providing financial assistance in building their adaptive capacity. Urgency of international action is rooted in the ethical, social and economic implications of the world ecological interdependence where UNDP emphasizes four moments that merit special considerations:

1. *Shared values.* The true ethical test of any community lies not in its wealth but in how it treats its most vulnerable members. Whatever the motivation—a concern for the environment, religious values, secular humanism or human rights—action on climate change fighting is an ethical imperative for developed countries.
2. *The Millennium Development Goals.* With climate change already impacting on the lives of the poor, the enhanced adaptation is a requirement for supporting progress to the 2015 targets.
3. *Common interest.* Climate change has the potential for humanitarian disasters, ecological collapse and economic dislocation on a far greater scale than are seen today. No countries will be immune to the consequences. While already fragile states could collapse under the weight of growing poverty and social tensions, the mass environmental displacement, loss of livelihoods, rising hunger and water shortages have the potential to unleash national, regional and global security threats. In the interdependent world, climate change impacts will inevitably flow across national borders.
4. *Responsibility and liability.* If the environmental damages generated by climate change were neatly contained within one legal jurisdiction, those who had created the damage would be faced with a legal obligation to compensate the victims. That would place an obligation on rich countries not just to stop harmful practices (mitigation) but to compensate for damage (adaptation).

4.2.2 Convergence and diffusion of environmental policies

In a globalizing world, national environmental policies become increasingly interdependent. The policy choices of one country are more and more affected by those of the others. Nations tend to adopt similar environmental policy innovations[6] and initiatives that increasingly spread across nations, both industrialized and transition. Some policy innovations are adopted even on a global scale. As a consequence, the striking similarities in the development of domestic capacities for environmental protection can be observed across a wide range of countries, while the growing number of individual policy adoptions aggregates to a remarkable degree of cross-national ***environmental policy convergence*** (Busch and Jörgens, 2005; Tews, 2005). This empirical phenomenon evoked questions about the nature of the similarities, and *why* and *how* this process takes place. Environmental policy convergence occurs if a large group of countries collectively or individually (and not necessarily simultaneously) chooses to adopt a particular policy innovation, which is perceived to be the best (or at least the most frequently adopted) solution for the respective environmental problem (Jänicke, 2005).

Three distinct international mechanisms causing national policy change and cross-national policy convergence have been identified by scholars in comparative political science and international relations. In particular, some authors (Busch and Jörgens, 2005; Jörgens, 2005; Liefferink and Jordan, 2005) define the term 'national policy' based on its content (the paradigms and goals of action; the instruments and their precise setting; the institutional structures and dominant styles of interaction) and employ a triad – *diffusion, harmonization and imposition* – for developing a set of expectations to foster the convergence of national policies. Although cited works were mainly aimed at the convergence of national environmental policy in the EU, they have a more universal character and may be used in transition counties as well. The components of triad refer to:

- *Harmonization* – the deliberative and cooperative attempt by a particular set of countries to solve problems which they are collectively confronted with;
- *Imposition* – the involvement of a country being intentionally forced to adopt the policies favored by another country, by an international organization or by a private actor;
- *Diffusion* – the process by which an innovation is communicated through certain channels over time among the members of the social system.

The distinction of these three mechanisms rests mainly on their basic mode of operation and the autonomy or leeway of decision for national decision makers to adopt,

[6] Busch and Jörgens (2005) divide the environmental policy innovations into six distinct groups: *environmental institutions* (ministries, agencies, advisory councils, sustainability commissions); *general environmental laws* (constitutional articles on environmental protection, legal provision for the public access on environmental information, framework laws); *specific laws and regulations* (air, water, nature and soil protection, waste laws and packaging regulations); *instruments for policy integration* (national environmental plans, sustainability strategies, impact assessments); *economic instruments* (energy/carbon taxes, feed in tariffs and quotas for renewable resources); *labels and standards* (eco-labels, energy efficiency labels and standards for refrigerators and freezers)

refuse or accept the implementation of a certain policy innovation (Busch and Jörgens, 2005).

In particular, ***harmonization*** involves the conscious modification of domestic policies by countries committed to international agreements or supra-national regulations that they have had a hand in drafting and upon which they deliberately agreed in preceding multilateral negotiations. As such, it is characterized by highly centralized and joint decision-making processes where national decision-makers convene at the international level to negotiate an international agreement. Implementation is often administered and monitored by an international body. National autonomy to deviate from the agreed policies is considerably constrained. While national decision-makers participate voluntarily in multi-lateral decision-making and, in principle, can actively influence the outcomes, once an agreement has been agreed upon, they are more or less strongly obliged to comply and to implement the agreement domestically.

Imposition*,* on the other hand, refers to processes where external actors force or coerce other nations to adopt policy innovations and is based on unilateral or multilateral conditionality. The imposing actors exploit asymmetries in political and/or economic power. Compared with harmonization and diffusion, the imposition most severely constrains the autonomy of national policy-makers to decide on the adoption of a certain policy innovation. The imposing actors more or less exclusively determine the design of a policy innovation and the time schedule for its adoption. This mechanism, thus, leaves little or no leeway for national policy-makers confronted with imposition to refuse or accept the innovation's domestic implementation and eliminates almost any voluntary element in national decisions to adopt a policy innovation.

While harmonization and imposition, as international political mechanisms leading to global or regional environmental policy change and convergence, have been at the core of theories of international governance for a long time, ***diffusion*** has so far received relatively little attention as a political mechanism. At the same time, the science of international relations has recognized that the behavior of states – in terms of policy outputs – converges even in the absence of binding international agreements, and the policy innovations spread even in the absence of harmonization and imposition. This spread cannot be attributed to independent national reactions to parallel problem pressures, although the latter undoubtedly still plays an important role for the adoption of certain policies. One can speak about diffusion, which complements harmonization and imposition as an international political driving force for national policy changes and cross-national policy convergence. Diffusion analysis asks for those conditions that favor or hinder the spread of policy innovations within the international system (Tews, 2005).

The essential feature of *policy diffusion* is its voluntary character, and that it occurs in the absence of formal or contractual obligations, resting on international communication processes. Jörgens (2005, p. 61) refers this term "mainly to the international spread of policy innovations driven by information flows rather than hierarchy or collective decision-making within international institutions". At the micro-level, diffusion is triggered by processes of social learning, copying or mimetic emulation. Thus, compared with harmonization and imposition, diffusion processes are based on the discretion of national decision-makers to accept or refuse the policy choices of another country. As a result, decision-making procedures are decentralized and remain at the national level. National decisions to implement a policy innovation similar to the ones already implemented elsewhere are often only loosely coupled, and policies of one country can be influential in shaping the policies of another without the country of origin even noticing (Busch and Jörgens, 2005).

These authors also distinguish two basic types of diffusion. In the first case, direct policy transfer or *horizontal diffusion* describes processes where nations learn from or imitate policies implemented elsewhere through bilateral communication and direct interaction or exchange of experiences. Horizontal diffusion of environmental policy innovations is not less important than '*vertical'* regulation by international organizations, and horizontal 'lesson drawing' may influence the development of global environmental policy and its preferred patterns more than most other policies (Jänicke, 2005). In the second case, internationally institutionalized policy diffusion comprises political processes at the global or international level and the actions of international organizations or of specific international expert and policy networks. These international actors, contributing to a more or less centralized international communication of environmental policy innovations, can directly or indirectly affect national decisions to introduce a certain policy innovation or increase the likelihood that national decision-makers emulate the policies of other countries.

However, a focus on political mechanisms alone cannot explain why environmental policy change occurs at all, and policy analysis increasingly faces the challenge of incorporating external forces on national policy developments into its analytical framework. Among the possible additional triggers of changes in environmental policy Jörgens (2005) names:

(1) *economic pressures,* such as the growing regulatory competition between nations which may force governments to modify regulatory policies in order to sustain or improve national competitiveness in a global economy;
(2) *ideational pressures* such as the ongoing normative redefinition of the 'nation state' as an environmentally responsible entity; and
(3) *environmental pressures* such as transboundary or global threats, which place similar demands on a wide range of countries.

On the whole, these pressures create necessary stimulus for subsequent environmental policy changes leading to convergence, although it was also found that, while convergence is clearly observable, significant differences remain as to the regulatory details of individual environmental programs and the administrative arrangements, created to implement these programs (Jörgens, 2005). While the most important sources of the policies convergence can be found at the international level, the domestic factors account for many of the remaining differences between real national policies and institutions. Moreover, the experience shows (Liefferink and Jordan, 2005) that even if environmental policies in the states are similar, this gives little indication as to whether their effects will also converge. The complex causal chains that are involved here include the degree and quality of policies practical implementation, its dependence on other policies and various non-policy factors.

Tews (2005) considers the neglect of this factor – how experiences from abroad and the way they are communicated affect national policy-making processes – as a central shortcoming of the macro-level approach in diffusion of research. A policy adoption alone (output level) does not tell either whether the imported policy has an impact, or whether the imported policy is intended to have an impact at the domestic level at all. To obtain the whole picture, it is necessary to include micro- and meso-level perspectives. The process of translation of international stimuli into national decisions to adopt certain innovations has been found to be a research question worth deepening. Even among CIS countries that are closely linked in terms of the former dense cultural, economic and political relations as well as with similar structural determinants of environmental capacity, there are differing propensities to innovate, with no single relationship between diffusion patterns and influencing factors, and the international drivers are not sufficient to account for the specific of the former. "International stimuli to adopt nationally a certain innovation meet *heterogeneous national capacities and actor configurations*, which function as filters or – in other words – determine the national responsiveness to experiences from abroad" (Tews, 2005, p. 74). For example, some aspects of internal environmental make-up in EU member states have undoubtedly become more similar under the influence of the common EU policies, but some structural developments were shared, notably, regarding the roles of national environmental ministries, national parliaments and NGOs (Liefferink and Jordan, 2005) (Box 4.3).

Adaptation to climate change provides a rare challenge for the Annex I and non-Annex I Parties to work more or less in tandem on the issue that requires each Party to undertake virtually identical tasks at the domestic level, thus providing tremendous

Box 4.3 National policy-making incorporation in EU environmental policy making

Effective environmental governance in the EU is crucially dependent on corresponding adjustments and changes in national institutions in order to provide the necessary structural and practical ingredients for the achievement of objectives spelled out in European legislation, leading to the convergence of regulatory arrangements across member states. As a result, responsibility for environmental policy making in the member-states has shifted remarkably to the EU level. However, along with achieving the harmonization of national policies and far-reaching convergence of environmental policy, there are a number of domestic and policy-specific factors diverting the path from reaching convergence (Liefferink and Jordan, 2005), and potential for national institutional change and cross-national convergence varies with the particular governance pattern embedded in EU environmental policy.

Knill and Lenschow (2005) distinguish between three ideal–typical governance patterns, or three sources of national institutional change:

– *prescriptive governance* based on the compliance of national implementers with legally binding EU rules;
– *communicative governance* based on information exchange between regulatory agents across national levels arranged in a EU legal or institutional framework; and
– *competitive governance* based on competition between national administrative systems to achieve EU requirements.

Each of these modes of governance affects differentially the process and outcome of national institutional change where three underlying rationalities – *persistence driven, legitimacy driven and outcome driven* – shape domestic processes of adjustment. In this context, there seems to be an inverse relationship between the political objective of harmonization and actual convergence. Prescriptive policies, which aim explicitly at harmonizing national policies, have a less pronounced drive toward convergence of domestic institutions than competitive and communicative governance approaches do.

Source: Knill and Lenschow, 2005; Liefferink and Jordan, 2005 opportunities for the all to reflect and to engage in mutual learning (Yamin, 2005). The adaptation underscores also the need to ensure coherence between, for example, what Annex I Parties are saying with regards to how adaptation might be 'integrated' at home and how it might be 'mainstreamed' by others abroad.

It is well-known that transition and developing countries should mainstream climate consideration into development planning, but they fail to reflect on their own the early experience of integrating climate change into international, e.g., EU, sectoral policies. Therefore, Yamin also emphasizes that mainstreaming is not a panacea; it requires resources, political will and time in order to achieve any significant results. Today's EU approaches fail to take into consideration the opportunities for learning and coalition-building, although many of the institutional challenges posed by integration and mainstreaming of adaptation are common to Annex I and other countries, though sometimes being masked. However, donor countries tend to use funding to tell the developing and transition world what to do or to forge support for other policy issues. Yamin (2005, p. 359) suggests that *"... the EU could reframe its stance of adaptation and on development partnerships so as to focus on forging coalitions and alliances with all those interested in learning about the transition to sustainable development and by providing developing countries with an honest account of the status of its internal developments in this regard"*.

4.2.3 Short history and contents of international cooperation in combating climate change

"We may assume that policy development is to some extent path-dependent in that it builds on past experience and success, which facilitate policy learning. The history of policy making and implementation may thus be a useful element for the explanation of current policies", – Kulessa *et al.* (2007, p. 81) believe.

The current international climate policy architecture reflects more than a decade of efforts, starting with several international conferences in the late 1980s. Scientific evidence of human interference with the climate first emerged in the international public arena in 1979 at the First World Climate Conference (Fig. 4.5). As public awareness of environmental issues continued to increase, governments grew even more concerned about climate issues, and in 1988 the UN General Assembly adopted Resolution 43/53, urging to protect the global climate for present and future generations. In the same year, the WMO and UNEP created IPCC as a body to marshal and assess scientific information on the subject, and already in 1990 the IPCC issued its First Assessment Report, which confirmed that the threat of climate change was real. The Second World Climate Conference, held in Geneva later that year, called for the creation of a global treaty. The call was responded by the General Assembly (Resolution 45/212), thus formally launching the negotiations on a climate change convention to be conducted by a special Intergovernmental Negotiating Committee (INC).

After 15-months negotiations, on 9 May 1992, the INC adopted the UNFCCC, and at the Rio de Janeiro Earth Summit (1992) it was opened for signature. The Convention entered into force on 21 March 1994, and ten years later had been joined by 188 States, including the FSU countries. This almost worldwide membership makes the Convention one of the most universally supported international environmenttal agreements. Since it entered into force, Parties to the Convention[7] have met annually at the Conference of the Parties (COP) to foster and monitor its implementation and continue negotiations on how best to tackle climate change. The COP decisions make up a detailed set of rules for the Convention's practical and effective implementation.

Because initial provisions of the Convention were not sufficient by themselves to tackle climate change in all its aspects, at the COP 1, held in Berlin in 1995, a new round of talks was launched to discuss firmer and more detailed commitments for industrialized countries – a decision known as the Berlin Mandate. As a result, in December 1997, a substantial extension to the Convention, which outlined legally binding commitments to emissions cuts, was adopted at COP 3 in Kyoto, Japan. The Kyoto Protocol sketched out basic rules that were further developed at the new round of negotiations, crowned at COP 7 (2001, Marrakesh) by the adoption of a broad package of decisions – *Marrakesh Accords.* This document spelled out more advanced prescriptions for implementing the Convention, Kyoto Protocol and its rules. 16 February 2005 the Kyoto Protocol entered into force. Status of the ratification of both documents by FSU counties is shown in Table 4.6.

Fig. 4.5 UNFCCC *(Convention)* and Kyoto Protocol *(Protocol)* timelines. *Source:* UNFCCC, 2005

The Convention's activity is tightly interwoven with other international organizations working towards sustainable development. To make the most of potential synergies and to avoid duplication, the areas where agendas are liable to overlap receive special attention.

So, in 2001 the Joint Liaison Group was set up by the Secretariats of three 'Rio Conventions' (UNFCCC, the Convention on Biological Diversity and Convention to Combat Desertification) that enables them to share insights about their work and methods, identify potential joint actions and anticipate potential problems. The regularly consulted institutions include WMO and the Ramsar Convention on International Wetlands. An input on specific issues also proceeds, for instance, from UNEP or the bodies of the

[7] Party to the UNFCCC are countries that have ratified, accepted, approved or acceded to the treaty

Montreal Protocol on potential synergies and conflicts between efforts to combat climate change and measures to curb ozone layer depletion.

Table 4.6 Status of ratification of UNFCCC and Kyoto Protocol by FSU countries

Country	*UNFCCC*			*Kyoto Protocol*		
	Signature	Ratification	Entry into force	Signature	Ratification	Entry into force
Armenia	13/06/92	14/05/93 (R)	21/03/94	-----	25/04/03 (Ac)	16/02/05
Azerbaijan	12/06/92	16/05/95 (R)	14/08/95	-----	28/09/00 (Ac)	16/02/05
Belarus*				-----	26/08/05 (Ac)	24/11/05
Estonia*	12/06/92	27/07/94 (R)	25/10/94	03/12/98	14/10/02 (R)	16/02/05
Georgia		29/07/94 (Ac)	27-Oct-94	-----	16/06/99 (Ac)	16/02/05
Kazakhstan	08/06/92	17/05/95 (R)	15/08/95	12/03/99		
Kyrgyzstan				-----	13/05/03 (Ac)	16/02/05
Latvia*	11/06/92	23/03/95(R)	21/06/95	14/12/98	05/07/02 (R)	16/02/05
Lithuania*	11/06/92	24/03/95 (R)	22/06/95	21/09/98	03/01/03 (R)	16/02/05
Moldova	12/06/92	09/06/95 (R)	07/09/95	-----	22/04/03 (Ac)	16/02/05
Russia*	13/06/92	28/12/94 (R)	28/03/95	11/03/99	18/11/04 (R)	16/02/05
Tajikistan						
Turkmenistan		05/06/95 (Ac)	03/09/95	28/09/98	11/01/99 (R)	16/02/05
Ukraine*	11/06/92	13/05/97 (R)	11/08/97	15/03/99	12/04/04 (R)	16/02/05
Uzbekistan		20/06/93(Ac)	21/03/94	20/11/98	12/10/99 (R)	16/02/05

Notes: R = Ratification; *At* = Acceptance; *Ap* = Approval; *Ac* = Accession. * – Annex I Party to the UNFCCC

The UNFCCC secretariat cultivates links with national or international non-governmental organizations, trade associations and various other non-statutory bodies. For example[8], at the 26th IPCC Session in 2007 (Bangkok, Thailand) the list of relevant participating UN bodies and Organizations included 24 names; the list of observed organization – 28 names (including 22 international NGOs).

In addition to the internal advice to support the formulation of a national strategy, there is a growing need for international assessments in order to provide the best available scientific information for international negotiations. In the climate change area this role is performed by the IPCC. Its periodic assessments of the causes, impacts and possible response strategies to climate change are the most comprehensive and up-to-date reports available on the subject, forming the standard reference for all concerned with these problems.

Siebenhüner (2003), using the IPCC as a case study, has analyzed the role of an individual nation in international assessments and has shown a tendency of increasing internationalization in the field of climate research and climate policy. He considers international assessments as *"...a part of an emerging system of global governance with a number of new institutions and organizations where nation states and international assessment bodies play a particular role"* (p. 114). More broadly, the assessments have been described as "the entire social process by which expert knowledge related to a policy problem is organized, evaluated, integrated, and presented in documents to inform policy

[8] See: *http://www.ipcc.ch/meetings/session27/doc2.pdf*

or decision-making"[9]. Being located between scientific and political realms, the assessments have to moderate between a dedication to notions of truth and credibility in the scientific world and claims of interest, power and legitimacy in the political world. On the basis of their findings the assessments are most influential when they manage to be *salient* to the potential users, *credible* in regard to the scientific methods, and *legitimate* in the way the assessment is designed. Among these elements, the involvement of nation states comes into play at different stages (Siebenhüner, 2003).

In principle, the IPCC is a scientific body: the information it provides with its reports is based on scientific evidence and reflects existing viewpoints within the scientific community. The comprehensiveness of the scientific content is achieved through contributions from experts in all world regions and all relevant disciplines including, where appropriately documented, all industry literature and traditional practices, as well as a two-stage review process by experts and governments. Given its intergovernmental nature, the IPCC provides scientific, technical and socio-economic information to policy- and decision-makers in 'a policy-relevant but policy neutral way'. However, by accepting the IPCC reports and approving their Summary for Policymakers, the governments acknowledge the legitimacy of their scientific content. Thus, the relationship between science and policy in assessments can be conceptualized conventionally as a circular influence from science to policy making and from the political sphere back towards science. In this perspective, the role of national representatives in preparing the assessments is of particular interest. Their function is twofold: (i) they have to pursue political interests of their country, and (ii) they are part of a scientific process, which is dedicated to informing policy makers on the basis of the latest research findings. These roles do not always coincide, and therefore political actors in assessments often are confronted with conflicting interests (IPCC, 2004).

Since its launch, more and more governments participate in the plenary sessions of the IPCC where the final documents have to be approved. Whereas the first session was attended by only representatives from 30 countries, the subsequent participation varied between 80 and 110 countries, indicating a decrease in the influence of the individual national governments given the increase of total participation. The nation states also take part in the IPCC process where their scientists participate in preparing the Assessment Reports as authors, reviewers or in other functions. The struggle for balanced participation of scientists from all parts of the world is one of the key issues of IPCC design. Wide participation of experts from different regions and nations is regarded as crucial for the acceptance of the assessment results by policy makers both in developed and developing/transition countries. For example, 73 Nationalities are engaged in the writing process of preparing the Working Group II contribution to the IPCC Fifth Assessment Report (AR5): "*Climate Change 2013: Impacts, Adaptation, and Vulnerability*" (see: *http://www.ipcc-wg2.gov/AR5/ar5.html*). Unfortunately, participation of FSU scientists in the IPCC activity is very limited (Table 4.7); this could be explained by the passivity of both the relevant national governmental bodies and the scientists themselves.

Finally, Siebenhüner (2003, p. 121) identified three criteria as being relevant for effectiveness of the assessments in a political process:

---

[9] The Global Environmental Assessment Project (GEA), 1997: *A Critical Evaluation of Global Environmental Assessments: The Climate Experience*. CARE, Calverton, p. 53

Table 4.7 Contribution of FSU countries to the IPCC Fourth Assessment Report

Country	Working Group I: The Physical Science Basis			Working Group II: Impacts, Adaptation & Vulnerability			Working Group III: Mitigation of Climate Change		
	CLA	*LA*	*CA*	*CLA*	*LA*	*CA*	*CLA*	*LA*	*CA*
Russia		3	10	2	5		1	4	1
Ukraine						1			
Lithuania								1	
Moldova					1				

Note: CLA – Coordinating Lead Author; *LA* – Lead Author; *CA* – Contributing Author

- *Firstly*, the design of the science-policy interface is crucially important not only for the effectiveness of the assessment itself but also for the possible influence national governments could have on the assessment process and through that on international politics;
- *Secondly*, even the simple presence of governmental representatives in the process has been found as a fruitful criterion for the measurement of the influence of individual nation states and of the group of nation states as a whole. Governments have to be integrated in the exchange of information within the assessment process in order to be able to influence the process. On the other hand, governments could even have a grip on the process through the involvement of scientists from their country which do not necessarily have to maintain government positions but they might communicate national research priorities, standards or convictions;
- *Thirdly*, the design of conflict resolution mechanisms in assessment processes seems relevant for the influence of national governments. Voting procedures as well as measures for quality assurance such as peer-review mechanisms have proven to be elementary for who has a say in the assessment process.

By and large, the analysis of the role of nation states in the IPCC based on these three criteria revealed that whereas this influence is rather indirect, the national governments, as parties to the COP, strongly and directly influence the international political process.

4.2.4 Enhancing the success of climate treaties through international cooperation

4.2.4.1 International cooperation in the context of global warming

Climate change as a long-term political issue cannot be solved unilaterally. Given its global character, the acceptability of solutions strongly depends on consensus or compromise among openly conflicting parties, often between North and South, but for the most part – across more complex divides. It is a common environmental problem, inherently international in both causes and effects, and can only be addressed through global actions requiring an *international approach* tightly linked to international negotiations with global participation. Finding ways to achieve a worldwide reduction of GHG emissions touches on the vital interests of diverse entities such as fossil fuel corporations and fuel exporting countries, car manufacturers, the renewable energy sector, and so on. Even though much agreement has been achieved, conflicts still emerge not only on technical issues, but also on fundamental questions of goals and values, resulting in different political approaches; these are becoming increasingly visible between developed countries and the rest world (Engels, 2005; Halsnæs and Shukla, 2007; Llewellyn, 2007).

The essential distinctive feature of diffusion, which was discussed above, is its voluntary character, i.e. it occurs in the absence of formal or contractual obligations and rests on international communication processes. Climate change also raises profound and significant ethical questions that are often not adequately considered in policy discussions, while forcing nations to decide whether they support the establishment of an international agreement or whether they will pursue a policy of narrow national self-interest. A failure to expressly consider certain ethical questions is tantamount to a failure to consider many current barriers to progress in climate change negotiations. Thus, ethical considerations need to be integrated into the scientific and economic discussions of climate change policy (Brown *et al.*, 2006).

The voluntary provision of public goods is a well-known problem in economics. If in their national framework the governments can provide the appropriate level of public goods, using, e.g., such financial instruments as taxation, this is more difficult to make in the international context. In the absence of a 'world government' the international environmental treaties rely mainly on voluntary participation and must be designed in a self-enforcing way that due free-rider incentives result frequently in facts that not all countries participate in the treaties and/or the agreed level of public provision only marginally exceeds non-cooperative levels. As a case in point, Eyckmans and Finus (2007) name the Kyoto Protocol that finally entered into force only eight years after its adoption.

Anantram and Noronha (2005) emphasize that public goods are so termed if they satisfy the following two criteria: *non-excludability* (impossible to prevent access by all) and *non-rivalry/competition* in consumption (consumption by one does not preclude consumption by another). Since public goods are non-rivalry and non-excludable, they face supply problems. A free market is highly unlikely to produce an optimum amount of the public good (resulting in non- or under-production), creating the situation known as 'market failure'. Provision of such goods by the state also faces several problems, e.g., rent-seeking behavior on the part of policy-makers/bureaucrats, biases in favor of certain segments of the population, etc. Hence, public goods face a double jeopardy-market and state failures.

The complex causal relations, uncertainties and risk, the conflicts about ends and means, and the extremely heterogeneous conglomerate of interests and viewpoints are crucial elements of climate change as a policy problem (Engels, 2005). On the other hand, some fundamental characteristics, associated with climate change as an environmental problem, make it even more difficult to solve than other global problems. Eyckmans and Finus (2007), considering fundamental forces that hamper successful treaty-making in fighting climate change, analyze two measures on self-enforcing climate treaties. The first measure that they see as enhancing the success of global climate treaties is *transfers* aimed at balancing strong asymmetries between the actors involved in climate policy. The second measure is a change in the institutional rules to make it more difficult to upset the stability of a treaty. In other words, they contrast open membership, which is typical for public goods, with exclusive membership, typical for club goods. Based on coalition formation in the global warming context, their approach combines a game theoretic analysis with numerical simulations.

Using a dynamic integrated assessment model, Eyckmans and Finus captured the feedback between economy, climate system and environmental damages and comprised six world regions: USA, Japan, European Union, China, FSU and ‘Rest of the World’. Both internal and external stability of coalitions was tested. Key results of their simulations are the following:

1. In the context of global warming, the difference (in ecological terms) between *full* and *no cooperation* is large. It was not so large in welfare terms due to discounting and because the benefits from cooperation will occur mainly in the future.
2. Partial cooperation can be an important step to mitigate global warming; however, for the success of partial cooperation the identity may be more important than the number of members of a coalition. This indicates that concluding success from a high participation only, without measuring the effectiveness of an agreement, may be misleading. Moreover, it was found that coalitions that do not comprise key players with low marginal abatement environmental costs and/or high marginal damages will not achieve much at the global level. Thus, the finding stressed that including developing countries (apart from the industrialized) in future climate treaties will be of great importance.
3. Without transfers and under open membership rules, there was no stable coalition in the model. This result illustrated the difficulties of cooperation in the case of global warming because of large asymmetries between regions.
4. The success of cooperation could be improved through different transfer schemes. Hence, the authors argued, the making of agreements, individually profitable to all participants, through transfers is a necessary but by no means a sufficient condition to establish successful self-enforcing treaties. Strong free-rider incentives are an obstacle to higher participation and success.
5. ‘Status quo’ transfer schemes performed better than the ‘morally motivated’ schemes, which imply large transfers from industrialized to developing countries and therefore mitigate the asymmetric distribution of the gains from cooperation observed for no transfers, but at the expenses of introducing a ‘new’ asymmetry. This did not allow for stable coalitions with participation of key industrialized countries that is important for the success of joint climate policy. In contrast, ‘status quo’ transfer schemes implied a more moderate redistribution and therefore were more successful in attracting both industrialized and developing countries for stable cooperation. Consequently, the moral motives may not always be a good guide to establish effective agreements if they are not in line with fundamental free-rider incentives.
6. The change of the institutional design from open to exclusive membership could make a big difference, being as important as transfers. Therefore, in future environmental treaties open membership should not be taken for granted despite that it may seem an obvious rule in the context of public goods.

As a general conclusion, the quoted authors think that evidently, in the presence of free-rider incentives and because of the need for self-enforcing agreements, it may be the case that less ambitious abatement targets and/or a departure from a cost-effective abatement allocation may be more successful if this allows for a sufficiently higher participation in a stable agreement.

In turn, Halsnæs and Shukla (2007) presented arguments and ideas on how future international climate change cooperation can be developed in a way where (1) international framework conditions ensure that there is a worldwide incentive to participate, but (2) wherein as much freedom and initiative as possible are given to countries and stakeholders. In this way, international cooperation can be established based on a strong element of *bottom up* initiatives. The most critical issues in developing the climate policies with such a bottom up element is the design of appropriate international framework conditions that can facilitate climate benign actions by individual stakeholders. 'Framework conditions', in this context, are understood by the authors in a broad way, which can both include international agreements like the UNFCCC, the Kyoto Protocol or regional collaboration similar to that implemented in the EU and national or state-level regulations.

Several difficulties in the establishment of international climate agreements based on an *environment-centric policy agenda* are seen by Halsnæs and Shukla in the evidence that climate change is not an isolated environmental problem, but is closely linked to more general development issues, and the climate policies can imply significant costs and benefits redistributed among stakeholders, within- and across generations – the issues, more than once emphasized in this book. There is a challenge to create incentives that are strong enough to motivate decision makers, including business and governments, to take confronting the climate change into consideration in their routine decisions.

A central and key methodological issue that emerges, when considering international climate cooperation, is to devise ways and means through which climate change concerns become internalized in economic accounting and other decision-making of countries and stakeholders. It is well recognized that international agreements as well as national laws and voluntary actions, in particular implying GHG emission reductions, have to be based on some sort of perception about the value of avoiding negative climate change impacts. Since these impacts are very uncertain, and various governments and stakeholders experience and perceive them differently, they are expected to have different policy ambitions.

To avoid such situations, some policies, alternatively to voluntary provision and certain commitments under international treaties, can be built around economic principles following the logic "that countries engage based on willingness to accept as an insurance value against climate change" (Halsnæs and Shukla, 2007, p. 5). As an example, these authors, discussing the mechanisms to support international cooperation, distinguish between measures that can support climate change mitigation in a short-term perspective and measures that support the creation of longer-term climate policy frameworks. While the former focuses on how to create a market value of carbon, the longer-term perspective also considers how technological change and penetration programs can be created and supported.

Finally, international agreements, bringing all actors to the table, do not always provide the incentive structure needed to reach operational solutions on the ground for the widespread local issues of sustainable development (for example, in the case of Ukraine; Box 4.4). Partnership is a certain alternative in providing direct government-to-government agreements to catalyze actions in transition countries.

From this position, Hale and Mauzerall (2004) differentiate global issues, which affect all nations, and widespread local issues that primarily localize causes and effects. They studied one widely publicized, but controversial outcome of the World Summit (UN, 2002) that may help to promote global action on local problems – the so-called *Type II partnerships.* Partnerships of this kind are voluntary, non-negotiated, inter-national,

Box 4.4 EU co-operation on climate change with Russia and Ukraine

Following Russia's ratification of the Kyoto Protocol (February 2005), EU climate cooperation with Russia has progressed significantly. At the Environment Permanent Partnership Council on October 10, 2006 the two parts agreed on the terms of reference for a bilateral Environment Dialogue and established seven expert subgroups. The subgroup on climate change involves the European Commission and the Russian authorities that will drive forward co-operation into areas such as adaptation and mitigation policies, future action, reporting and research.

EU-Ukraine climate change co-operation has developed slowly due to frequent changes of the government in recent years, although (because of its dependence on energy imports) Ukraine has a strong interest in making its economy more energy efficient.

Source: European Commission, 2007

collaborative projects for sustainable development. They are referred to as Type II agreements to be distinguished from the politically negotiated agreements and commitments that were considered as the first outcome of the Summit; their members are drawn from governments, international organizations, private corporations, civil society, etc.

These authors' recommendations to transmute the Type II partnerships to harness effectively global resources for addressing widespread local issues include the development of:

– *a learning network to share information*
– *a transparency-based system to hold partnerships accountable*
– *increased private sector participation*
– *involvement of small stakeholders in institutional home to support partnerships, and*
– *adherence to multilateral priorities.*

Undoubtedly, policy makers have now recognized the need to integrate thinking about climate change into all areas of international policy making. However, this understanding has mostly tended to focus on mitigation decisions. Clearly, there is also an adaptation dimension to climate policy internationalization, which has not been adequately explored, and there is a growing appreciation that the international policy context in which adaptive decisions are made must also be considered (Urwin and Jordan, 2008). Aldy and Stavins (2008) believe that in identifying the appropriate international policy response to adaptation needs, the international policy community should proceed from two kinds of discourse: (1) adaptation policy should focus on producing public, not private goods, and international adaptation policy should focus on producing global public goods; (2) international adaptation policy focused on national and local public goods may be reasonable in the context of facilitating adaptation among the most vulnerable with the least capacity to adapt. In this case, an effective international adaptation policy would be intricately linked with development policy.

Burton *et al.* (2006), discussing different international policy options to adapt to climate change, showed that an effective adaptation response also requires a wide array of measures and strategies. In particular, they described three broad approaches:

- *Adaptation under the UNFCCC,* or strengthening mechanisms and support for proactive adaptation under the Convention by facilitating comprehensive national strategies and committing reliable funding for high-priority implementation projects;

- *Integration with development,* or factoring adaptation into development assistance through measures such as mandatory climate risk assessments for projects financed by multilateral and bilateral lenders;
- *Climate 'insurance'* or committing funds to support climate relief or insurance-type approaches in vulnerable countries for losses resulting from both climate change and climate variability.

Each of these approaches, pursued independently, could contribute to national-level efforts to reduce or cope with climate risks. Together, they also could be seen as complementary elements of a comprehensive international effort that (1) supports proactive planning and high-priority implementation; (2) promotes integration with the broader development agenda; and (3) provides a safety net to ameliorate unavoidable impacts.

From a political standpoint, *adaptation under the UNFCCC* may be most plausible to pursue future corresponding efforts within the Convention. To the degree that additional adaptation support is bound with the question of future commitments on climate mitigation, the UNFCCC negotiating process is the most obvious venue for structuring agreements that speak to both. Moreover, a proactive approach under this regime could help to address urgent climate change-specific impacts, while also facilitating comprehensive long-term climate risk management at the national level. Specific elements of a Convention-based approach could include *(ibid,* p. 15):

- Support to vulnerable countries for the development of comprehensive national adaptation strategies;
- Reliable funding to assist countries with approved national strategies to implement high-priority measures, with priority given to those addressing impacts reasonably attributable to climate change; and
- Establishment or designation of an international body to provide technical support, judge the adequacy of national strategies, and select high-priority projects for funding.

As to the two other approaches – *integration with development* and *climate insurance* – the former will be discussed in Chapter 5, the latter – directly below.

And, finally, the effectiveness of any international cooperation depends ultimately on approaches to its implementation in each specific country (Box 4.5).

4.2.4.2 Financing and insurance as adaptation options

Mainstreaming adaptation in financing

Adaptation discussions are usually linked to discussions on funding, which is itself a particularly contentious issue in the UNFCCC negotiations. Calls for adaptation policy have been frequently and closely accompanied by calls for appropriate funding to aid developing and transition countries in adapting to the adverse climate change effects (Schipper, 2006).

Box 4.5 Climate change policy in three FSU countries

Russia, Ukraine and Kazakhstan entered into the process of UNFCCC negotiations with strong encouragement from the developed states, especially the USA. However, their ability to benefit from the climate change regime is contingent on two vital preconditions: entry into force of the treaty and establishment of credible domestic structures—including ones that can conduct national reporting, compile credible inventories, and regulate the use of flexible mechanisms in each member state. Despite the fact that these preconditions have proven more problematic than the three nation states anticipated, all three have continued to participate in the process with some successes, but with markedly different climate policies reflecting their different approaches and priorities. In particular, with regard to key actors, Kazakhstan's experience shows differences in individual entrepreneurs' policymaking; Ukraine's experience highlights the extent to which civil society can have a marked impact; Russia's experience demonstrates how industry can be a contributing force in the climate policy process. There were also different challenges: Kazakhstan has learned how much uncertainty in the international process can raise the costs for the state; Ukraine has faced the problem of designing structures sufficiently resilient to survive high turnovers in government; Russia has had the problem of bringing together long-established institutions that have historical animosities.

Source: Sabonis-Helf, 2003

There are far fewer estimates of needed adaptation investments, and those that exist are not readily comparable. The World Bank's studies, which attempted to tackle these issues, suggest that needed investments could be upward of $80 billion annually in developing countries alone (Word Bank, 2010). This is only a twentieth of current spending on development of new infrastructure globally and a tenth the expected cost of emissions reduction (Stern Review, 2007). In turn, the UNFCCC estimated that between US$50 billion and US$170 billion per year (in current values) will be needed by the year 2030[10]. UNFCCC (2008) also assumes that although the estimated additional amount of investment and financial flows needed to address climate change is large, it is small (1.1–1.7%) in relation to the estimated total global investment in 2030. However, much adaptation (e.g., damages to irreplaceable biological systems or the costs of continuing to irrigate for farming in drying regions) may not be physically possible or economically worthwhile. According to an estimate, this impracticable adaptation would amount to two-thirds of all damages — about $1 trillion per year in 2030, or ten times the UNFCCC estimate for total adaptation funding (Parry *et al.*, 2009).

A considerable gap exists between the actual (as well as projected) supply of funding and estimated adaptation needs. It is acknowledged that mere financing represents only a part of what is needed in order to adapt to climate change. Effective adaptation measures also depend on a series of other factors, such as information, institutional capacity, technology, transparency and political stability. However, the scale of the challenge is also difficult to assess, irrespective of mitigation*,* because it is so closely connected to other developments such as economic and population growth, poverty, the spread of diseases, as well as on institutional and political factors such as transparency and stability (Flåm *et al.*, 2009).

Most of the additional investment and financing needed for confronting the climate change is expected to be provided by corporations, although this requires government

[10] UNFCCC secretariat. 2007. *Investment and Financial Flows to Address Climate Change*. Available at: *http://unfccc.int/files/cooperation_and_support/financial_mechanism/application/pdf/background_paper.pdf*

policies and incentives. Therefore, to support enhanced action on the provision of financial resources for adaptation, the UNFCCC (2008) considers and influences four broad means: (a) private finance, (b) public finance, (c) national policies and (d) the Convention itself.

Public funding, both domestic and international, plays a large role in financing adaptation actions because the benefits generated by these actions often have the characteristics of public goods. Additionally, public funding is used to mobilize new and additional sources for financing adaptation.

The private sector already invests significantly in many vulnerable sectors, providing financial resources for adaptation through investments, financial risk management, the commercial provision of capital and the philanthropic provision of resources through private foundations. With its emphasis on profit, private funding tends to be more effective and innovative in its approaches to controlling administrative costs and fraud. In addition, private insurers can offer cost-efficient products, marketing and distribution channels, as well as claims-handling systems. In light of its efficiencies, the private sector may be able to act as underwriting agent for the public sector or may perform a variety of services, even if it does not finance the risks itself (Dlugolecki and Hoekstra, 2006). Ensuring that such investments help to reduce vulnerability and exposure to climate risks and contribute to effective adaptation can channel a large source of funding towards climate-resilient outcomes.

National policies are a key to strategic adaptation planning. They can help to create an enabling environment that ensures scaled-up and optimized financial resources used to support integration of adaptation in sectoral and development planning shifted towards those activities that hold the greatest promise for reducing vulnerability. With this in place, adaptation funding can be directed not only to those who are most vulnerable, but also to those who will receive the greatest benefit in terms of reduced vulnerability and enhanced adaptive capacity. Political agreement is needed on issues related to sources of financial support, principles underlining institutional arrangements for providing financial support, and the categorization of adaptation activities to facilitate mobilization and allocation of resources.

UNFCCC (2008) also considers three broad strategies for providing the additional investment and financial flows needed to address climate change:

- ✓ Shift investments and financial flows to more climate-friendly and climate–resilient alternatives;
- ✓ Scale-up international private and public investments and financial flows;
- ✓ Optimize the allocation of the funds available.

Table 4.8 summarizes possible options, tools and mechanisms available to achieve these strategies.

A balanced portfolio of adaptation measures can have a profound and positive impact on economic development. Here's why, although adaptation can be at least partially self-financed, a substantial increase in funding for adaptation, over and above resources currently committed to development, should be an important part of a sound climate change policy (ECA, 2009). Although mainstreaming is an effective approach for putting adaptation into practice, the financing of adaptation needs to reflect the fact that this activity "is responding to the additional burden posed by climate change, quite distinct from the aggregate flow of resources towards overall socio-economic development goals" (UNFCCC, 2008, p. 26).

Table 4.8 Possible strategies for providing additional investments to enhance adaptation actions

	Funding sources		Provision	
	Private finance	*Public finance*	*National policies*	*Convention*
Scale up	Scale up investments and financial risk management tools, including insurance	Scale up financial flows and investments	Scale up efforts in national strategic planning for adaptation and in the integration of adaptation into sectoral and development planning	Scale up tools and mechanisms to mobilize new and additional resources in adequate, predictable and equitable manner, e.g., through levies on market instruments and commodities
Shift	Shift investments towards climate-resilient activities	Shift resource mobilization from budgetary allocations/voluntary contributions to automated contributions through levies on market instruments/ /commodities Shift investments towards climate-resilient activities	Shift from short-term project-based planning to long-term policy planning to identify and implement all possible adaptation actions, including economic diversification	Shift disbursement of financial resources to a more upstream level from project to programs and/or budgets, taking into account national priorities and circumstances
Optimize	Optimize public private partnerships for investments and financial risk management mechanisms to reduce vulnerability and enhance adaptive capacity for the economy and society at large		Optimize the integration of adaptation and development related financial resources Optimize enabling environments to enhance adaptation action, including through: ✓ *Legal frameworks* ✓ *Institutional arrangements* ✓ *Sectoral management* ✓ *Information tools*	Use Convention funds to leverage/catalyze additional funds Optimize the categoryzation of adaptation actions to enhance mobilization and allocation of financial flows Optimize delivery mechanisms for financial flows, including: ✓ Institutional arrangements; ✓ Access, e.g., via vulnerability metrics; ✓ Monitoring and reporting.

Source: UNFCCC, 2008

Thus, adaptation to climate change is typically understood as additional to a certain development baseline. Considering this feature of adaptation, the Convention offers a means for grouping adaptation actions into three broad categories:

(a) those that climate-proof socio-economic activities by integrating future climate risks
(b) those that expand the adaptive capacity of socio-economic activities to deal with current and future risks
(c) those that are purely aimed at adapting to climate change impacts and would not otherwise be initiated.

The second dimension, along which UNFCCC classifies adaptation, relates to the type of action. Here, several kinds of action may be identified with technology as a cross-cutting issue: (a) capacity-building; (b) research and assessments; (c) disaster risk reduction and risk management; (d) specific interventions (e.g., infrastructure or economic diversification). The adaptation component to be funded could either constitute the whole action (category C) or part of the socio-economic activity (categories A and B).

As adaptation funding is about to start only now, the evidence of the development impact of activities in this area is so far rather limited. Michaelowa and Michaelowa (2007, p. 4) believe that to avoid the disappearance of adaptation funds "like a drop in the desert due to unclear criteria for the setup of the corresponding projects,…there has to be an active guidance to avoid that adaptation funds are flowing into the coffers of the least vulnerable and thus exacerbate existing inequalities".

Options, tools and mechanisms to mobilize financial resources

Countries with economies in transition, just as developing countries, need help to build their capacities to respond to climate change. Areas where this need is acute include, along with, e.g., improving and transferring technology, drawing on finance (UNFCCC, 2005). The Frameworks for capacity-building in EIT Parties (UN FCCC, 2002), as a part of the *Marrakesh Accords*, call these Parties to continue to declare specific needs and priorities, while interacting with one another to share lessons and experiences. In turn, Annex II Parties are expected to provide additional financial and technical resources. By ratifying the Convention they have accepted a general obligation to assist developing and transition countries in meeting the costs of adaptation under certain circumstances. COP 7, in decision 3/CP.7 urged "…Annex II Parties, through multilateral agencies, including through the Global Environment Facility (GEF) within its mandate, bilateral agencies and the private sector, as appropriate, to make available financial and technical support for the implementation of the framework for capacity building, including assistance for the development of national action plans of Parties with economies in transition consistent with their priorities" (UNFCCC, 2002, p. 15).

Multilateral mechanisms for funding adaptation efforts[11] in non-Annex 1 Parties have been developed under a range of initiatives. Some of them include the following:

- The Marrakesh Accords established three new funds (two under the Convention and one under the Kyoto Protocol) and advised GEF to expand the work on adaptation and capacity-building in the scope of activities eligible for funding. The two UNFCCC funds – the *Least Developed Country Fund (LDCF*) and the *Special Climate Change Fund (SCCF)* were established under the auspices of the GEF and are financed by donors, through voluntary pledges. *SCCF,* complementing other funding mechanisms, was created to finance projects relating to capacity-building, adaptation, technology transfer, climate change mitigation and economic diversification for countries highly dependent on income from fossil fuels**.** It addresses the special long-term adaptation needs of developing countries, with a remit covering health, agriculture, water and vulnerable ecosystems. As of 2007 (operational since 2005), the SCCF has received

[11] Funding the *mitigation efforts,* also linked with financial support of transition countries, e.g., through the 'flexible mechanisms' established by the Kyoto Protocol, are not discussed here

pledges of US$67.3 million, of which US$56.7 million is specifically earmarked for adaptation (UNDP, 2007a).

- ❖ With the entry into force of the Kyoto Protocol in 2005, another potential source of financing was created in the form of the special *Adaptation Fund.* This fund supports concrete activities, i.e. finances practical adaptation projects and programs and support capacity-building activities. The fund receives revenues through the Clean Development Mechanism (CDM) transactions – a 2% levy on credits generated through CDM projects from voluntary commitments by Annex I Parties – that allows a country-donor to gain emissions reduction for investing in sustainable-development projects in developing/transition countries. If implemented, the levy could generate a total income in the range of US$160–950 million by 2012, depending on trade volumes and prices (UNDP, 2007a).
- ❖ One short-term mechanism – *the Strategic Priority on Adaptation (SPA)* – was created in 2004 to fund pilot projects from GEF's own resources. Over a 3-year period SPA earmarked US$50 million for pilot projects in a wide range of areas, notably ecosystem management.

Current institutional arrangements to provide financial resources and investments under the UNFCCC are shown in Fig. 4.6.

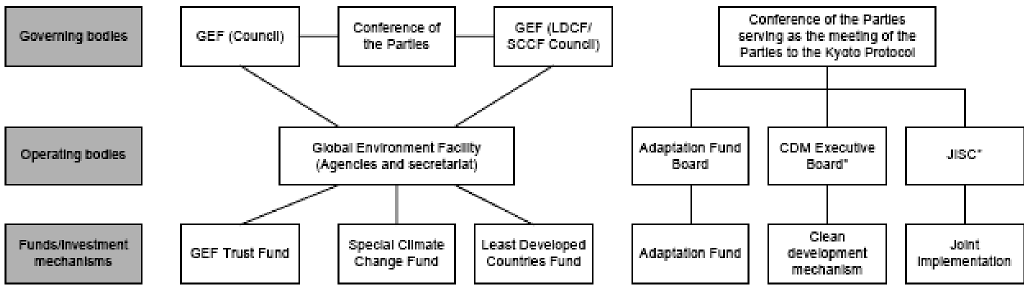


Fig. 4.6 Institutional arrangements to provide financial resources and investments under the UNFCCC and its Kyoto Protocol. *Source:* UNFCCC, 2008. *Abbreviations*: *GEF* – Global Environment Facility[12], *JISC* – Joint Implementation Supervisory Committee, *LDCF* – Least Developed Countries Fund, *SCCF* – Special Climate Change Fund. * – Entities supervising investment mechanisms and not delivering financial resources

[12] The UN's Global Environment Facility (GEF) is currently the only multi-donor funding mechanism specifically designed to help tackle key global environmental issues. It was conceived as a means to provide new and additional grant and concessional funding to meet the agreed incremental costs to achieve agreed global environmental benefits. Over its about 20 years, GEF has allocated US $7.5 billion intended to develop and implement scientifically and socially credible solutions to key global environmental problems, including climate change. Mee *et al.* (2008) evaluation showed that the GEF obtained impressive results for tackling problems of limited complexity and easily quantified benefits, but progress is slower on more complex and less tangible problems impeding sustainable development. Potentially, the GEF could enable adaptive management through a 'learning by doing' process, transforming it into an innovative mechanism for delivering global benefits. A continued emphasis on 'easy wins' would not allow it to achieve this goal. *Source: Socially Responsible Investment (SRI) compass*, 2005. Available at: *www.sricompass.org*

There is also an increase in the supply of investment products, especially investment funds, claiming to comply with sustainability criteria. Given the large number of sustainability funds (for example, 313 such funds were available in Europe in 2002-2003[13]) and a growing need for transparency with respect to their ecological and social performance, Koellner *et al.* (2005) developed a conceptual framework for rating their non-financial performance. Sustainability rating allows the identification of funds with positive sustainable performance, thus facilitating better-informed investment decisions. Koellner and co-authors proceeded from the precondition that to be managed in accordance with ecological and socio-economic goals and strategies each sustainability fund should be rated with respect to two aspects: (1) *business/research processes* in fund management (driver), and (2) *sustainability performance* of funds (outcome).

According to this concept, the fund's sustainability performance is defined for its bonds and stocks in three areas:

- *economic impact* – corporate governance, innovations, suppliers' relations, etc.
- *social impact* (including all aspects of ethics and culture) – exploitative child labor, human rights, stakeholder relations, etc.
- *ecological impact* – energy input; water, land and material use; harmful emissions (including GHG), etc.

The total performance of a portfolio of funds increases if one or more aspects of performance improve. Anantram and Noronha (2005) see several shortcomings of available funding approaches in the following:

- Contributions are essentially voluntary and insufficient to meet needs;
- It is clear that climate change operational programs are mitigation oriented;
- Terms of funds are not fully negotiated;
- Amount of funds in the Adaptation Fund depends on the size of the CDM market, which makes adaptation contingent on its development.

These authors also argue that a financing mechanism for adaptation should be viewed through a public goods lens. The goods and services that adaptation measures or actions provide need to be filtered based on the provision of global or regional public goods, or services that calls for international or regional cooperation, and national or local public good (service) that calls for a top-up to conventional development transfers. The provided goods and services are public in their nature, as it is not possible to exclude people from their use; also their consumption is non-rival. Their provision would have universal benefits on regions and different socio-economic groups. Anantram and Noronha also suggest that financing of adaptation measures should be distinguished according to the services they provide:

- *New* financing for international and regional collaborations and programs for those adaptation measures, which provide regional and global public goods to meet adaptation priorities;

[13] Socially Responsible Investment (SRI) compass, 2005. Available at: *www.sricompass.org*

- ⇨ *Additional* financing to top-up development aid programs (greater value for resources invested) be provided to support the provisioning of goods and services to enhance adaptive capacity at the country level;
- ⇨ *Special compensatory financing* designed on fairness and 'polluter pays' argument that recognizes differential vulnerability and the least advantaged to support activities and measures that reduce vulnerability of individuals and communities in developing countries.

"Disaggregating adaptive responses and measures by the types of goods and services they provide enables a more systematic distinguishing between the various streams of financing required, and provides a rationale for the additional resources that need to be generated for adaptation", – Anantram and Noronha believe (2005, p. 9).

Undoubtedly, all adaptations funds are inadequate to the adaptation tasks facing non-Annex 1 Parties. For example, by mid-2007 the actual multilateral financing delivered under the broad umbrella of initiatives set up by the FCCC had reached a total of US$26 million that is equivalent to one week's worth of spending on flood defense in the UK. Total committed financing for adaptation through dedicated multilateral funds will amounts to US$279 million and will be disbursed over several years. The Human Development Report 2007/2008 (UNDP, 2007a) shows the striking contrast between this sum and adaptation efforts in rich countries. This special report, dedicated to fighting climate change, names a second figure: the German state of Baden-Würtemberg is planning to spend more than twice as much as the entire multilateral adaptation effort on strengthening flood defenses.

'Skewness' in climate change fighting financing (with an accent on mitigation) in transition countries can be illustrated on the example of Latvia (Box 4.6).

Thus, *"calls for adaptation funding continue to challenge the existing funding structures in an effort to seek channels for addressing this issue"*, – Schipper (2006, p. 90) stated, and this process appears to be halted by the questions about the essence of adaptation. "There is evidence that scholarly discussions about adaptation are not in complete rhythm with policy debates" (*Ibid)*. In particular, climate change adaptation has to be brought to the top of the international agenda for *poverty reduction* – one of principal goals of the Millennium Development. Evidently, poverty reduction programs cannot be fully climate-proofed, however, they can be strengthened in ways that build resilience and reduce vulnerability. National poverty reduction plans and

Box 4.6 Climate change financing in Latvia

Over the 2001 to 2004 period, 13 studies with climate change relevance were funded by *Latvian Council of Science.* However, practically all these researches were in the field of effective energy use and creation of renewable energy potential. The national budget program "Latvian Environmental Protection Fund" provides funding for various research projects on GHG emission reduction and implementtation of related environmentally friendly technologies. For example, in 2005 this program funded seven climate change related projects, but only three themes under financing can be attributed to the study of climate change impacts, vulnerability and responses:

- *"Global fluctuations of climate and measures to reduce their impact in Latvia"*
- *"Providing education on climate change in Latvia", and*
- *"Financial resources, financial investments and activities to provide technologies".*

Source: Fourth National Communication of the Republic of Latvia to the UNFCCC, Ministry of Environment, Riga, 2006, p. 101-102 budgets are the most effective channel for achieving these goals.

Although there are no blueprints to be followed, UNDP (2007a) identified some conditions for success.

First of all, developed countries have to move beyond the current system of underfinanced and poorly coordinated initiatives. Faced with the threat to human development posed by climate change, the world needs *a global adaptation financing strategy* that should be seen not as an act of charity on the part of the rich but as an investment in climate change insurance for the world's poor. The aim of this insurance is to empower vulnerable people to deal with a threat that is not of their making. The climate change impact in the lives of the poor is not solely the result of natural forces; it is also the consequence of human actions. More specifically, it is the product of energy use patterns and decisions taken by people and governments in the rich world. In other words, the case for enhanced financing of adaptation is rooted partly in a simple ethical principle, namely: those countries which are responsible for causing harm are also responsible for helping those affected by the consequences. *"International cooperation on adaptation should be viewed …as an expression of social justice, equity and human solidarity"* (UNDP, 2007a, p. 194).

Thus, the world nations should agree with the UNDP position that protecting natural systems and infrastructure against climate change risks is only one critical element of adaptation. Building resilience against incremental risks is about more than investment in physical infrastructure and post-emergency recovery; it is also about empowering people to cope with climate shocks through public policy investments that reduce vulnerability. The overwhelming focus on 'climate-proofing' infrastructure objectively excludes strategies for empowering, and hence climate-proofing, the people. *"The latter is more difficult to put a price on, but no less critical to successful adaptation"*, – UNDP argues (*Ibid*, p. 193).

Moreover, insufficient financing is not the only constraint to the development of successful adaptation strategies. At present, both donors and national governments are responding to the adaptation challenge principally through project-based institutional structures operating outside planning systems for budgets strategies. Project-based assistance cannot provide a foundation for scaling up adaptation partnerships at the pace or at the scale required. Whereas projects operate on short-term cycles, adaptation planning and financing provisions have to operate over a longer time horizon. UNDP (2007a) names two lessons that emerge from the adaptation experience related to requirements for developing such strategies:

- ▲ *Reforming dedicated multilateral funds.* The major multilateral funds should be unified into a single fund with simplified uptake procedures and a shift in emphasis towards program-based adaptation;
- ▲ *Putting adaptation at the centre of aid partnerships.* Donors need to mainstream adaptation across their aid programs, so that the effects of climate change can be addressed in all sectors. By the same token, national governments need to mainstream adaptation across ministries, with the coordination of planning taking place at a high political level.

To soundly formulate an adaptation project under the various funds, the UNDP's Regional Coordinating Unit in Bratislava elaborated certain criteria to be eligible for funding and key steps for developing an adaptation project concept (NCSP, 2006).

Criteria for adaptation projects. Although details vary, all funds under the UNFCCC and its Kyoto Protocol require project proposals to clearly demonstrate the relevance of climate change impacts to the vulnerability to be addressed. Two key points are critical in this context: (1) historical data needs to be referred to for identifying occurrences of hazards under present climate conditions; (2) to show the trend of future climate change and its impacts. Adaptation projects should help move from spontaneous responses towards anticipatory ones in a planned fashion. The rationale for this moving is based upon the premise that planned and anticipatory responses will both be more cost-effective and help avoid major losses.

Experience of adaptation projects developed for funding under the Special Climate Change Fund (SCCF) indicated a common suite of adaptation measures that fall into four main categories: adaptive capacity building; integration of risk reduction into national/sectoral strategies, policies and plans; implementation of adaptation hard measures; and financial instruments such as pricing and tariff measures, insurance and other risk transfer mechanisms.

Key steps for developing an adaptation project concept include:

- *Identification of national priorities* for adaptation based on the review of existing national assessments;
- *Verification of the case for adaptation* that involves using scientific data and information to demonstrate vulnerabilities of concerned sectors/communities to observed current climate variability and projected future climate change;
- *Development of priorities for adaptation action* that includes national/sectoral development priorities and ongoing/planned development programs (including those of bilateral and multilateral donors) need to be consulted to ensure the complementarity and synergies of projects and activities;
- *Conducting of policy dialogues* that engage key stakeholders in the process of elaborating a planning, implementation, monitoring and evaluation framework for the identified adaptation project.

Numerous additional details on funding for adaptation to climate change, including the sources, strategic priorities, the procedures to operate with and so on, can be found in Mace (2005).

Natural disasters risk financing

In Chapter 1 it was shown that a number of climate-related weather events or weather-related disasters (henceforth referred to as *natural disasters*) and the economic losses caused by them have been increasing during the last decades and will continue to do so in the future due to climate change. This trend is primarily attributable to the steady growth of the world population, the increasing concentration of people and economic value in urban areas, and the global migration of populations and industries into areas, such as coastal regions, which are particularly exposed to natural hazards. Hoeppe and Gurenko (2006, p. 608) define as *great natural disasters* "the events in which the affected region's ability to help itself is distinctly overtaxed." They also proposed the following criteria (one or more) that may be applied to these events:

- ✓ *Thousands are killed*
- ✓ *Hundreds of thousands are made homeless*
- ✓ *Substantial economic losses*
- ✓ *Considerable insured losses*
- ✓ *Interregional or international assistance is necessary.*

Although the economic losses caused by natural disasters are highest in industrialized countries, in relative terms the overall impact on their economies has been rather minimal because they still have sufficient financial and technological resources to absorb it. However, for many of the poorer countries, the increasing exposure to natural catastrophes, in conjunction with the higher vulnerability of their economies to natural disasters and highly volatile and insufficient external financial assistance, entails large risks for their development.

Ultimately, natural disasters have a clear regressive effect on sustainable development because they impact the poorer nations far more than rich ones, influencing the distribution of income, wealth, and costs. Based on the review and synthesis of the literature and case studies addressing differential impacts of natural disasters on a society and its economy, Ibarrarán *et al.* (2009) have drawn three lessons that can be useful for policy implications:

First, given that the poor are more vulnerable to natural disasters, climate change has a potential to create a vicious cycle of poverty and vulnerability.

Second, investment in disasters prevention, awareness, and mitigation will be progressive in terms of inequality and poverty reduction. However, a country or community may somewhat insulate itself from their negative effects through physical, economic, and institutional development.

Third, though natural disasters can be unexpected and uncertain in their occurrence and effects, they need to be considered as events that are likely to happen and therefore require advanced planning. Moreover, subgroups vulnerability should be addressed and built into natural disaster prevention programs to avoid further gaps among the poor, thus increasing overall social and economic resilience to such events.

The quoted authors also propose implementing financing of adaptation to natural disasters on two levels. *Household and community level* strategies may be put in place to reduce risk. They may include moving out of hazard-prone zones, investing in hazard-resistant technology, and diversifying income sources. At the second – *public level* – short-run policies are to design a contingency fund within the budget to provide aid when a disaster takes place. Other public level policies that could be accomplished in the medium term may include relocating settlements and building physical infrastructure to mitigate the effects of natural disasters and contain their magnitude; in the long run, policies such as diversification and relocation of economic activity or the generation of resources to face future disasters may be vital. However, these and other policies to address risks of natural disasters, including global catastrophe insurance, also need new innovative financing mechanisms that can address the increasing volatility and severity of losses sustained by national economies due to these events, and at the same time – provide appropriate incentives for *ex-ante* risk management and adaptation to adverse impacts of climate change that are likely to become even more pronounced in the future (Hoeppe and Gurenko, 2006).

Natural hazards risk financing can be provided from various sources, including the at-risk population, governments, donors, and, if conditions are right, the private insurance sector. A fruitful approach to explore is *public–private partnership* (PPP) where the public sector sets a rigorous framework to reduce the physical risks, provides cover for high levels of risk or segments with high administration costs, and sets the rules for a private market for other risks, while the private sector provides services and offers coverage for lower levels of risk and segments that are more easily accessible (Dlugolecki and Hoekstra, 2006). Since in transition countries public resources are limited, PPP seems to be the appropriate model for insuring climate risk. Involvement of the private sector in disaster risk financing schemes has various advantages. For instance, risk-based pricing can be an effective risk-revealing mechanism, while the presence of international (re)insurers helps diversify the risk globally and transfer lessons internationally. PPPs may also find it advantageous to cede at least a part of their catastrophe risk peak accumulations to the global reinsurance or capital markets. Dlugolecki and Hoekstra outlined also the respective roles of the public and private sectors here (Table 4.9).

Table 4.9 Public and private sector roles in catastrophe insurance

Function	*Public sector role*	*Private sector role*
Risk assessment	Data collection, generic models	Risk modeling
Risk reduction	Regulation and enforcement	Product-based incentives
Product design	General regulation, consumer protection	All stages of product design
Risk financing (infrequent events)	Guarantee fund	Risk capital
Distribution/marketing	Consumer awareness, high-cost sectors	Multi-channel delivery
Loss handling	Minimal	Major role
Administration	Minimal	Major role

Source: Dlugolecki and Hoekstra, 2006

Climate and weather insurance

Another element of financing is support of recovery from climate-related disasters**.** Most climate change financial assessments rarely consider low-probability, but with high-consequences, extreme events. However, the largely proactive approaches that develop measures aiming to reduce climate risks are unlikely to be fully effective in this case. The reactive approaches are also needed to help vulnerable countries to cope the risks that remain. That is why, as one facility of adaptation, the Framework Convention and Kyoto Protocol identified ***'climate insurance'.*** Insurance as well as alternative risk-transfer instruments that provide a disaster safety net for the most vulnerable nations are an important cornerstone for risk management and a possible no-regrets adaptation strategy. Climate risk management is emerging on the climate change agenda; it has been a topic much discussed in recent years[14]. A much less intensively discussed issue is the question about whether insurance can play a role in cushioning possible negative impacts of climate policies, although there are a lot of measures with an equally wide range of potentially

[14] See, for example a special issue of *Climate Change* **6** (2006)

adverse and positive effects (Michaelowa, 2006). Interest is growing regarding the potential role that insurance can play in the implementation of climate change adaptation, particularly for the areas, most affected and least able to absorb negative effects. Sufficient climate adaptation efforts require mobilizing funding at the scale required, particularly given that the available funding is currently two or three orders of magnitude smaller than the levels needed, and insurance is considered as a possible way to increase the scale of funding. Research also suggests that appropriately designed and implemented insurance mechanisms can bolster sustainable development and reduce poverty. Appropriately designed insurance can provide incentives for both public and private risk reduction, and contributes to a positive cycle of security and stability for those participating in the insurance scheme(s). "The challenge is to construct a financial compensation mechanism which would not only enable even the poorest countries to recover from damages caused by natural hazards, relying on the help of international community, but would also reduce their vulnerability to future natural disasters" (Bals *et al.*, 2006, p. 638)

Climate insurance could take many forms, some of which only loosely relate to insurance in the traditional sense, while intended primarily to provide relief after losses have occurred. Some concepts of insurance at its application in adaptation to climate change were considered by the Policy Division of the UK Department for International Development (DFIR, 2004) (Box 4.7). The principal statements of this work are repeated here.

Coping with risk is an intrinsic part of life. Insurance is an important part of dealing with risk, and is a way of transferring it to other agencies and spreading the financial cost of recovery over time. Insurance works by setting aside resources that

> **Box 4.7** Key concepts of insurance
>
> The ***cost of insurance*** is dependent on the supplier's view of the expected loss, the frequency of that loss, and the costs of administering the scheme. Premiums are calculated in order to ensure that insurance schemes are financially sustainable. This is done on the basis of actuarial (historic) data on the risk of an event and expected damage costs in the event of a payout.
>
> To be sustainable, insurance schemes must collect more in premiums than they pay out over a number of years, although this may not be the case for individual years. International reinsurance through global financial markets enables schemes to survive in high cost years. Insurance becomes unsustainable when premium costs rise beyond what the target customers can afford, either due to increased frequency or damage from events, or administration costs.
>
> ***Moral hazard*** is where an individual's behavior changes in a way that increases the chance of disaster simply as a result of taking out insurance. For example, safe in the knowledge that insurance will pay out, individuals may make riskier decisions: they may plant climate-sensitive crops or fail to protect property against floods; governments may not enforce precautionary measures such as building codes and zoning, which would reduce vulnerability.
>
> ***Asymmetric information*** is where the insured and insurer have different information about the circumstances of a loss, such as a fall in crop yield – and the extent to which weather or other practices are to blame. The greater the differences, the more resources have to go into assessing loss and the greater the cost of administering the insurance.
>
> ***Covariate risks*** are those that affect whole communities, regions, or countries at the same time, raising the cost of providing insurance. Weather events and disasters are covariate. High costs in individual years must therefore be offset through the reinsurance market.
>
> ***Adverse selection*** is where the premiums offered are higher than low-risk individuals are prepared to pay. Only high-risk individuals will seek insurance, leading to even higher premiums.
>
> *Source:* DFID, 2004

can be called on if an individual or organization experiences a sudden shock. Formal insurance is provided through private or public schemes. Informally, the alternatives are to use microcredit and savings, invest in 'liquid' (saleable) assets – such as livestock – that can be sold in times of need, or to trust in family and social networks. As such, insurance can offer a method to spread the risk associated with climatic shocks and to provide access to essential funds in the event of a climate disaster. For example, in the UK, where flooding is common, flood insurance is a mandatory element of home contents insurance, and 70% of households have a cover (DRID, 2004).

However, innovative approaches are required to provide affordability of insurance in adaptation to climate change. Undoubtedly, demands for insurance will increase, while at the same time its cost will also increase. A challenge is to find ways to make insurance more affordable by reducing administrative costs.

Weather-related insurance has always posed a problem to the insurance sector. The problem will likely be exacerbated by the increasing risk and unpredictability of climate-change driven extreme weather. Even in developed countries, the climate insurance market is limited by insufficient information and understanding of risks on both sides. Past climate variability is a poor predictor of future risks, especially when climate is changing, leading to volatile markets and costs of insurance. Low awareness also means that even those at risk who could afford weather-related insurance often do not take it up. Formal weather-related insurance markets are historically weaker in developing countries and, especially, in transition economies where the former state insurance system is being replaced by private insurance companies.

Nevertheless, the research community, IPCC and governments of climate-vulnerable countries are beginning to recognize that insurance must be a key element in the climate change adaptation toolkit (Burton *et al.*, 2006; Mills, 2004).

For governments, insurance can offset the costs of reconstruction, recovery, and debt servicing; insurance payouts can also provide immediate cash flow to avoid further debt accumulation. In the medium and longer term perspective, insurance payouts can prevent divert resources from other development plans. The options open to governments include conventional insurance and reinsurance in international markets, group insurance with other vulnerable countries, or self-insurance through national funds, underwritten with novel financial instruments.

For individuals and businesses, climate insurance can help survive the immediate hardships of a disaster and allow rehabilitating personal businesses with a minimally possible disruption. Insurance can also be a factor in reducing people's future vulnerability to climatic events, stipulating (at the expense of insurance payouts) the reconstruction of infrastructure or housing in less vulnerable locations according to climate-proof design standards. In some developed countries the insurance companies are already exploring the low-cost adaptation techniques as a condition of insurance policies and lower premiums charged for climate-proof buildings, infrastructure and crops.

And, at last, DFID (2004) proposed several opportunities for the international community to stimulate the development of insurance as a tool for climate change adaptation:

❖ *Support pilot projects at local, national and regional levels that make affordable insurance available to vulnerable individuals and governments.* This approach requires the partnership between public and private sectors and better understanding of vulnerabilities and existing capacity that can be built on. Lessons from pilot projects provide models for scaling up and linking with international insurance markets to spread risks.

❖ *Facilitate improved information-sharing and more relevant information collection.* Insurance schemes have heavy information and modeling needs (for example, in meteorological data, climate predictions, economic vulnerability data, etc.) to escape high administrative costs and unaffordable premiums. Much of this information is also critical for pro-poor risk reduction and disaster management. International agencies can support active information-sharing between climate scientists, private sector insurance providers, and governments.

❖ *Promote pro-poor insurance conditions.* Insurance mechanisms need not simply offset risk, but also be used to reinforce appropriate responses to climate risks such as crop and livelihood diversification. Donors can assist by encouraging new and existing insurance and credit schemes to incorporate climate 'conditionality' terms.

Burton *et al.* (2006) described two insurance-type approaches that in some cases could be designed to encourage proactive efforts:

- *International response fund* – Donor countries would commit to regular contributions to a multilateral fund to assist countries suffering extreme and/or long-term climate impacts;
- *Insurance "backstop"* – Donor countries support the introduction or expansion of insurance-type instruments in vulnerable countries by committing funds to subsidize premiums or to reinsure governments or primary insurers.

The climatic events of recent years in transition countries, such as records high temperatures and drought in Moldova in 2007 and the disastrous plain floods in 2008 in Moldova and Ukraine, as well as the record hot summer with unprecedented wildfires in Russia in 2010, have drawn unusual levels of post-disaster assistance. However, these and other humanitarian flows remain largely ad hoc, dependent on a new round of pledging following each new event. To provide a more predictable and timely response to natural disasters and other humanitarian crises, the UN recently established the Central Emergency Response Fund supported by voluntary contributions and replenished at regular intervals[15]. Burton *et al.* (2006) propose to advocate this approach further within the climate arena as a new instrument, supported by long-term funding commitments, to provide relief from extreme climate impacts. We think that such a fund, narrowly targeted at the impacts directly attributable to climate change, could also be regional, in the frameworks of current regional alliances, for example, CIS. These funds seem most practical if they will be directed at risks arising from both climate change and climate variability, responding for major climate-related impacts whatever their cause. In addition to addressing losses directly attributable to climate change, such funds would help to rationalize climate disaster assistance by substituting regularized funding for reactive and unpredictable post-disaster aid.

A different strategy would be to commit funding to help facilitate insurance and other risk-transfer mechanisms within vulnerable countries. Commercial insurance is presently

[15] More about the Central Emergency Response Fund can be found at: *http://ochaonline.un.org/cerf/CERFHome/tabid/1705/Default.aspx*

available for a wide variety of weather-related risks, however only to those who can afford it. In 1980 to 2003, insurance covered 40% of weather-related disaster losses in high-income countries, but only 4% in low-income countries (Mills, 2004). Donor governments, in partnership with the private sector, could support insurance-type approaches in vulnerable countries by subsidizing premiums or by pledging backup capital to reduce risks to public or private providers. Some of risk-transfer instruments that could be supported for different sectors and types of risk are shown in Box 4.8.

The last listed instrument – index-based mechanisms such as *weather derivatives* – is an especially promising approach. It assures payoffs without requiring the demonstration of losses, thus avoiding the costly and time-consuming process of verifying claims. In particular, the World Bank developed a proposal for a Global Index Insurance Facility, with $100 million in public and private capital, to reinsure governments and primary insurers providing index-based coverage against weather and other risks (Burton *et al*., 2006). Michaelowa (2006) propose to use financial derivatives for the short term (up to 3 years) reducing losses of fossil-fuel-exporting countries from global climate change adaptation measures.

Backstopping or *reinsurance* is usually provided for acute losses from extreme events such as hurricanes. Backstopping could take the form of catastrophe bonds, in which investors funding a reinsurance pool receive above-market returns if no losses occur but risk their investment in the case of a major disaster. Donor governments, alone or with private investors, could use this mechanism to back climate relief in vulnerable countries or regions. However, while the risks and resources of reinsurance firms bode well for their active participation in climate change policy, the equity implications of such participation are not necessarily so good for poor people around the world, who typically carry no insurance at all. So, whereas additional resources devoted to preventing and adapting to climate change are welcome, Clark (2008) remembers that insurance claims are not always the appropriate relative measure of tragedy. For example, Hurricane Katrina caused 1,833 deaths and $43.6 billion in insurance losses, but the December 2004 tsunami caused 230,000 deaths and only $4 billion in insurance payouts.

Insurance-type approaches can

Box 4.8 Examples of insurance-type instruments to cover climate-related risks explored or tested by insurance industry and developing countries

- *Pooling Cash Reserves*. As a form of collective self-insurance, the Eastern Caribbean Central Bank is accumulating cash reserves through mandatory contributions by member governments, which can then draw loans if struck by natural disasters.
- *Indemnifying Debts*. The Commonwealth & Smaller States Disaster Management Scheme provides insurance to risk-prone governments so they can continue to service outstanding debt following natural disasters. Countries pay a 1% flat-rate premium of the sum insured.
- *Catastrophe Bonds*. The World Bank is exploring whether catastrophe bonds *(Cat bonds)*, now in use in developed countries, might be extended to developing country markets. Catastrophe bonds insure against a predefined event. Investors who purchase them realize a return if the event does not occur but may lose their entire investment if it does.
- *Indexed Insurance for Agriculture*. The contracts, known as weather derivatives, provide payments to farmers under predetermined conditions (such as number of days with temperatures above a set threshold) without requiring proof of loss.

Source: Adapted from Burton *et al.* (2006) and DFID (2004) also serve to promote proactive climate risk management. As with a development-centered approach, climate 'insurance' would extend well beyond the traditional scope of the climate change regime, particularly if designed to address also the impacts of climate variability. Here, Burton *et al*. (2006) see the possible launch of a concerted effort only through a political bargain struck within the climate regime. In addition to technical issues, the fundamental challenge may be one of political acceptability. Wealthy countries cannot easily commit to substantial long-term funding, without which a meaningful program would be not viable. On the other hand, non-Annex 1 countries may resist sharing in the costs of a program that, in their view, should hold them accountable for risks created by others.

Bals *et al.* (2006) proposed the concept a Climate Change Funding Mechanism (CCFM) of the provision of financial support to sovereign governments for the rehabilitation of public infrastructure that has been damaged or destroyed by natural hazards (Fig. 4.7). Under the proposed concept, countries with a high risk profile could *opt into* (OPT-IN) the CCFM system, which would enable them to cover infrastructure damage caused by natural hazards in situations where the country's financial capability is over-stressed. This capacity could be defined upon entering the CCFM system. At the same time, the system would provide incentives for increased adaptation and risk reduction measures.

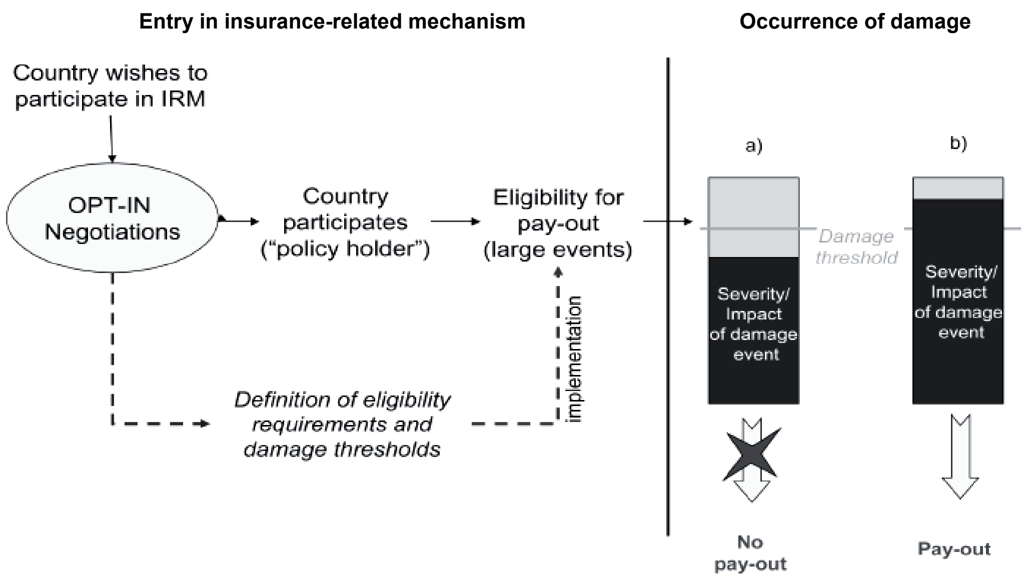


Fig. 4.7 Concept of the Climate Change Funding Mechanism. *Source:* Bals *et al.*, 2006

To address the different risk context of stochastic sudden- and slow-onset weather related disasters, Linnerooth-Bayer and Mechler (2006) suggests a two-tiered climate insurance strategy. The first tier – *Climate Insurance Programme* – is the core of this strategy and supports nascent disaster risk financing mechanisms for climate related risks

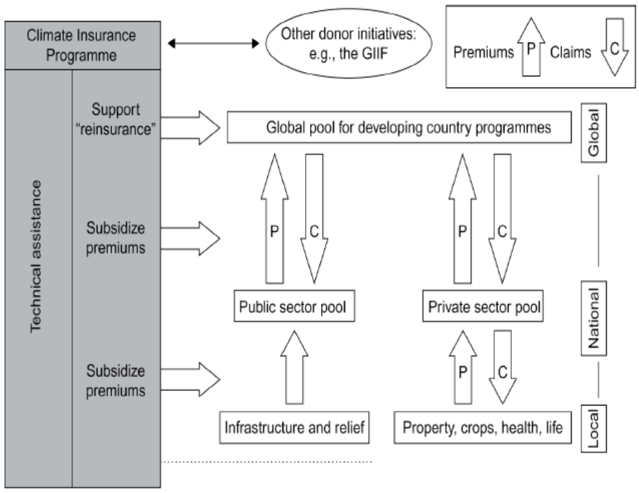


Fig. 4.8 An illustration of climate insurance program. *Source:* Linnerooth-Bayer and Mechler, 2006

at the local and national levels. The second tier – *Disaster Response Programme* – provides adaptation funding of post-event relief for weather-related disaster risks that are not (yet) financially protected as well as for uninsured disaster because of data or institutional limitations.

The main goal of the climate insurance program (Fig. 4.8) is to enable the establishment of public/private safety nets for stochastic weather-related shocks by making use of insurance instruments that are affordable to vulnerable and marginalized communities, coupled with actions and incentives for proactive preventive (adaptation) measures. Assistance could take many forms, including technical support for feasibility studies and capacity building, and financial support in the form of reinsurance and subsidies. It could be extended to schemes from the local to global levels, complementing each other and leading to better global risk diversification and, as a consequence, reduced premiums.

To undertake the key insurance functions, specialized 'actors' are evolved: insurers, reinsurers, risk modelers/actuaries, claims adjustors, agents/brokers and customer associations. Competitive forces drive the search for best practice and cost-efficiency, including fraud reduction. The stakes for each actor are not equal (Dlugolecki and Hoekstra, 2006).

UNFCCC (2007c) formulated some cost-effective insurance initiatives that can help adaptation and opportunities for the international community to support insurance-related solutions to climate change in developing countries (Table 4.10). We believe that these initiatives and opportunities are also acceptable for transition countries.

UNDP (2007a) adds to these insurance initiatives and opportunities the ***insurance for social protection.*** Climate change is likely to create incremental risks for the lives and livelihoods, especially of the poor. Climate shocks can rapidly erode the entitlements of vulnerable people through their impact on income, nutrition, employment, health, education and so on. Since poor people cannot fully manage even current climate risks with their own resources, any adaptation strategy needs to strengthen risk management capabilities. Empowering people to cope with climate shocks (without suffering the long-term setbacks) is a condition for sustained progress in human development.

Climate change provides a strong rationale for strengthening the social protection safety nets for the poor, along with other fields, in such areas as cash transfers, crisis-related and insurance-related transfers. In particular, cash transfers linked to clear human development goals can weaken the transmission mechanisms that convert risk into

Table 4.10 Possible cost-effective insurance initiatives to help adaptation to climate change and opportunities for the international community

Insurance initiative	
◆ Innovative risk transfer mechanisms such as multi-state risk pooling ones ◆ Regional reinsurance facilities, either through the private market or from the state, whereby the re-insurer assumes responsibility for covering a portion of the risk, especially for rare but extreme event losses ◆ Catastrophe funds linked to international financial markets that pay out on a trigger condition, such as temperatures over a certain value with a certain, rather than on proof of loss ◆ National/regional disaster funds supported financially by the international community	◆ Micro-finance and micro-insurance ◆ Public-private partnerships ◆ Generation of carbon credits in exchange for support for insurance ◆ Weather derivatives which provide payouts in response to weather triggers rather than in response to demonstrated losses ◆ An international insurance pool that suggests that payments into an insurance pool would be a form of compensation linked to responsibility or liability for the impacts of climate change
Opportunities for international communities	
◆ *Supporting public private partnership* by transferring the risks of national or regional public-private insurance systems in the capacity of re-insurer or consider subsidizing the costs of alternative hedging instruments ◆ *Supporting relief and reconstruction* by assisting governments in transferring their risks of public infrastructure damage either through private insurers or directly to the capital markets through alternative risk-transfer instruments ◆ *Supporting micro insurers* by playing a possible role in supporting and transferring the risks of micro-insurers, e.g., those offering weather hedges, possibly by acting as re-insurer or assuming the interest payments of catastrophe bonds	◆ *Supporting data collection and analytical capacity-building* by providing support to developing countries in collecting the requisite data and in building analytical capacity as any insurance or insurance-related system requires knowledge of these risks ◆ *Supporting new risk hedging instruments* by creating national-level market incentives, for example tax reductions to individuals or institutions for purchasing developing country catastrophe bonds at lower interest

Source: Adapted from UNFCCC (2007c)

vulnerability. They can also create incentives for the development of human capabilities. UNDP demonstrates the necessity of crisis-related transfers by using agriculture as an example. Climate shocks have the potential to lock smallholder agriculture into downward spirals that undermine the prospects of its further functioning. Farmers can be left without seeds or cash for their purchasing. This increases the prospect of reduced income and employment, and hence of continuing dependence on food aid. This self-reinforcing downward spiral can be broken, or at least weakened, only through the transfer of a range of productive inputs.

4.2.4.3 Pioneer countries and leadership

The actual direction of the change and convergence in environmental policy is signify-cantly influenced by *political pioneer countries* and so-called *'lead markets'* for green technologies, i.e. advanced countries in the development and marketing of technological innovations and ecological modernization (Box 4.9). The development of tangible techni-cal and political means to deal with the pressure of natural force triggers the environmental

Box 4.9 Pioneer countries as a pre-condition for ecological modernization

The theory and policies of ecological modernization raise a number of rather complex questions that could be expressed in six theses:

1. The pivotal component of ecological modernization is advanced technology;
2. The most important pre-condition of eco-innovation is stringent regulation;
3. Environmental innovation takes place in lead markets of pioneer countries. Despite globalization, environmental policy and technological innovation remain dependent on individual pioneer countries because global environmental regimes are rarely suitable points of departure for developing technological environmental innovations;
4. Internationally active companies are central to the creation and global diffusion of eco-innovations;
5. Environmental innovations do not easily trickle down the hierarchy of the world-system. Leapfrogging and tunneling is possible, but limited.

Thus, the most important factors, or actors respectively, are regulation by nation–state governments (thesis 2) aimed at stimulating and backing eco-innovative activities of pioneer countries and companies creating national lead markets (theses 3 and 4). Eco-innovations diffuse by domestic and global adoption (theses 3); however, such diffusion within the world-system meets with specific restrictions inherent in uneven development (thesis 5).

Source: Adapted from Huber (2008)

policies and may be later presented and transferred to other countries or serve as examples for international legal accords. Such ‘pioneering’, or ‘leadership’, plays a crucial role in determining the issues for policies convergence. So, in the climate mitigation context the term ‘leadership’ is typically associated “with the stated ambition of nation-states to curb greenhouse emissions: the more ambitious the emissions reduction goal, the higher the leadership score” (Andresen and Agrawala, 2002, p. 41). However, the concept of leadership is much more nuanced and contested within international relations theory. Summarizing the available research, the quoted countries identified four types of leadership: intellectual, instrumental, power-based and directional ones. Different actors can exert different kinds of leadership; for example, directional leadership is exerted by nation states.

The role of pioneers and the domestic conditions necessary for a country to become a pioneer in environmental policy are discussed in different works (Andresen and Agrawala, 2002; Jänicke, 2005; Kulessa *et al.*, 2007; Yamin, 2005).

Generally, there is a reason to believe that *environmental policy convergence* (see Sect. 4.2.2) is influenced not only by functional imperatives of the world market (*globalization* as an example), but also by a collective behavior of national governments where ‘pioneer countries’ act as intellectual leaders. Their solutions for general environmental problems are adopted by other countries. As a rule, there is one single solution that is preferred by a large group or the majority of countries. This regulatory ‘conformism’ makes the pioneering highly relevant, and its role in the environmental policy as in a new policy field has been existed since the early days. Pioneer countries’ solution for a special environmental problem, being adopted by a relevant group or the majority of other countries, creates a certain policy convergence. This mechanism was identified as a ‘condition for a success’ in the international environmental policy (Jänicke, 2005).

This author’s vision of the character and role of pioneer countries is more than simply ‘first movers’. To initiate a regulatory trend, a pioneer country need a certain ‘visibility’, and it is important whether or not its policy innovation contributes to the international policy agenda. Here, international institutions play an important role. “Pioneer countries are actors within the international policy arena" (*ibid,* p. 130). Nevertheless, policy innovations as well as their early adoption by other countries depend primarily on domestic factors. Jänicke depicted some factors, which determine the pioneer role of a country in the environmental policy, in the form of 'the funnel of causality' (Fig. 4.9).

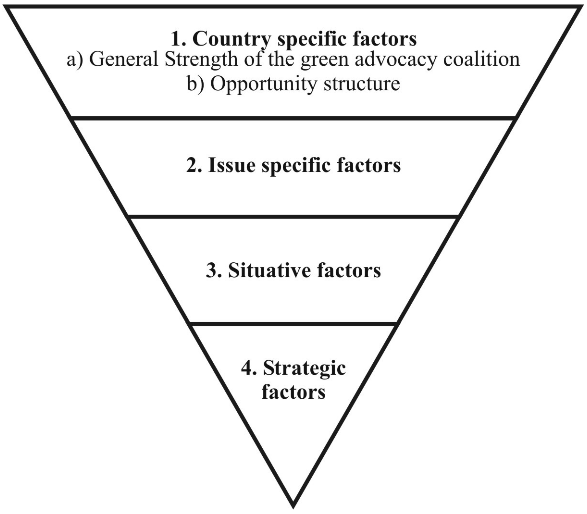


Fig. 4.9 National pioneer roles in environmental policy: the funnel of causality. *Source:* Jänicke, 2005

In this depiction, for becoming a pioneer country, the first necessary condition (1) is *a high domestic capacity for environmental policy-making*. Jänicke defines this term as "…the relatively stable limits beyond which successful action is impossible" (*Ibid*). These limits depend on the existing strength of the 'green' advocacy coalition together with the existing institutional, economic or informational structures. Pioneer activities are also *issue specific* (2), that is countries may be generally 'strong' in the field of environmental policy, but in particular issue areas they may have their own stories of success or failure. *Situative* factors (3) support or restrict the full use, or the enlargement of a given capacity (policy windows). Lastly, the author attributes the sufficient explanation of a given effective pioneer role to *strategic factors* (4): the 'will and skill' of using a given capacity and situative context. Thus, 'pioneers' in environmental policy are those countries where a strong green advocacy coalition is skilful enough to use an advanced opportunity structure – together with situative chances – to introduce more than one environmental policy innovation contributing to international regulatory trends. Objectively, pioneers countries play a leading role in international policy making.

From this viewpoint the question that arises is: *Who can act as a leader for transition countries in formulation their climate regime?* At present we think of the European Union as the best option.

As a high politics issue, climate change is firmly established on the agenda of political leaders around the world as well as figures regularly in bilateral and multilateral international meetings. It shapes, and is shaped, by international politics at large. General position in the international system and strategic orientation in this system support EU leadership on climate change and may be particularly suitable and strategically beneficial, although some analysts have suspected that this leadership has also been motivated by the desire to strengthen the role of EU in international politics on the whole[16] (Kulessa *et al.*, 2007). In March 2007 the European Council underlined once more "the leading role of the

[16] See, for example, Andresen and Agrawala (2002, p. 45): "The EU position was not necessarily only a reflection of concern for an environmental problem, but perhaps equally important as a stepping stone to stand forth as a strong and unified block on the world scene"

EU in international climate protection" (EC, 2007). Thus, in contrast to the USA or Russia, the EU had assumed a self-declared leadership role on the climate issue.

Transition countries were not 'leaders' in any kind of leadership and at any stage of the climate regime development. One rare exception was Russia's role as a driving force behind the Kyoto Protocol.

On the example of EU, Kulessa *et al.* (2007) conceive the potential leadership in international climate policy as a mixture of structural and directional leadership. The *structural component* follows mainly from the general influence and standing in international affairs based on overall and issue-specific political and economic weight, rather than on any particular action. As regards the *directional* (normative) dimension, one can only speak about leadership on climate change if an actor leads into the direction of strengthened climate protection, increasingly accepted as a commonly shared objective of humankind. The authors illustrated their statement by stating that since the negotiations on the UNFCCC in the early 1990s the EU has been the major leader in international climate policy, in particular, the major international proponent of ratifying the Kyoto Protocol and convincing Russia to bring it into force. In the ongoing discussions on the future of international climate policy, the European Council (EC, 2007) made an "independent commitment" to reduce EU greenhouse gas emissions by 20% from the 1990 level by 2020 as well as declared an intention to commit to its 30% reduction in the case of comparable commitments by other industrialized countries and the adequate commitments – by advanced developing countries. Since the beginning of the current century, the EU has increasingly implemented domestic climate policies, first of all, the emissions trading scheme; it has no major stake in the production of fossil fuels, demonstrating a particularly strong and increasing interest in the development and export of renewable energy technology (especially wind and solar) where it has a globally leading position.

Thus, there is no doubt the EU plays a significant leading role in the climate regime. Various factors indicate that this international leadership is built on a sound basis, and domestic political systems provide comparatively favorable conditions for the articulation of environmental interests. Climate policies have also broad public support being backed by economic interests and growing interest in climate-friendly energy sources and energy security. The EU's clear progress in the implementation of domestic climate policies provides an additional rationale for its international leadership on this issue.

Meanwhile, Kulessa and colleagues (2007) do not deny that recent trends in the international climate politics question the long-term stability of EU leadership. A climate policy gap between the EU and other countries is smaller than one may suspect, and the leading role may transfer to, e.g., USA and major developing countries. Undoubtedly, transition economies cannot remain aloof. That is why Yamin (2005) notes that maintaining the EU's leadership requires avoiding dissonance between the internal and external dimensions of its climate policy and to spend much more time and policy attention on developing countries, whose cooperation will be vital in upholding the Kyoto architecture and momentum for the climate regime as a whole. Transition economies should take full advantage of this opportunity.

4.3 Technology policies for climate targets

Another aspect, which has been very much debated in Global Warming literature, is the importance of *technological change.* Undoubtedly, the environmental impact of anthropogenic activities is deeply influenced by the rate and direction of technological change. On the other hand, sustainable development is also becoming a scientific and technological endeavor. According to the Forum on Science and Innovation for Sustainable Development (*http://sustsci.aaas.org/*), it "…focuses on the way in which science and innovation can be conducted and applied to meet human needs while preserving the life support systems of the planet". New forms of global support for capacity building for sustainable development are already possible, and new technologies have created many alternative tools.

Efforts to confront global climate change require technological innovations deployed on a massive scale which cannot happen overnight (Alic *et al.,* 2003). Many of the needed technologies do not yet exist commercially or are too costly; some alternatives, such as transition to biofuel, have to gain widespread social and political acceptance. IPCC AR4 (IPCC, 2007a, p. 68) emphasized *high agreement* and *much evidence* that stabilization of atmospheric concentrations of GHGs at a level that prevents dangerous anthropogenic interference with the climate system "…can be achieved by deployment of a portfolio of technologies that are either currently available or expected to be commercialized in coming decades, assuming appropriate and effective incentives are in place for development, acquisition, deployment and diffusion of technologies and addressing related barriers." Since at least some adaptations to climate change will almost certainly be necessary, they also will require innovation and would have profound implications for industrial and industrializing economies. Only with new technologies at competitive prices, climate change can be curtailed without sacrificing growth (World Bank, 2009).

Winne *et al.* (2005), considering a long-term European strategy on climate change policy, note that we "would move the discussion away from the negative aspects of mitigation, towards technology development and business opportunities" (p. 248), taking advantage of the current awareness of the benefits of modern technology and emphasizing the positive aspects of its change in future, based on a tremendous growth of fundamentally new technological systems. Moving on, Buchner and Carraro (2005) explored the idea of replacing international cooperation on GHG emission control with international cooperation on climate-related technological innovation and diffusion. Based on theoretical arguments and empirical facts, this idea proceeds from an understanding that incentives to free-ride are much greater than in the case of technological cooperation. As such, technological cooperation has also been proposed as the framework of a new approach to climate policy at an international level.

The aim of this chapter is to review some current climate policy proposals relating to technology development, to gain some insights into the nature of technological change and to present some policy suggestions on what needs to be done when it comes to developing more advanced and efficient technologies.

4.3.1 Technological change as process

Technological change encompasses at least three steps: *inventions* as new ways of doing old or new activities; i*nnovations,* which are often seen as a modification of a creation/invention to make it suitable for adoption; and *diffusion* as the process of disseminating inventions and innovations (Sanden and Azar, 2005). To some extent differently, Alic *et al.* (2003) consider *inventio*n as the process of discovery that leads to scientific or technological advance, perhaps in the form of a demonstration or prototype, while referring *innovation* to the translation of the invention into a commercial product or process. The subsequent implementation by users of new technology is referred to as *adoption* or *diffusion.* However, in any interpretation, transforming an invention into a product or process that can be commercialized and widely adopted typically requires significant improvements in performance, reductions in cost and involves prolonged cycles of incremental improvement before a new technology is adopted and spreads widely in the marketplace.

The ***key lessons for climate change,*** which Alic *et al.* (2003) have formulated from the analysis of US technology and innovation policies (supporting their finding by a large body of literature in economics and other fields that is omitted here), include the following:

1. *Technological innovation is a complex process involving invention, development, adoption, learning, and diffusion of technology into the marketplace***.** This process is highly iterative, and the different policies influence outcomes at different stages. The 'linear model' of innovation, which views the process as a one-way flow of ideas from basic scientific research into innovation, has been politically influential but fundamentally misrepresents the innovation process. A unidirectional flow of information and knowledge – from fundamental research through development into innovation – treats feedback from downstream development, field service experience, and marketplace as much less important. But empirical studies show that feedbacks are critical for innovation. More accurate conceptualizations view innovation as the outcome of a series of iterative steps linked by learning and feedback that flow both 'downstream', from research to design and development, and 'upstream' – from the development process to fundamental research. Policy debates and policy design often focus on '*upstream'* support for research, while overlooking '*downstream'* processes, although the latter are major sources of technological improvements and accelerated adoption. Such perspectives highlight the importance of learning both by the innovators and the users of their products.

2. *Gains from new technologies are realized only with widespread adoption process, which takes considerable time and typically depends on a lengthy sequence of incremental improvements that enhance performance and reduce costs***.** 'Radical' breakthroughs in scientific or technological knowledge generally are less economically significant than the lengthy series of incremental innovations and improvements necessary to arrive at a cost-effective and attractive to user product. An appreciation of incremental advances is essential to the formulation of policies for fostering innovation. The broad-based deployment of early versions of new technologies often are costly and may offer only limited performance improvements over the existing technologies, requiring additional large reductions in costs and substantial improvements in reliability and other performance

measures. As an example, Alic *et al.* (2003) named the process of using the gas turbines derived from military jet engines for electric power generation. It has taken several decades before their efficiency and reliability were improved to become cost-effective.

3. *The translation of inventions into innovations and subsequent incremental improvements entail extensive technological learning which is an essential step in pacing the adoption and diffusion.* Usually, technological learning occurs through three different but interrelated processes:

- ☑ Learning that leads to improved products or processes through research, development, and design;
- ☑ Learning in production, leading to reductions in manufacturing costs and/or process improvements; and
- ☑ Learning by users, which may be fed back into R&D and new or improved designs and/or incorporated into users' maintenance procedures and operating practices. Users also contribute to technological learning when the knowledge they gain through operation and maintenance helps manufacturers improve their products.

In this triad, 'learning-by-doing' contributes to reductions in production costs while the adopters of new technology contribute to ongoing innovation through 'learning-by-using.' Widespread adoption accelerates the incremental improvements from learning both by users and producers, further speeding adoption and diffusion. As these two processes proceed, more people and organizations participate, the costs decline and performance improves over time. The close linkage between technological advance and marketplace adoption is a major force in sustaining the overall dynamic of technological innovation. Because the benefits of technological innovation come only with widespread adoption, and because adoption and learning are mutually reinforcing processes, the policy portfolio should support diffusion of knowledge and deployment of new technologies as well as research and discovery. In short, R&D alone is not enough.

4. *Technological innovation is a highly uncertain process.* Pervasive uncertainty characterizes invention, innovation, and technology adoption. The potential outcomes of basic research are difficult if not impossible to anticipate, and the future applications of research results are even more uncertain. The long-term impacts of a new technology cannot be predicted accurately because operational characteristics and functional performance change over time, and because the pace of adoption is subject to a wide array of economic and social influences that are difficult to foresee. Large uncertainties cloud the future of many advanced technologies, and pathways of development cannot be predicted. Therefore, government policies should support a portfolio of options, rather than a particular technology or design.

4.3.2 Policies for development of more advanced technologies to fight climate change

Any swift technological change is difficult in achievement. While the drawbacks for individuals of implementing, e.g., carbon taxes, are obvious, the negative feedback on inactions is diffuse and distant in space and time. Hence, "political courage will be necessary to induce change" (Sanden and Azar, 2005, p. 1561). World Development Report 2010 (World Bank, 2010, p. 3) states that "time is not on our side". This conclusion was based on the rate of growth of CO_2 global concentrations in the atmosphere that ranged between 200 and 300 ppm for 800,000 years, but shot up to about 387 ppm over the past 150 years. The impacts of GHG released into the atmosphere will be felt for decades, even millennia, making the return to a 'safe' level very difficult. Immediate action is needed to keep warming as close as possible to 2°C. Such warming is not desirable, but it is likely to be the best we can do. Although there is no consensus that this value is optimal, the Word Development Report endorses a growing consensus in policy and scientific circles that "aiming for 2°C warming is the responsible thing to do"; from a development perspective, warming much above 2°C is simply unacceptable. However, stabilizing even at this level will require major shifts in lifestyle and technologies, and substantial adaptation would still be needed. *"Coping with climate change will require all the innovation and ingenuity that the human race is capable of"*, – the Report concludes (*Ibid*).

There is an academic debate on the main driver of technological change between proponents for *technology push* (supply of new technologies) and *technology pull* (changed demand), although a combination of both policies is needed (Winne *et al.,* 2005). The first policy could be useful for the long-term climate targets. For example, escaping carbon lock-in will be a slow process extending over many decades and is comparable with the growth of the fossil fuel system. A century was needed to increase the oil market share of 1% of the world's primary energy supply in the 1870s to 46% in 1973 (Sanden and Azar, 2005). Moreover, when habits, institutions and technological networks are adapted to the use of fossil fuels it is unlikely that 'spontaneous' technical change will take the world out of the carbon lock-in. Pulling new technologies into the marketplace requires economic signals stemming from comprehensive instruments such as taxes. The wide economy instruments not only affect price relations but also represent a signal of political ambition that affects expectations about the future and, thereby, the direction of the search for new solutions in the industry.

Using energy policy as an example, Sanden and Azar (2005) showed that early action is needed in at least four dimensions:

- To take measures to achieve actual emission reductions in the near term that is important for two reasons: (i) unabated emissions in the near term will make it technically and politically more difficult to meet the long-term stringent stabilization targets, and (ii) by implementing neat-term abatement policies, policy makers and other actors will learn how the energy system responds and this will make it possible to adopt better policies;
- To develop international institutions and rules of games that are needed to address climate change challenges;
- To develop new technologies that are required to meet future more stringent abatement targets;
- Strengthen private-sector, NGOs, and networks of actors that recognize the need for stringent climate policies.

The Kyoto Protocol is considered as a comprehensive vision of the problem. It addresses near-term emission reductions (the first bullet) and the development of institutions (the second bullet). Doing so, some technology development (bullet three) and actor support (bullet four) will be stimulated as well. On the whole, one can see in the Protocol the first step towards more stringent targets.

Sanden and Azar also examined the broad spectrum of policy instruments directly supporting the development of specific technologies. Among the available instruments they named R&D funding, demonstration, network formation, niche market management, standardization, and so on. They see the role of different policy instruments as follows:

1) *Funding of R&D* is crucial for technologies that are not expected to become commercial in the near term. It is not only basic scientific research that requires funding but also research that supports the whole innovation chain, including processes of technology, systems research and market assessments.

2) The *demonstration* functions both as a test, which generates knowledge of system performance and the user response that can be fed back into development, and as an advertisement that raises the level of awareness of the technology. In the early phases when performance uncertainty is high and awareness is low, demonstrations may get widespread attention and strengthen the support for other policy instruments.

3) The *formation of networks* around new technologies is crucial to disseminate knowledge and visions; the interaction of a number of actors forms a new technological system. Governments can facilitate networking by arranging or supporting necessary meetings, technical publications and developing the organizations for collaboration.

4) The rationale for *niche market* creation lies in that the increased adoption could lead to lower costs and increased utility via the positive feedback mechanisms. Market formation – an issue that is especially true for transition economies – has proved to be critical when a private demand for a product has yet to be formed or when costs need to be bought down to become competitive on the commercial markets. Policy-makers may form markets in many ways, and policy design will have an effect on technology choice and speed of development. Table 4.11 lists four types of policy instruments to create niche markets.

Table 4.11 Four types of policy instruments for niche market creation

Government procurement	Governments arrange technology procurement i.e. a government agency acts as a broker that identifies a bundle of potential customers for a new technology and then arrange a competition among suppliers. This guarantees a first market
Green labeling	This is a way to support articulation of the demands of certain customer groups, which may be organized by governmental bodies or NGOs
Assured market shares	To reserve market shares for specific technologies or technologies with specific characteristics
Assured price or subsidy	This class contains policies that change the cost for investing in specific technologies directly. More technology specific support may come in the form of direct investment subsidies, tax redemption or low interest loans

Source: Sanden and Azar, 2005

5) *Regulations* and *educational systems* need to be adjusted so the former do not automatically discriminate against new technologies, and the latter – to be able to supply new industries with a skilled workforce and new entrepreneurs, as well as to increase the general awareness in society.

All policy instruments need to be coordinated to enable a balanced development of new technological systems. Sanden and Azar (2005) argue that neither R&D funding nor various forms of market stimulus are effective on their own. For example, without substantial R&D there will be no technologies that may gain from market creation;

without market creation, emerging technologies will be unable to gain from economies of learning and scale. When the technology is adopted and diffused on a niche market the new entrants will supply more resources to R&D that in turn will enhance the technology and enable more widespread diffusion. There are also feedback loops between the adoption of the technology and institutional change. R&D investments will create knowledgeable technology proponents, and market diffusion will increase the number of actors, the size of economic interests and the strength of the networks involved. These forces will influence policy instruments that need to be adopted to sustain the development of the technology to a point of competitiveness and self-sustained growth.

However, not only the combination of different kinds of policy instruments is important, but also the *timing* of intervention. Funding of network formation at a time when the emerging technological system is mature enough to form its own networks is pointless, much as funding a demonstration at a time when the technology already is well-known may be ‘a way of demonstrating good will’.

And, at last, a policy needs not only to be balanced and timed; it also needs to be stable and predictable over long time periods. It is a challenge for political systems in transition, with sometimes frequent shifts in government, to ensure stability and predictability over the long term. A lack of understanding of the time lags involved in technical change could create disappointment among politicians and the public, which in turn could reduce the interest and support for emerging technologies. Inconsistency in funding could lead to a loss of technological capability.

In speeding up the rate of technical change and development of new technologies, it is important to take into account the risk of going in the wrong direction. That is why an important policy task is to balance the speed of change with sustained variety of technological capability, or ‘***technodiversity’,*** to reduce the risk of a premature lock-in to one design and thereby reducing the risk of reaching a ‘dead end’. In particular, summarizing the US experience, Alic *et al.* (2003, p. 41) state: “*Greenhouse gas emission reductions will require a broad portfolio of policies to foster technology development and adoption by actors ranging from households to multinational corporations.* The policy portfolio should combine technology policies with other policies to induce innovation and deployment”. While important, technology policies cannot adequately respond to global climate change by themselves. They should be part of a comprehensive approach that includes ‘non-technology’ policies. In particular, the technological response to climate change will depend critically on national environmental, economic and energy policies.

The specific issue with maintaining variety and avoiding premature selection in the context of climatic change is that a number of technologies with large-scale potential need to be ready to start to grow very quickly, in less than two decades, especially if one remembers the recent numerous warnings, for example, of UNDP (2005a, p. 22):

> *“We have less than a decade to ensure that the window of opportunity for successful mitigation is kept open. That does not mean we have a decade to decide on whether to act and to formulate a plan, but a decade in which to start the transition to low-carbon energy systems.”*

Thus, technical change is complex and uncertain, and technology assessments will never be able to take into account all aspects. To avoid premature lock-in to technologies with limited potential or negative consequences, it is crucial to have long-term strategic thinking and investments in a broad variety of technological options. At the same time, Sanden and Azar (2005) notice that technologies that are constrained or have low potential in the longer term do not necessarily lead to dead ends. They could act as "bridging technologies that pave the way for technologies with greater potential". A new technological system is born within the old, and the bridging or hybrid technologies often form a pivotal intermediate step. With regard to climate change – an issue with time horizons in the decades to centuries – learning-by-doing and learning-by-using have special salience. Technology policies should leave 'space' for continuing technological improvements based on future learning.

Some authors accentuate '*governmental'* role in promoting technical change that is very important for new transition economies. So, Philibert (2005) believes that although market instruments would drive some technical change, the usual short-sightedness of market actors is unlikely to provide for the broad changes required. It is equally unlikely that an approach limited to 'technology push' would be sufficient to achieve the UNFCCC's objective. The author sees the first reason in a large potential for cuts that could be achieved in the short run with existing technologies. Secondly, the development of new future technologies requires a market pull as much as a technology push, particularly as the former may speed technology improvements due to learning-by-doing processes. Combining *push* and *pull* policies would help bring new climate-friendly technologies into markets and benefit from learning-by-doing processes.

Alic *et al*. (2003) also support this statement. Although most innovations come from private firms, many types of government policies influence the rate and direction of technological change at all stages of the innovation process. Some lessons, which have been learned from the US experience with technology policies, include several principal positions:

▼ *Federal investments contribute to innovation not only through R&D but also through 'downstream' adoption and learning.*

▼ *Partnerships may have particular advantages in fostering vertical collaborations*, such as those between suppliers and consumers.

▼ *Smaller firms may be less able to absorb innovations without government assistance*. Adoption of innovations, which originate outside a firm or industry, often requires substantial internal investments in R&D and human resources. Private investments respond primarily to near-term market incentives, and public investments are necessary to build a technological infrastructure able to support innovation over the long term. The key ingredient of such infrastructures is a vibrant community of technologists and entrepreneurs working in settings where knowledge and information flow freely. Government financial support for education and training, as well as for research, enhances such infrastructures.

▼ *Competition within government can improve performance in fostering innovation*. The messy and often duplicative structure of R&D support and related policies creates diversity and pluralism, fostering innovation by encouraging the exploration of many technological alternatives. On the other hand, competition among firms contributes to effective selection of innovations, while competition among academic research groups contributes to discovery. Similarly, competition among government agencies and government laboratories contributes to policy success, exposing ineffectual bureaucracies, out-of-touch laboratories, poor policy choices and project-level mistakes. For these reasons, policy-makers should channel new funds for R&D through multiple agencies and allocate funds to industry and other researchers on a competitive basis. Since little can be learned without some failures, the policy-makers must be prepared to tolerate mistakes and to learn from them.

▼ Because processes of innovation and adoption are lengthy and convoluted, the *effective policies and programs require insulation from short-term political pressures*. For example, while reliable political constituencies are essential for the development of new technologies in defense or other sciences, the technology policies for addressing climate change face a discordant political environment. Long-term Russian debate on the Kyoto protocol is a good example[17].

Lastly, to encourage innovation in response to climate change, the governments should support the development of the environment that nourishes creativity and learning in science, technology, and commercial applications. Well-designed technology policies support the free flow of information, thus promoting the evaluation of new ideas and the acceptance and diffusion of the best new technologies. Government policies set the underlying conditions for (and constraints on) innovation. The effectiveness of climate change policies will be judged by the innovation that follows.

Technology for adaptation to climate change

Thus far, technology innovations have mostly been for the purposes of mitigation, primarily for the energy sector, and have typically involved transferring ideas or equipment from developed to developing countries. There may thus be a temptation to envisage transfers for adaptation following the same pattern. However, technologies for adaptation differ from those for mitigation in a number of important respects (UNFCCC, 2006). Unlike mitigation, which is a relatively new task, adaptation to climate change is generally the continuation of an ongoing process for which many of the technologies are already being applied even in some of the least developed countries. Moreover, adaptation, rather than being concentrated in one sector, such as energy, will essentially be ubiquitous, dispersed across all socio-economic sectors, each of which presents its own challenges and will involve myriad stakeholders in different if overlapping groups. In many respects, compared with mitigation, adaptation is thus far more diverse and complex.

In some cases people will adapt to climate change simply by changing their behavior – by moving to a different location, or by changing their occupation. However, often they will employ different forms of technology, whether ‘hard’ forms, such as new machinery, equipment or irrigation systems, but also know-how and management (‘soft’ technologies), such as insurance schemes or crop rotation patterns. They could use a combination of *hard* and *soft*, as with early warning systems that combine hard measuring devices with soft knowledge and skills that can raise awareness and stimulate appropriate action. Many of these technologies are already available and widely used, and thus it should be possible to adapt to some extent by modifying or extending existing

---

[17] See, for example, Berdin V., Danilov-Daniliyan V., Kokorin A., Kuraev C., 2006: *Kyoto Protocol: Mission executable.* Russian Regional Ecological Center, 12 p (in Russian)

technologies. Others, however, can employ much higher levels of technology, from advanced computer-controlled flood barrages to such ‘high’ technologies as earth observation systems that provide more accurate weather forecasts. Whatever the level of technology, its application is likely to be an iterative process rather than a one-off activity. Moreover, although many of these technologies will already be available and in place, they often need further investment to make them more effective, for example, using different materials or modified designs.

Adaptation measures are also likely to be less capital intensive and more amenable to small-scale interventions. They should therefore be more flexible and adaptable to local circumstances, which mean that in addition to being socially and legally acceptable they can be made reasonably cost-effective. Nevertheless, as with any form of technology, there is always a risk that adaptation measures will be more accessible to wealthier communities. Policymakers thus need to ensure that new forms of adaptation do not heighten inequality but rather contribute to a reduction in poverty. Due to the long lead time required for investment in technologies, and the high uncertainties associated with climate change and its impacts, priority needs to be given to technological measures that both address current needs and are justifiable under a changing climate (i.e., “win-win” or no-regret options). Consideration also needs to be given to the varying time scales associated with investment in technologies for different sectors. Deploying costly technologies, whose benefits would be perceived in the distant future, could be difficult to justify, especially if such technologies seek to solely address a climate change concern.

However, while technological adaptation measures are important in reducing vulnerability to climate change, they have certain limitations. Klein *et al.* (2007) distinguish three issues that need to be considered here:

- Technological adaptation measures may be only partially effective if they do not address non-climate factors that contribute to vulnerability to climate change. For example, the inequitable distribution of water rights or its price may be more important causes of vulnerability to drought than deficient water supply technology;
- Technological adaptation measures may be ineffective if they are not suited to local conditions. So, acceptance of drought-resistant crop varieties may depend not only on their efficiency, but also on their costs as well as on access to fertilizer and other inputs;
- Technological adaptation measures may turn out to be maladaptive if they are implemented without recognition of relevant social and environmental processes.

Moving towards a climate-sustainable economy always results in winners and losers. In particular, an important concern for many people in this respect is the impact of climate change policy on employment. Fankhauser *et al.* (2008) distinguish three kinds of effects in the analysis of this question:

- ✓ A short-term effect, when jobs are lost in directly affected sectors and new ones are created in replacement industries. We can think of this as the direct employment effect.
- ✓ A medium-term effect, when the impact of climate change policy ripples through the economy. Jobs are created and lost along the value chains of affected industries. These are the higher-order, *economy-wide effects* of climate policy.

- ✓ A long-term effect, when innovation and the development of new technologies create opportunities for investment and growth. We can call this the *dynamic effect* of climate policy.

The adaptation technology assessment should be part of a broader assessment of adaptation needs. Once adaptations are identified, those that require transfer of technology should be separated out and might receive special attention as part of the technology assessment process. According to NCSP's (2006) recommendations, the most effective technologies for adaptation may be those already available in the country, and those that are simple and well-understood. Some general conclusions that could be drawn from the discussions on technology for adaptation to climate change are shown in Box 4.10.

Box 4.10 Some criteria for assessing adaptation technologies

- Technological measures represent a subset of adaptation options. Hence, any needs for the transfer and adoption of technologies should be assessed within the broader context of adaptation assessment. Only after the key sectors and adaptation priorities have been identified and the need for technological interventions confirmed, a separate assessment for adaptation technologies should be undertaken;
- Due to the considerable initial investment required for adaptation technologies, and the long lead time of the investment, prioritization of adaptation technologies is essential to ensure the cost-effectiveness of investments;
- Prioritizing adaptation technology options could consider, among others: (1) effectiveness for reducing vulnerability; (2) level of implementation and maintenance costs; and (3) knock-on effects on natural environment and socioeconomic sectors/activities and resource use;
- Where possible, priority should be given to endogenous technologies as they do not involve the transfer of technology (lowering transaction costs) and are often better understood at the national level.

Source: NCSP, 2006

4.3.3 International technology collaboration: Technology diffusion and transfer

Climate change technology transfer has been receiving much attention in a variety of international forums, in addition to the meetings associated with the UNFCCC and Kyoto Protocol. This question is important not only for developing and transition countries that are needed in new technology and knowledge, but also for industrialized countries, as technology transfer provides export potential for climate-friendly technologies. Although technology transfer is often mentioned as an ancillary benefit of the Kyoto Protocol's Clean Development Mechanism (e.g., de Coninck *et al.,* 2007; Youngman *et al.*, 2007), this claim has hardly been researched or substantiated.

There are different views on what technology transfer comprises, and the literature offers a broad array of definitions and notions. The definition, adopted by IPCC, is shown in Box 4.11. However, Brewer (2008), putting forward a new paradigm and policy agenda in climate change technology transfer, proposes to adopt a new encompassing notion of technology. With such an approach, the term *technology,* commonly referred to mostly tangible goods (e.g., hard and soft technologies), also includes intangible elements of

Box 4.11 *Technology Transfer: IPCC definition*

The broad set of processes covering the exchange of knowledge, money and goods among different stakeholders that leads to the spreading of technology for adapting to or mitigating climate change. In an attempt to use the broadest and most inclusive concept possible, the report uses the word 'transfer' to encompass both diffusion of technologies and cooperation across and within countries.

Source: Metz *et al.*, 2000, p. 460

organizations' activities as applied knowledge or know-how. Furthermore, the term is used to include managerial know-how in the engineering of production processes and also more generally in management processes. Brewer also makes a distinction between *explicit* and *tacit* knowledge and emphasizes that over time the literature on international technology transfers has progressed from a relatively narrow definition of technology as scientific and engineering knowledge, which is principally the outcome of R&D, to the current concept of technology that includes a second notion – namely, technology as *tacit* knowledge that is embedded in firms' procedures and personnel. While the first conceptualization leads to an analytic focus on explicit knowledge concerning specific products and their associated production processes, the second conceptualization leads to a focus on the capabilities and processes of firms, or the tacit knowledge that is embedded in them. Thus, tacit knowledge can be defined as "…knowledge that is not covered by the patent but is embedded in skills and know-how" (Stern, 2007, p. 567).

Halsnæs and Shukla (2007), considering sustainable development as a framework for participation in international climate change policy, are convinced that technology oriented climate mechanisms can be designed as *multi-country cooperation vehicles* including the focused technology initiatives (a portfolio of technologies), based on various economic and business interests, and on local and global environmental agendas. The cooperation is robust if it rests on a wider foundation that includes other non-climate or energy related interests agreed to by the parties as a sort of side payment to the climate activity.

International cooperation on R&D allows each participant to benefit from others' efforts. In the judgment of Philibert (2005), it magnifies and accelerates results and helps disseminate them. The international exchange of lessons learned and best practices in technology policies, from research to deployment, can contribute to improving the economic efficiency of the increasing use of clean and efficient technologies. Specifically, international collaboration on technology development reduces the costs of R&D by enabling the sharing of results, avoiding the duplication of efforts and through the resulting increased rate of technological progress. International science and technology development, their exchange and diffusion through public-private partnership for technology absorption, capacity building and innovative project-financing mechanisms are desirable and mutually beneficial to both developed and developing countries. Philibert also suggests that conclusions relevant to effective national policies against climate change (the *push* and *pull* technology policies, the short-term and long-term approaches building upon learning-by-doing processes) might be similarly relevant in the area of international technological collaboration, especially with respect to R&D.

His reasons stems from the economic theory of public goods. If rational economic agents acting in isolation are likely to limit their R&D efforts so as to equalize the marginal abatement costs they incur, with the marginal benefits they gain from their own efforts, the cooperating agents are likely to raise their level of effort to equalize the costs with the benefits that each of them receives from the actions of all. By simply extrapolating the '*economic agents'* to '*countries'*, as Philibert believes, the international technology cooperation may ease some of the barriers to strengthening emissions mitigation in building a post-Kyoto climate regime. This result could be achieved by: (a) promoting a deeper understanding of each other's difficulties; (b) helping to build confidence among countries; (c) increasing the depth of relationship between government, NGO and business people in/between the various countries; and (d) engaging the remaining countries on common mitigation action at a time when they have difficulties agreeing on any global scheme to address GHG emissions. Halsnæs and Shukla (2007) added that transfer of efficient and cleaner technologies will enlarge choices and produce cross-enhancements which can deliver a significant positive spill-over for climate change. New technology transfers also imply social transformations and capacity of people and organizations to continuously adapt to changing world circumstances and to acquire new skills.

Thus, international technology collaboration has a number of benefits. At the same time, there might be several possible drawbacks that Philibert (2005) identified as follows:

- The search for wide agreement may require time- and resource-consuming efforts and thus slow, rather than speed, the innovation and diffusion process;
- Some players might deliberately slow processes in some technologies in order to protect vested interests in competitive technologies;
- The difficulty of protecting intellectual property rights in close cooperative work may offset an incentive for some players;
- Premature technology selection could impede necessary competition between various technology options.

Nevertheless, in spite of the possible drawbacks in adopting environmentally friendly technologies and sustainable development approaches, they should enable developing and transition countries to avoid wrong turns taken by the developed world in the past, before the risks were known.

The success of ***technology transfer*** depends on three vital factors: endogenous capacity, enabling environment, and mechanisms for the transfer (Halsnæs and Shukla, 2007). On the other hand, a variety of tools can be conceived to speed dissemination of innovative allocations, and a wide number of policy instruments would probably be used – either to supplement broad market-based ones or to make them more efficient, specifically dealing with various market failures. In this way, the UNFCCC's secretariat supports the Parties' efforts by synthesizing and sharing information on technology transfer activities (Box 4.12).

Box 4.12 UNFCCC's framework for technology transfer

Following a two-year consultative process, the convention agreed on a framework for 'meaningful and effective actions' in technology transfer as a part of the Marrakesh Accords that covers the following areas:

- assessing technology needs
- establishing a technology information system
- creating enabling environments for technology transfer
- providing capacity-building for technology transfer
- funding to implement the framework.

Source: UNFCCC, 2005

Independently of any technology cooperation and transfer policy, the technologies ***diffuse*** from country to country through a wide number of channels, including ‘formal’ ones (trade, foreign direct investment, patent licensing) and ‘less formal’(emigration, travel and visits, exchanges of students, international scientific/technology publications and meetings, and so on). Philibert (2005) characterizes three basic ways for a country (firm, company) to exploit its technologies abroad, and consequently, three different ways to acquire those technologies:

- *Through trade.* Such international technology transfer occurs when a country imports higher-quality (than it can produce itself) intermediary goods to use in its own production processes;
- *Through licenses.* A technology may be licensed to an agent abroad who uses it to upgrade its own production;
- *Through investment.* A foreign establishment can be set up to exploit the technology itself.

A foreign direct investment (FDI) is the most important means of transferring technology because it generates benefits that are unavailable when using other modes of transfer. FDI is not only composed of technology, but also includes the entire ‘package’, such as management experience and entrepreneurial abilities, which can be transferred through training programs and learning-by-doing.

Since technological change is driven by diverse factors, the financial mechanisms to support development and deployment of climate friendly technologies must include diverse elements where Halsnæs and Shukla (2007) singled out the following:

- Research and development grants, demonstrations and applications of new technologies;
- Financial mechanisms targeted to support the implementation of specific technologies;
- Joint venture agreements between experts, companies and eventually governments in different countries about research, innovation, penetration, licenses, maintenance, and all other elements in technology transitions and market development;
- Agreements between companies or governments about technology implementation;
- Programs including the energy, transportation, industry and other sectors.

Implementations of these mechanisms can be promoted by favorable prices and/or by various sorts of side-payments, international trade negotiations, and direct investments.

The role of individual countries in the development and transfer of technologies also depends to some degree on the activities of the multinational firms in the countries; this is so regardless of whether the countries are home to the parent firms’ headquarters or host to their foreign affiliates. The international trade, investment, licensing and joint venture arrangements of multinational firms are often key channels of international technology transfers. For example, the large multinational concern Siemens not only has 22,000 employees in R&D centers in its home country (Germany) but another 7,000 in China, 2,000 in India and 1,300 in the USA (Brewer, 2008).

However, there is one great problem, highlighted by UNDP in its special issue of the *Development Policy Journal* (UNDP, nd). Developing and transition countries need to 'own' this technological transformation and their technical co-operation programs if they have the commitment needed to make such programs work. In other words, national agents should be not only 'active participants' but also should control the design, planning and implementation processes. While governments are no longer the sole partners for development initiatives, a failure to recognize their legitimate roles can produce tension, confusion and leadership crises. Equally, local ownership requires that accountability processes also be based on local systems.

At present, there is sometimes a great gulf between donors and recipients, particularly in poor countries many of which find that they have caught themselves in 'no-win' situations. They need technical co-operation because their institutional and social infrastructures are weak, but the same weakness limits their capacities to effectively determine a country's direction and acquire the knowledge needed to move in this direction. Technical co-operation may also unintentionally undermine development of the needed local capacities through its demands for counterpart budgets and its propensity to lure away the best officers to work on donors' projects. At the same time, the unequal relationship is inevitable because donors will always control their funds to some degree. Broad international support for pooled funds is unlikely without stronger accountability systems. Donors typically impose conditions and tighten control mechanisms in countries with weak accountability systems and may disengage from countries unable to meet conditions or maintain controls.

Thus, precise mechanisms should match local circumstances but also need to change existing links between donors and programs in order to promote real national ownership. Though it is not possible to level the 'playing field' completely, at least the gradient can be reduced. Integration of external support into national planning and monitoring systems allows governments to really own those funds and to determine how to best address their capacity development needs. Civil society groups, NGOs and the media in recipient countries all have a role to play in helping make sure that their governments use their own resources effectively.

Technology research and development, due to its public good character, are also supplied by private *stakeholders*. Therefore, technology transformation requires the creation of appropriate incentives for stakeholder participation. Technological development is in the interest of both governments and stakeholders, and together they might find technology centered solutions to environmental problems more attractive than instruments like taxes, with lower implementation costs and implications confined to a few locales or sectors. "Acceleration of research and development efforts is vital to the ultimate success of climate policies; however, in the absence of economic signals an *a priori* selection of a basket of technologies can be far from cost-effective. It will not be effective when innovations are to be diffused and deployed in numerous end-use services operating in very diverse contexts", – Halsnæs and Shukla (2007, p. 13) insist.

Cooperation between countries should not preclude competition between companies. For example, a company that likes to develop and promote new and more efficient climate benign technologies might need support to initiate and to shape a niche market for such environmentally friendly, but more expensive products. This may drive governments to increase their efforts, especially in supporting basic R&D of producers that have comparative strengths in innovation, and whose business strategy rests on technology leadership and developing competitiveness in domestic niche markets on the way to become leaders in global technology. One way to develop niche markets for advanced technologies, e.g., in energy efficiency or GHG pollution, is through technology standards and other policy measures that aim at these targets (Halsnæs and Shukla, 2007; Philibert, 2005).

The *effectiveness of international technical co-operation* has been assessed and reassessed frequently during the past two decades (UNDP, 2007a, nd). We used some indirect indicators to adumbrate R&D activity in FSU countries (Table 4.12). In the two last rows of the table the comparison between transition (CEE and CIS) and OECD countries is made to reveal the situation from the perspective of effectiveness of this activity. Relative R&D expenditure in OESD is 2.4 times higher than in transition economies; the relative number of researchers in this sphere – about 1.3 times higher. However, a relative number of patents granted to residents in OECD are 3.3 times higher, and royalties and license fees – more than 25 times higher. Such differences (let even partly) explain differences in net foreign investments (5.7% of GDP in FSU vs. 1.6% – in OESD).

Table 4.12 Technology creation and diffusion in FSU countries

Country	R&D expenditures (% of GDP)[a]	Researchers in R&D (per million people)[a]	Patents granted to residents (per million people)[a]	Receipts of royalties and license fees (US$ per person)	High-technology exports (% of manufactured export)	Net foreign direct investment inflows (% of GDP)
	2000–2005	*1990–2005*	*2000–2005*	*2005*	*2005*	*2005*
Armenia	0.3				0.8	5.3
Azerbaijan	0.3		39		0.7	13.4
Belarus	0.6		76	0.3	2.6	1.0
Estonia	0.9	2.523	56	4.0	17.6	22.9
Georgia	0.3		45	2.1	22.6	7.0
Kazakhstan	0.2	629	83		2.3[c]	3.5
Kyrgyzstan	0.2		17	0.4	2.2	1.7
Latvia	0.4	1.434	36	4.3	5.3	4.6
Lithuania	0.8	2.136	21	0.8	6.1	4.0
Moldova	0.8[b]		67	0.4	2.7	6.8
Russia	1.2	3.319	135	1.8	8.1	2.0
Tajikistan	–	660	2	0.2	41.8	2.4
Turkmenistan	–	–	–	–	4.9	0.8
Ukraine	1.2		52	0.5	3.7	9.4
Uzbekistan		1.754	10			0.3
CEE & CIS	**1.0**	**2.423**	**73**	**4.1**	**8.3**	**5.7[d]**
OECD	**2.4**	**3.096**	**239**	**104.2**	**18.2**	**1.6**

Note: [a] – Data refer to the most recent year available during the period specified; [b] – Data refer to 2004; [c] – Data refer to an earlier year than that specified; from 2000 onwards; [d] – Data refers to FSU countries only. *Source:* Adapted from UNDP (2007a)

There is also a general conclusion: technical cooperation was effective for accomplishing specific tasks, but less effective at developing local institutions or strengthening local capacities. It also tends to be expensive and donor-driven, often heightening the dependencies on external specialists and distorting national priorities. Donors and recipients responded to some of these criticisms through redesigning aid programs, reducing the numbers of expatriate personnel and focusing more on nurturing national professionals.

In spite of these and other drawbacks, the Scientific Expert Group on Climate Change (SEG, 2007) recommended increasing investments and cooperation in energy-technology innovation to develop the new systems and practices, needed to avoid the most damaging consequences of climate change. Current levels of public and private investment in technology research, development, demonstration, and pre-commercial deployment are not even close to commensurate with the size of the challenge and the extent of the opportunities. Recommendations from the UN experts are shown in Box 4.13. Although, formally, these recommendations refer to energy-technology innovations, they can easily be transposed to any other.

Box 4.13 Recommendations of the UN Scientific Expert Group on Climate Change (SEG) in energy-technology innovation

SEG recommend to national governments and the UN system:

- Advocate and achieve a tripling to quadrupling of global public and private investments in energy-technology research, emphasizing energy efficiency in transportation, buildings, industrial and other sectors.
- Promote a comparable increase in public and private investments – with particular emphasis on public–private partnerships – focused on demonstration and accelerated commercial deployment of energy technologies with large mitigation benefits.
- Use the UN institutions and other specialized organizations to promote public–private partnerships that increase private-sector financing for energy-efficiency and renewable-energy investments, drawing upon limited public resources to provide loan guarantees and interest rate buy-downs.
- Increase energy-technology research, development, and demonstration across the developing regions of the world.
- Potential options for achieving this goal include twinning arrangements between developed and developing countries and strengthening the network of regional centers for energy-technology research.
- Over the next two years, complete a study on how to better plan, finance, and deploy climate-friendly energy technologies, using the resources of UN and other international agencies such as the UNDP, the World Bank, and the Global Environment Facility.

Source: SEG, 2007

4.3.4 Technological change and uncertainty

Large uncertainties accompany many new advanced technologies, inventions and both incremental and radical innovations (Alic *et al.*, 2003). The potential outcomes of basic research are difficult if not impossible to anticipate, and their future applications are even more uncertain. The long-term impacts of a new technology cannot be predicted accurately because its operational characteristics and functional performance change over time, and because the pace of adoption is subject to a wide array of economic and social influences that are difficult to foresee. No single factor or influence drives the process. In some cases, R&D funding is the most important; in other cases, a procurement or user feedback is critical. Successful innovation strategies must support a diverse and interactive set of activities including invention, innovation, adoption, and subsequent learning. Alic *et* *al.* (2003) see unknowns in technological evolution as to the levels of performance which can ultimately be achieved, the technological attributes that will prove most attractive to adopters, and the costs of technologies. They consider technical design and development as fluid, open-ended activity with multiple choices, tradeoffs and often ambiguous selection of evaluative criteria. Being inherit in innovation, the uncertainties can be resolved only through learning processes that "…are often slow and piecemeal, studded with lessons from both successes and failures" (*ibid,* p. 41), and where technology-oriented and non-technology policies must function alike in such settings.

As was discussed above, a technological progress driven by climate change is complex and unpredictable, and therefore a climate change policy package must accommodate uncertainties, not only regarding the course and impacts of climate change itself, but also in the pace, cost and outcomes of innovation.

Castelnuovo *et al.* (2003), analyzing uncertainty and technical change in environmental modeling and assessment, used a simple climate model, with the specification of environmental uncertainty, to evaluate how the optimal choices of the economic agents (countries, regions) in a stylized economy are affected by the possibility of having "the end of the world" at a certain (unknown) point in time. They also wanted to investigate how the presence of endogenous environmental technical change matters for the agents' decisions and summarized their findings in two propositions:

§ *Proposition 1*. When environmental uncertainty is considered, the behavior of the agents becomes more cautious, and emissions are reduced with a strategy of lower production, which implies that uncertainty is actually costly for them. The reduction of the production level is achieved via the implementation of an increased domestic abatement effort as well as a reduction of both physical and intellectual capital accumulation. R&D expenditures decumulation is a predictable outcome when the environmental technology is *exogenously* shaped, given that knowledge does not play any role in the environmental context.

§ *Proposition 2*. In presence of *endogenous* environmental technical change, uncertainty leads to a more cautious behavior by the agents in the economy, very much like when the environmental technology is exogenous. However, the positive impact of R&D expenditures on the emissions–output ratio stimulates agents to increase their stocks of intellectual capital, so rendering less costly (in terms of GDP reduction) the lack of knowledge on the exact moment in which an environmental 'catastrophe' will take place. Moreover, when the environmental technology is *endogenous* the R&D expenditures seem to play a positive role in driving all the regions on a balanced growth path featured by a bounded growth rate of the GDP loss in presence of environmental uncertainty.

Thus, Castelnuovo and colleagues found that as long as R&D expenditures are not environmentally friendly, they are optimally reduced and do not trigger the 'engine' of growth. But when environmental R&D spending is also considered, conclusions turn out to be different. The uncertainty, when other conditions are equal, stimulates countries to undertake more R&D expenditures in order to reduce the emissions–output ratio, so enabling them to produce more GDP. In this case, the GDP growth rate is still less than that in the 'no-uncertainty' scenario, but the difference between the two is much tighter than the growth observed with models exogenously shaping the emissions–output ratio.

Moreover, when the environmental technological change is endogenous the R&D expenditures seem to play a positive role in driving on a balanced growth path featured by a bounded growth rate of GDP loss in the presence of environmental uncertainty.

This leads to a general conclusion that the presence of uncertainty renders even the most important key-variable R&D spending when it is also environmental. Hence, policy-makers and researchers should try to better understand how to create a sound basis for environmental R&D investments.

4.3.5 Technology needs assessment: Azerbaijan's vision & Tajikistan case study

Technology needs assessment (TNA) is a very important stage in the process of technology transfer. As was frequently mentioned, the technologies that serve to confront climate change impacts must be environmentally sound and support sustainable development. To identify the technology needs of a country, it is necessary to assess not only specific technologies, but also the entire system that includes such aspects as know-how, production procedures, goods and services, organization and management considered. Development and introduction of new technologies must be based upon the national development priorities, especially in transition countries where achievement of social and economic growth is the basic objective of their policies.

Fig. 4.10 shows, as an example, Azerbaijan's approach to estimating national technology needs.

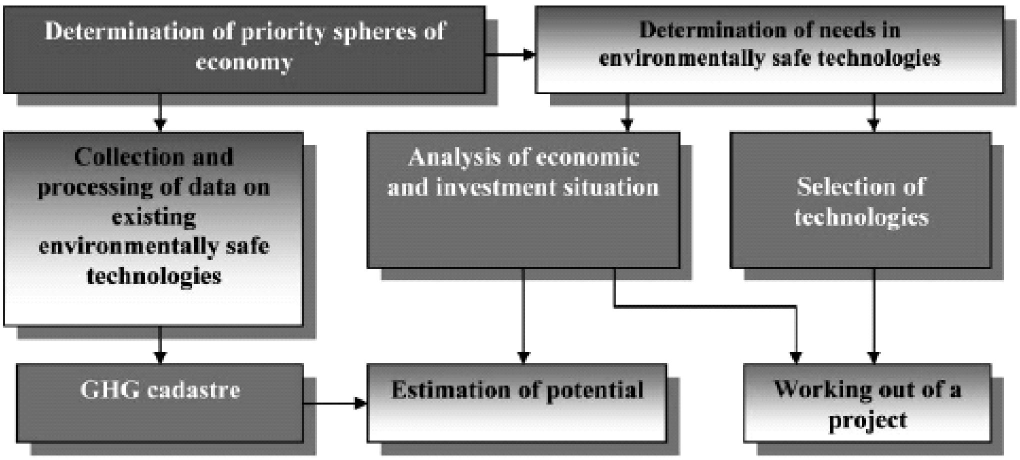


Fig. 4.10 Scheme of identifying, estimating and presenting the technologies needs. *Source:* Initial National Communication of Azerbaijan Republic on Climate Change. Phase 2, 2001: *Capacity Improvement Activities on Climate Change in the Priority Sectors of Economy of Azerbaijan,* Baku, 58 p.

The main *technology needs* in the Republic of Tajikistan are driven by specific physical-geographic conditions of the country[18].

[18] Adapted from Makhmadaliev *et al.* (2003)

Tajikistan is a Central Asian country, with a territory of 143.1 thousand sq. km. It is a landlocked country where mountains occupy about 93% of its area, and about half of which is situated at an altitude above 3,000 masl. The highest elevation is 7,495 masl (Ismoil Somoni peak in the Pamirs). Natural disasters, associated with unfavorable weather events, are likely to become stronger in the projected new climate for this country. Being unexpected and unpredictable, they are difficult to adapt to. For example, in one decade only (1991-2000), over 90% of people who suffered from dangerous natural disasters died from their severe meteorological and hydrological consequences. 38% of these imminent phenomena were landslides, 31% – mudflows and floods, 21% – erosion processes. Rockfalls, avalanches, river bank washout, and suffosion amount to 10% of these processes. Over 50,000 landslide areas and 466 settlements, prone to floods and mudflow that can be caused by intensive rainfalls (snowfalls) or glacier melting in the spring and summer, were found in Tajikistan. Another cause of catastrophic mudflows and floods come from glacier blocked-up lakes, which are numerous in the mountainous part of the country.


Avalanche in the Pamir Mountains (left) and mudflow in the Varzob Gorge (right). *Photo by A. Kayumov* (Makhmadaliev *et al.*, 2003)

To conduct TNA in Tajikistan, three thematic working groups of experts were established and focused on the following priorities: (i) technology needs in economic sectors, (ii) the potential for improvement, and (iii) systematic observations. As main executors in these groups, the experts from ministries and departments, interested representatives from industrial sectors, business circles and NGOs as well as independent experts were invited.

The *informational sources* and a *methodological base* for TNA included:

- ▲ IPCC assessment reports and technical papers
- ▲ International methodologies and publications
- ▲ Local research on climate change issues
- ▲ National informational sources and statistic reports
- ▲ National legislation, development plans, industrial strategies and programs.

The *main tools* of involving technologies in priority sectors were:

- Reforming and improving the legislative and institutional base
- Personnel training and increasing its expertise level in technology transfer
- Removing the barriers in technology transfer
- Realizing the demonstration and full-scale projects
- Research studies and access to recent technological information
- Raising the awareness of policy makers, specialists, and the public on the climate change problem, including technology assessment and transfer.

The *technology need* to improve protection from natural disasters included:

- Applying and expanding the network of devices for automatic data collection on weather conditions, snow accumulation, heavy precipitation, floods, sharp change of rivers water level, etc.
- Improving the natural disaster forecasting, based on personnel training and application of high-efficiency forecasting methods, computerized data processing, and satellite monitoring systems
- Development of regional climatic models to assess the risk of droughts and floods
- Installations of a meteorological radar to determine centers of hailstones, heavy rainfalls and snowfalls and to minimize their impacts
- Protective constructions in high-risk zones; anti-hailstone installations for protecting 200-300 thousand ha of the agricultural lands
- Development and timely updating the databases on mudflow, flood, landslide, avalanche, drought, and other dangerous phenomena issues with wide application of GIS technologies
- Applying new means of radio communication and early warning systems to inform people on likely natural disasters in the most vulnerable areas
- Development of audio- and video-materials for population education and instruction on their behavior in case of natural disasters and extreme weather events
- Development of and providing with special equipment the rescue groups in vulnerable areas.

As one of the most important prerequisites for active participation in the international mechanism of confronting climate change, including technology transfer, the identification of inside partnerships was considered. The process of privatization and market reforming promotes growth of the non-state economic sector. The business and private sectors play a key role in implementing technological projects, while the role of state bodies is in regulating and focusing on supporting social and scientific projects.

In particular, the state bodies provide a general guidance, technology transfer coordination, and, in many cases, internal and international investment involvement. Their role and functions are described as follows:

- Providing with access to, distribution and exchange of information
- Setting minimum requirements to climate change related projects
- Developing and applying rates and branch standards
- Determination of the list of project priorities and development of the infrastructure for project coordination and realization
- Development of strategies for project realization and their co-financing

▶ Assessment and monitoring of project realization.

Technology needs assessment activity includes three following steps:

▼ Identifying priority sectors and problem analysis
▼ Identifying the major technology options for each sector
▼ Identifying the main barriers and ways to their overcoming.

The key factors determining the priorities in TNA, and project expediency for funding, are the development benefits, market potential and contribution to principal climate change issues. Some existing barriers in technology transfer and possible solutions are shown in Table 4.13.

Table 4.13 Potential barriers to new technologies transfer and possible solutions in Tajikistan

Potential barriers	Possible solutions
Financial	
• Poverty and enterprise low solvency • Undeveloped system of environmental funds • Insufficient financing of science • Deficiency of capital for updating technologies • Inadequate tariff policy in the energy sector • Lack of greenhouse gas emission payment system • High costs of non-traditional renewable energy sources • Difficulties of investment involvement	• State support, involvement of local and international investments • Improving the tariff policy in the energy sector • Reforming environmental funds • Identifying financing sources with international donors involvement • Establishing special development funds • Financial support of integration processes in science and education • Studying a possibility of partly refunding enterprises' waste and emission payments
Legislation and programs	
• No incentives or privileges are provided in realizing measures on climate change policies • The interaction of economic development plans with climate and atmosphere protection policy purposes is not shown • No GHG emission rates or commitments on emission control and reduction are provided • Understated penalty sanctions and payments • There are no standards of energy efficiency in the building and industrial sectors • There is no framework legislation in the renewable energy sector • There is neither a strategy of energy and industry development, nor a concept of rational use of energy resources and recycling raw materials and waste products • No CDM strategy, criteria and procedures of project discussion, registration, and realization are developed	• Improving the legislation in climate change related sectors • Providing privileges for emission reduction or voluntary commitments to reduce emissions and apply new technologies • Developing and applying rates and reports on GHG • Bringing the national legislation to conformity with international rules and standards • Developing and amending available taxes, penalties, and payments • Applying the main NAP regulations on climate change in investment project implementation • Developing and including projects on energy efficiency and emission reduction in the Program of State Investments • Creating conditions for reaching specific rates of energy consumption • Developing strategies and programs of economy sectors development, combining issues of climate and environment protection

Table 4.13 (continued)

Potential barriers	Possible solutions
Institutional	
• Undeveloped system of compiling a national cadastre of greenhouse gas emissions • There is no institutional base for CDM implementation • Insufficient support at the local level for encouraging low-energy projects, etc. • Non-transparent mechanisms of management and property in the energy sector	• Developing a state mechanism of GHG emission management • Re-organizing available structures of the energy complex management
Market	
• Undeveloped structure of new technology market • Low rates of reforms in economic sectors • There are no real possibilities for developing private property in the energy sector, primarily small energy • Prevailing interests of large energy producers and consumers • Indistinct dynamics of energy-carrier costs	• Developing legal mechanisms, permitting a leasing and long-term purchasing of small energy enterprises
Technological	
• Outdated technologies and lack or high costs of new technology maintenance • Lack of or inappropriate state of air emission purification facilities • Lack of the industrial production of small energy devices and infrastructure • Risk of technical breakages preventing reaching the rated capacity	• Technology updating • Assessing the potential of non-traditional renewable energy sources in districts and economic zones • New technology purchase (transfer) • Organizing a local production and maintenance of small energy appliances • Implementing the demonstration projects
Information, publicity, and education	
• Short of skilled personnel • Lack of updated scientific-technological and research base • Limited access to recent technological information • Poor awareness of business circles, officials, and the public of climate change mitigation technologies, non-traditional renewable energy sources, etc. • Lack of open discussions and referendums on new technologies development and management • The teaching programs do not consider climate change issues.	• Training personnel, teaching people at all levels • Scientific research in priority trends • Developing technology database • Popularizing climate change issues in mass media and internet; organizing training and seminars • Raising the authorities' awareness of GHG emission problem • Involving industrial enterprises and the private sector in applied research • Organizing public discussion of technology policy documents before they are adopted.

Source: Adapted from Makhmadaliev *et al.* (2003)

However, the main barrier in the economic and technological development of Tajikistan is a lack of capital. With the small inflow of foreign investments, any intensive, state-of-the-art development is impossible. The available productive capacities can be considered obsolete and require updating and restructuring. From the environmental point of view, the greater part of the production base of the republic (over 75%) is considered inefficient. Being rich in manpower resources, the republic has an evident deficiency of skilled specialists.

The greater part of investments for environmental protection comes from the industry's own funds, or as investments on account of payment for emissions, which are transferred to environmental foundations. The updating of available technologies can be expected through, first of all, demonstration projects, experience distribution and the optimal distribution of available finances (Table 4.14).

Table 4.14 Projects for financing in priority adaptation sectors and observation systems in Tajikistan

Project title	*Sector*	*Funds, $US*	*Required technologies and support*
Reducing the risk of malaria	Public health	200 thou	Improving the collector-drainage and irrigation systems, particularly near settlements; Implementing malaria-preventive works in malaria areas and water reservoirs
Applying the water-saving irrigation methods in agriculture	Water management	500 thou	Drip and intra-soil irrigation and other advanced technologies
Reducing the risk of and damage caused by catastrophic mudflows and floods in the conditions	Water management	50 mil	Applying high-efficiency anti-mudflow engineering structures – Reconstructing the existing anti-mudflow and bank-protecting structures – Constructing mudflow-catching canals
Using data of long-term climate forecasting in agriculture	Agriculture	199 thou	Numerical high-resolution climate change models; Models of climate change impact on agriculture
Increasing the efficiency of methods to combat pests	Agriculture	500 thou	Efficient biological methods of combating agricultural pests
Restoring the existing and constructing new protective structures at the main roads	Transport	15 mil	Advanced anti-avalanche, anti-mudflow, water-way and slope-protecting constructions
Providing the central and local emergency bodies with advanced communication tools	Natural disasters	60 thou	Advanced means of radio communication
Improving hailstone protection efficiency	Hydrometeo-rological service	300 thou	Hail detecting systems (radars); Expendables (anti hailstone cartridges, shells)
Introducing GIS-technologies of avalanche and mudflow risks monitoring and reduction in the command- and control activity		40 thou	Providing with satellite survey of avalanche risky areas, GIS software and computers. Training of specialists
Studying the shearing movements of pulsating glaciers and minimizing the associated risk	"–"	100 thou	Organization of aerovisual observations; Providing with satellite information on dangerous areas; Providing with GIS-technologies and hardware

Table 4.14 (continued)

Project title	*Sector*	*Funds, $US*	*Required technologies and support*
Automation of the on-line activity of the Tajik Met Service based on the automatic job network	"–"	30 thou	Purchasing and installing AJN: Satellite Weather Forecaster, Agro-Hydro- and Meteorologists; Expert's service and local specialists training
Improving the Communication Commutation Center (CCC) at the Tajik Met Service Administration	"–"	50 thou	Purchasing and installation of equipment for the computerized CCC and training of local specialists
Introducing and testing high resolution climate change models and their applying to assess the adverse impacts on socio-economic and natural systems	"–"	30 thou	Providing with software for climate change modeling; Specialists training
Introducing a system of climatic data management	"–"	15 thou	Providing with computer equipment, software and network communications
Providing instrumentation and expenditure materials to restore aerological observation network	"–"	15 thou	Upper-air observation equipment for Dushanbe and Kurgan-Tube stations; the expendables; specialists training
Providing equipment and expendables for ambient air quality monitoring	"–"	300 thou	Instrumentation and equipment for air pollution definition at 20 stationary and one mobile observation posts
Providing equipment and expendables for surface water quality monitoring	"–"	200 thou	Instrumentation and equipment for measurement of surface water chemical contamination in five river basins (80 observation points)
Providing Automatic Weather Stations (AWS), precipitation-measuring stations, and radio-transmitting equipment	"–"	300 thou	Automatic Weather Stations (AWS) and transmitting equipment – 10; Remote precipitation-measuring points, equipped with means of communication – 30
Providing instrumentation and equipment fort overland observations of glaciers	"–"	80 thou	Helicopter aerovisual observations and expedition; Expedition equipment and observation instruments

Source: Makhmadaliev *et al.*, 2003

4.4 Uncertainty in climate policy analysis and policy making

4.4.1 Policy decisions with the uncertain future

Researchers examining alternative policies to address the threat of climate change have become increasingly concerned about uncertainty. However, uncertainty is not unique to the issue of climate change but pervades all areas of human activity, sometimes resulting from a lack of information, on other occasions – from inherent unpredictability of natural and social systems. In fact, uncertainty is a multi-dimensional concept that is omnipresent in our society. Uncertainties are usually more difficult to quantify than the factors to which they apply; their treatment is more complex both conceptually and operationally, and the normal use of language to describe uncertainty is often ambiguous (Dessai *et al.*, 2007; Manning and Petit, 2003; Moss, 2007).

As a result, scientific *policy advice* under uncertainty is 'a tricky balancing act' (Betz, 2007). On the one hand, scientists are supposed to provide all the knowledge they have acquired about the policy problem; otherwise they potentially prevent the most effective policy decision from being taken. On the other hand, they are not entitled to pass mere conjectures off as scientific knowledge; such conjectures are not warranted by any scientific argumentation whatever. "The issue for policy, – Risbey (2007, p. 12) argues, – is not whether science contains some subjective interpretation based on irreducible approximations and assumptions. It always will contain such elements. The issue for policy is whether the underlying assumptions and approximations matter from the perspective of the policy issue under consideration. The subjective elements at stake will lead to some uncertainty in the projected outcome or value of policy-relevant variables. If policy choices *are* sensitive to the uncertainty of science outcomes, then the sources of uncertainty need to be probed and identified".

In practice, for most moderately complex policy issues, the subjective elements of the science are contentious and lead to uncertainty in policy relevant science outcomes; the choice of policies is sensitive to that uncertainty. *"Even in a rational world, we cannot rely on science alone to tell us what to do… The goal of science is therefore not to determine policies, but to inform them*", – Risbey concluded (*Ibid).* To fulfill this task, the science must: (1) try to reduce the level of assumption and approximation to that which can be reasonably justified; (2) state the underlying assumptions and approximations, and their effects on outcomes of relevance to policy decisions, and (3) quantify outputs as precisely as consistent with the limitations of the science, which may be more or less precise than that required to formulate policy.

Thus, the role of scientists is to understand the meaning of available observations, to develop rational projections of the future and to communicate available uncertainty, regardless of the fact that when they do this the non-scientists often conclude that no action is necessary because the uncertainties are so large. As Ha-Duong *et al.* noted (2007, p. 9), *"situations where precise probabilities are not well defined cannot be avoided when assessing the long-term future of a real global system"*. Natural developments are characterized by radical changes that may dramatically modify living and economic conditions, and natural phenomena may be irreversible. Moreover, the fact that natural developments do not follow linear evolutionary trends makes it more difficult to take into account the role of uncertainty (Castelnuovo *et al.*, 2003).

Walker and Marchau (2003, p. 1), discussing methods for dealing with uncertainty in policy analysis, started from the notion that "policymaking is about the future. If we were able to predict the future accurately, preferred policies could be identified (at least in principle) by simply examining the future that would follow from the implementation of each possible policy and picking the one that produced the most favorable outcomes". However, for most natural, social and economic systems such prediction is not possible due to their increasing complexity, interrelationships with other systems, and the uncertainty of developments external to the system that have important effects on it. Some characteristics of systems, for example, global scale, long time lags between forcing and response, the impossibility of experimental controls, and the large number of research disciplines involved in policy analysis, make assessment of uncertainty particularly challenging. Today's world is undergoing rapid changes, with an uncertain future. Given globalization and the interrelationships among systems, the consequences of wrong policy decisions have become not only global, but also more serious and potentially even catastrophic.

Dealing with systems that can only be influenced rather than controlled creates serious difficulties for policy analysis. However, though such systems can be considered 'fundamentally unpredictable' and in spite of the profound and partially irreducible uncertainties and serious potential consequences, the policy decisions have to be made.

We should agree with Walker and Marchau (2003) that if the future cannot be predicted, it is possible to prepare for it, and public policies must be formulated in spite of profound uncertainties about the future. Uncertainties cannot be entirely eliminated and must be accepted, understood and managed. The presence of uncertainty in policymaking should be explicitly acknowledged; this acknowledgment may lead to a paradigm shift in the approach to choosing policies, thus resulting in possible fewer negative 'surprises' from their implementation. The quoted authors see two questions that should be answered here:

1. *How can uncertainty in policy analysis and policymaking be characterized?*
2. *How can policy analysts and policymakers deal with uncertainties?*

They also distinguish two ways by which policy analysts and policymakers have usually dealt with uncertainty about the future.

The first approach is to ignore uncertainty, or act as if it does not exist at all. An implicit assumption is made that the future world will be structurally more or less the same as the current world or as a simple extrapolation of the past. Of course, this does not solve the problem of uncertainty, merely sweeping it 'under the rug' with serious consequences.

The *second* approach to dealing with uncertainty about the future corresponds to the current policymaking paradigm and forms the basis for traditional 'what-if' policy analysis. The central assumption of this paradigm is that the future can be predicted sufficiently well to identify policies that will produce favorable outcomes in one or more specific plausible future worlds. Such so-called *scenarios* are well-known for anybody working in the climate change research field.

A set of approaches to deal with uncertainty about the future, proposed by Walker *et al.* (2001), are based on the following logic: in the unpredictable rapidly changing world it is almost impossible to identify robust, or fixed static policies that will perform well against all plausible futures, but over time we gain information that resolves current uncertainties about the future, and thus the best policies will be adaptive. Such 'adaptive' approaches explicitly focus on monitoring the validity of the assumptions underlying policies, and as time proceeds knowledge increases and events unfold, specifying actions that should be taken to adjust to the new circumstances.

Thus, uncertainty is inherent in the very nature of making policies for the future and in the dynamic behavior of the systems being affected. Moreover, the existence of uncertainties in practically all policymaking situations is generally understood by most decision-makers, as well as by the scientists providing decision support. The acceptance of this fact opens up possibilities for the successful development and use of multi-disciplinary, multi-method approaches, based on the integration of quantitative and qualitative research that recognize and handle the full spectrum of uncertainties.

Characterization of uncertainty need to be a prelude in defining policy choices, although there is a number of opposite approaches, starting with available policy options and then assessing and comparing uncertainties associated with these options. Lempert *et al.* (2004) describe two general approaches that encompass the means for characterizing policy-relevant uncertainty: (1) the *predict-then-act* framework, often supplementing expert elicitation with new approaches to deriving probability distributions from empirical evidence; (2) the *assess-risk-of-policy* framework that seeks to identify the uncertainties most relevant to choosing among alternative policies, that is which takes a fundamentally different view, assessing the risks associated with particular policy options.

The ***predict-then-act*** framework envisions a large number of consensus probability distributions (one for each important uncertainty) as inputs to a process that generates policy recommendations contingent on these probabilistic statements about the world. The ***assess-risk-of-policy*** framework envisions a process that generates policy options whose satisfactory performance is especially insensitive to uncertainties and outputs a small number of probabilities to characterize the residual risks of choosing such a policy. In many respects, this framework is more subjective then *predict-then-act* because it forces analysts and decision-makers to explicitly decide, through their choice of strategy, the futures to which they remain vulnerable, including those uncertainties that might be considered as ‘surprises’. Thus, from a policy point of view it can be important to distinguish between the uncertainties related to lack of knowledge about the way biogeochemical and socio-economic systems function and those related to the understanding of the role of human choice.

“Where no single or well-bounded policy problem can be defined and deep uncertainty exists, efforts to characterize uncertainties as a prelude to decision-making may be counterproductive”, – Lempert *et al.* (2004, p. 2) believe. There is a little appreciation of many different dimensions of uncertainty, and there is a lack of understanding about their different characteristics, relative magnitudes, and available means to deal with. A better understanding of these realities and their implications for policy choices would likely lead to more trust in the scientists and ultimately – to better policies. The need for more constructive approaches to accountability about uncertainty in regulatory decisions has grown with increasing attention being given to the ‘precautionary principle’ in environmental management that has put uncertainty more firmly and explicitly on the political agenda (Walker *et al.*, 2003a).

4.4.2 Uncertainty in theoretical perspective

There are many different classifications or typologies for the origins of uncertainty, and while the appropriate choice may vary from one discipline to another such typologies should be used to develop a comprehensive view of all plausible sources. Whereas a number of different uncertainty typologies have been proposed and used in the literature, there is no agreement on the best uncertainty classification (van Asselt and Rotmans, 2002; Ha-Duong *et al.*, 2007; IPCC, 2007a; Manning and Petit, 2003; Moss, 2007; Walker *et al.*, 2003; Walker and Marchau, 2003, and other).

Swart *et al.* (2009) reviewed a few key issues on the foundations of uncertainty analysis, summarized the history of the uncertainty treatment by the IPCC and found that 'there is a reason to agree to disagree'. Their typology of uncertainty, represented as an uncertainty matrix, is shown in Table 4.15. According to this typology, uncertainties can have different *locations* (that is, where in the assessment the uncertainties arise), different *levels* (from determinism to ignorance), different *nature* (epistemic, variability), different *qualification* of the knowledge base (from weak to strong); uncertainties also involve *valueladenness* of choices. These authors also show that uncertainties:

1. Depend on the context of the assessment and the ecological, technological, economic, social and political questions, which are addressed: how do we define the problem, and which choices do we make in this definition?
2. Arise at the level of observations and from how the data from observations are turned into indicators used in the assessment.
3. Arise during modeling (e.g., choices of parameters, soft- and hardware, input data).
4. Introduced when outputs are processed, e.g., through the formulation of statements and key findings, and by constructing indicators to communicate these findings.

Table 4.15 A typology of uncertainty, represented as an uncertainty matrix

Location of uncertainty		Level of uncertainty (from determinism, through probability and possibility, to ignorance)			Nature of uncertainty		Qualification of knowledge basis			Value-ladenness of choices		
		Statistical uncertainty	*Scenario uncertainty*	*Recognized ignorance*	*Epistemic*	*Variability*	*-*	*0*	*+*	*-*	*0*	*+*
Context												
Expert judgment												
Model	*Structure*											
	Implementation											
	Parameters											
	Input											
Data												
Outputs												

Source: Swart *et al.*, 2009

For the sake of simplicity, below we describe the most fundamental statements of this and other classifications in the uncertainty science. Some other components of the Swart *et al.* typology are partially discussed in the following sections.

Generally, uncertainty is the situation in which it is not possible to predict what will happen. The role of science in view of uncertainty has long bothered thinkers and academics. Knowledge is not equivalent with truth and certainty, and therefore uncertainty is not simply the absence of knowledge and can still prevail in situations where a lot of information is available. New information can either decrease or increase uncertainty, and new knowledge may reveal the presence of uncertainties that were previously unknown or underestimated. In this way, more knowledge shows that our understanding is more limited or that the processes are more complex than previously thought. More knowledge thus does not imply less uncertainty and *vice versa* (van Asselt and Rotmans, 2002).

At the same time, uncertainty, as scientifically understood, although being an ever-present component in a projecting process, does not preclude confidence in scientific results[19]. Leary *et al.* (2007) consider uncertainty as a 'problematic' term, often leading users to conclude erroneously that little is known or understood about the drivers of change, system behavior, its consequences, and feasible response options. This daunts both researchers and users. In reality, all research results are of varying degrees of confidence, with varying proportions of uncertainty.

The ***probabilistic approach*** to uncertainty in relation to climate change raises some important conceptual issues. In particular, characterization of uncertainties should clearly reflect their origin and the ways in which corresponding probabilities are derived. Manning and Petit (2003) classify the origins of different components of uncertainties into five broad areas:

1. *Incomplete or imperfect observations* – a joint property of the system being studied and our ability to measure it
2. *Incomplete conceptual frameworks* (models that do not include all relevant processes) – shortcomings in our understanding that essentially require a 'breakthrough' to rectify and is the most difficult aspect to characterize uncertainty accurately
3. *Inaccurate prescriptions of a known process* (poor parameterizations) – defects in our understanding that are subject to incremental improvement
4. *Chaos* – a property of the system being studied that, as defined classically, arises where future states of the system are highly sensitive to small changes in initial conditions
5. *Lack of predictability* – some aspects of studies that are much less amenable to prediction than others.

It is also difficult to define uncertainty, and usually this is done by classification. Van Asselt and Rotmans (2002) see one way to classify uncertainty by investigating its origins. They developed taxonomy of sources of uncertainty (Fig. 4.11) that enables analysts to differentiate uncertainties in a more constructive manner. This taxonomy is meant to be generic, i.e. applicable to all contexts, and permits the tracing of revealed uncertainties back to one or more sources of the taxonomy.

At the highest level of aggregation the authors distinguished two sources: an *uncertainty due variability* and uncertainty due *limited knowledge.* Variability is an attribute of reality, and in this case the system/process under consideration can behave in different ways or is valued differently (an ontological source). Limited knowledge is a property of the analysts performing the study and/or of our state of knowledge (an epistemological source). A similar conclusion is made by Walker *et al.* (2003): an uncertainty due to lack of knowledge (although uncertainty is not simply the absence of knowledge) and an uncertainty due to variability inherent to the system under consideration.

As different sources of variability, Asselt and Rotmans (2002) distinguish the following (in square brackets there are given examples of uncertainties related to this source that pertain to integrated assessment of climate change):

---

[19] At the same time, "More confidence does not mean 100 percent confidence" (Snell, M.B., 2009: TNR Q&A: Dr. Stephen Schneider. *The New Republic,* November 9, 2009, p. 2)

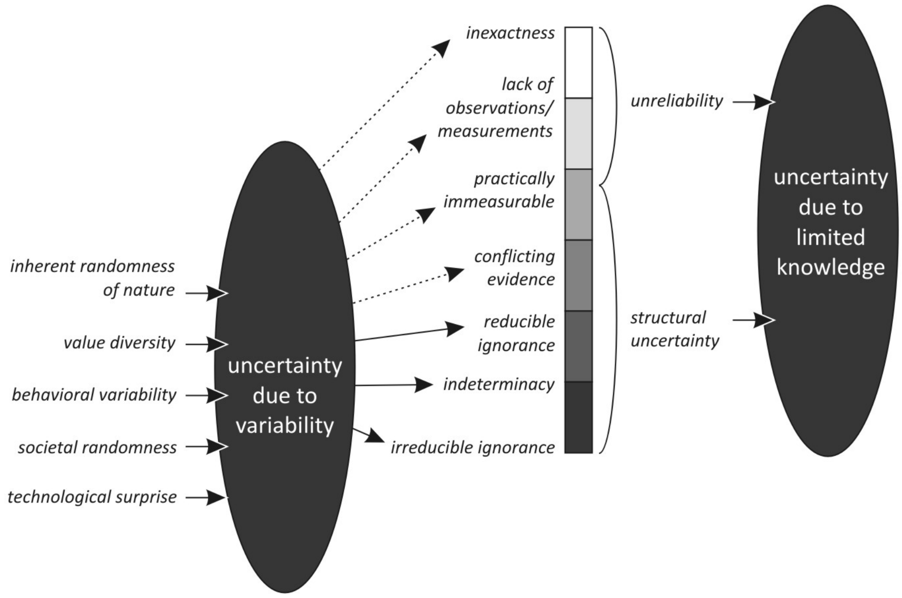


Fig. 4.11 Typology of sources of uncertainty. *Source:* van Asselt and Rotmans, 2002

- *Inherent randomness of nature*: The non-linear, chaotic and unpredictable nature of natural processes [Ocean dynamics and the behavior of clouds]
- *Value diversity*: Differences in people's mentalities – world views, norms and values, due to which problem perceptions and definitions differ [Adverse climate risk vs. adverse economic risk]
- *Human behavior* (behavioral variability): 'Non-rational' behavior; discrepancies between what people say and what they actually do (cognitive dissonance), or deviations of 'standard' behavioral patterns (micro-level behavior) [Consumption patterns related, e.g., to energy use]
- *Social, economic and cultural dynamics* (societal variability): The non-linear, chaotic and unpredictable nature of societal processes (macro-level behavior) [Effectiveness of policy agreements, institutional conditions for infrastructural changes in energy supply]
- *Technological surprises*: New developments or breakthroughs in technology or unexpected consequences – 'side-effects' – of technologies [Renewable energy options, ecological effects of large-scale biomass plantation].

Due to variability, in combination with limited resources to measure and obtain empirical information, reality exhibits inherent uncertainty and unpredictability. As such, it contributes to limited knowledge, which thus partly results out of variability, but as to deterministic processes can also be incomplete and uncertain.

A continuum in uncertainty, in Asselt and Rotmans (2002) definition, ranges from *inexactness* to *irreducible ignorance* in the following order (examples of uncertainties related to this source that pertain to climate change are also given in square brackets):

- *Inexactness* – lack of precision, inaccuracy, metrical uncertainty, etc.: 'We roughly know' [Life-times of greenhouse gases]
- *Lack of observations/measurements* – lacking data that could have been collected, but haven't been: 'We could have known' [Temperature feedbacks]
- *Practically immeasurable* – lacking data that in principle can be measured, but are absent in practice: 'We know what we do not know' [Indirect effects of aerosols]
- *Conflicting evidence* – different data sets/observations are available, but allow room for competing interpretations: 'We don't know what we know' [CO_2-fertilisation effect]
- *Reducible ignorance* – processes that we do not observe or theoretically imagine at this point in time, but may in the future: 'We don't know what we do not know' [Geophysical feedbacks]
- *Indeterminacy* – processes of which we understand the principles and laws, but which can never be fully predicted or determined: 'We will never know' [Weather dynamics]
- *Irreducible ignorance* – processes and interactions between processes that cannot be (or not unambiguously) determined by human capacities and capabilities: 'We cannot know' [Role of sun spots][20].

The uncertainty continuum thus ranges from unreliability to more fundamental uncertainty; the latter referred to as radical, structural or systematic uncertainty. Uncertainties in the category of unreliability are usually measurable, or can be calculated, in the sense that they stem from well-understood systems or processes. Such measurable processes are also referred to as 'ergodic processes'. This implies that in principle either their margins or patterns can be established, and usually the uncertainty can be described quantitatively. The opposite end of the continuum involves uncertainties that can at best be roughly estimated. Such radical uncertainty generally arises due to conflicting evidence, ignorance, indeterminacy and uncertainty due to variability.

More than a century of philosophical discussion on uncertainty has shown that there are three fundamental divisions between ***uncertainty approaches*** that must be respected, namely: those between the objective and the subjective views of uncertainty, those between precise, probabilistic risk and imprecise uncertainty, and those between uncertainties in natural systems and human choice (Ha-Duong *et al.,* 2007; Swart *et al*., 2009).

The oldest division is division between the *objective* and *subjective* views of probability. The *objective* views include the classical approach (probability is the

[20] Giampietro (2002), discussing some challenges for Integrated Assessment, also makes distinguishing within the concept of uncertainty between *uncertainty due to indeterminacy* and *uncertainty due to ignorance.* To the first case he refers a reliable knowledge about possible outcomes and their relevance, but absence of possibility to predict with the required accuracy the movement of a system in its accessible state space. Such an uncertainty implies that we are dealing with problems which are classifiable (we have valid categories for the problem structuring), but that they are not fully measurable and predictable. The second case is the situation in which it is not even possible to predict what will be the set of attributes that will result relevant for a sound problem structuring. That is, ignorance implies the awareness that the information space used for representing the problem is: (i) finite and bounded, whereas the information space, which would be required to catch the relevant behavior of the observed system, is open and expanding; and (ii) our model is missing relevant system qualities

proportion of favorable cases over total cases), the frequentist approach (probability is the limit of frequency in the long run), and the propensity approach (probability is a physical tendency). These views are objective, i.e. probability is seen as an intrinsic property of the system. From the *subjective* point of view, probability refers to degrees of belief. The distinction between *risk* and *uncertainty* describes the difference between situations where information can legitimately be represented using precise probabilities (*risk*) and situations where information is too imprecise to meaningfully use a probability distribution (*uncertainty*). In the differentiation of uncertainty in natural systems and uncertainty in human and social systems, the former are causal: the past determines the future. Human systems are intentional, so the arrow of time can be reversed: long-term goals can determine the present.

4.4.3 Uncertainty in model-based decision support

Decisions about the management of social and natural resources are frequently informed by predictions from models. In order to manage the models' contribution to decision-making, it is important to understand the uncertainties associated with these predictions. However, in practice this is not straightforward because models are structurally diverse, are used in a wide range of contexts and for many different reasons, and the quality of predictions may be highly case-dependent (Norton *et al.*, 2006).

Walker *et al.* (2003) proposed an *uncertainty analysis framework,* which later Krayer von Krauss *et al.* (2006) was called the W&H framework, with the aim to provide a conceptual basis for the systematic treatment of uncertainty in model-based decision support activities, such as policy analysis, integrated assessment, and risk assessment. This framework was also born out with a desire to integrate the wide variety of terminology, being used in different disciplines to communicate uncertainty, into a comprehensive and generic coherent conceptual framework.

In particular, Walker *et al.* (2003, p. 8) adopt the definition of uncertainty as "any departure from the unachievable ideal of complete determinism". Simultaneously, they argue that within the context of model-based decision support there is neither a commonly shared terminology nor agreement on a generic typology of uncertainties. They also distinguish between what can be called the modelers' view of uncertainty and the decision-makers'/policymakers' view. The former focuses on the accumulated uncertainties associated with the outcomes of the model and the robustness of conclusions of the decision support exercise; the latter includes uncertainty about how to value the outcomes in view of their portfolio of goals and possibly conflicting objectives, priorities, and interests.

Experts in uncertainty also agree that there are different dimensions of uncertainty related to model-based decision support exercises. So, Walker *et al.* classify uncertainties according to three dimensions (Fig. 4.12):

(i) *the location of uncertainty* – where the uncertainty manifests itself within the model complex;
(ii) *the level of uncertainty* – where the uncertainty manifests itself along the spectrum between deterministic knowledge and total ignorance;

(iii) *the nature of uncertainty* – the distinction between the above discussed two types – the modelers' and decision-makers'/policymakers' views. Here they are defined as *epistemic uncertainty* – the uncertainty due to the imperfection of our knowledge, which may be reduced by more research and empirical efforts, and *variability uncertainty* – the uncertainty due to inherent variability of the phenomena being described, which is especially applicable in human and natural systems and concerns the social, economic, and technological developments.

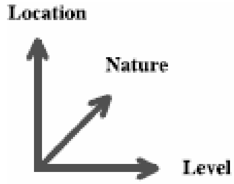


Fig. 4.12 Uncertainty: a three-dimensional concept. *Source:* Walker *et al.*, 2003

The ***nature of uncertainty***, by its essence, is very close to the highest level of aggregation in van Asselt and Rotmans (2002) typology of uncertainty's sources. Assessing this dimension may help to understand how specific uncertainties can be addressed. So, in the case of epistemic uncertainty, additional research may improve the quality of our knowledge and thereby improve the quality of the output. However, in the case of variability uncertainty, additional research may not yield such improvement.

Location of uncertainty refers to the logical structure of a generic system model within which it is possible to pinpoint the various sources of uncertainty in the estimation of the outcomes of interest.

An entire spectrum of different ***levels of knowledge*** ranges from the unachievable ideal of complete deterministic understanding, at one end of the scale, to total ignorance – at the other. In many cases, decisions must be taken when there is absent not only a lack of certainty about the future situation or about the outcomes from policy changes, but also when some of the possible changes themselves remain unknown. To distinguish between the various levels of uncertainty, Walker *et al*. (2003) employ different terminology – *determinism, statistical uncertainty, scenario uncertainty, recognized ignorance* and *total ignorance,* where:

Determinism is the ideal situation in which everything is known precisely. It is not attainable in principle, but acts as a limiting characteristic at one end of the spectrum.

Statistical uncertainty is any uncertainty that can be described adequately in statistical terms. It can apply to any location in the model, even to model structure uncertainties, as long as the deviation from the true value can be characterized statistically. Statistical uncertainty is what is usually referred to as 'uncertainty in the natural sciences'. The weakness of use of statistical models for socio-economic applications is demonstrated in Box 4.14.

A *scenario* is a plausible description of how the system and/or its driving forces may develop in the future. To be plausible, it should be based on a coherent and internally consistent set of assumptions about key relationships and driving forces (e.g., technology changes, prices). Scenarios do not forecast what will happen in the future; rather they indicate what might happen (i.e. they are plausible futures). Because scenarios make assumptions that in most cases are not verifiable, the use of scenarios is associated with uncertainty at a level beyond statistical uncertainty. Contrary to statistical uncertainty, where the functional relationships are well described and can be formulated, scenario uncertainty implies that there is a range of possible outcomes, but the mechanisms leading to these outcomes are not well understood and, therefore, it is not possible to formulate the

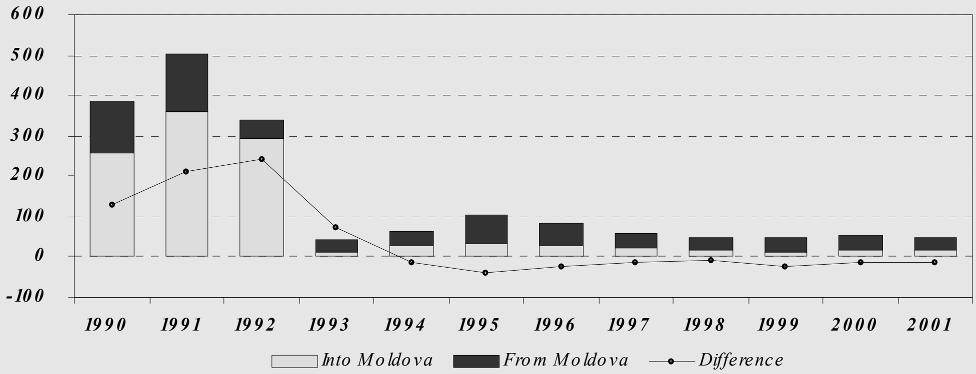
Box 4.14 Major weaknesses (uncertainties) of statistical models in predicting a tourists travel flow

Undoubtedly, tourism is dependent on a range of climate variables. Accordingly, it is expected that climate change will affect travel behavior as a result of altered weather conditions at the destination level from the viewpoint of their ‘comfortableness’ for tourists. However, Gössling and Hall (2006) showed that statistics-based models, sometimes used to express the tourists’ choice as a function of weather and climate (along with other natural and social factors) and thus seen as determinist approaches to understanding the interaction of tourists’ behavior, have found a number of evident weaknesses caused by a set of uncertainties:

- Validity and structure of statistical databases
- Temperature assumed as the most important weather parameter and largely unknown importance of other weather parameters and the role of weather extremes
- Unclear role of non-climatic parameters (e.g., social interest, political instability, risk perceptions)
- Existence of fuzzy-variables (terrorism, war, epidemics, natural disasters)
- Unrealistic assumption on linearity of change in tourist behaviour
- Uncertain future costs of, e.g., transport
- Uncertain future levels of disposable income *(economic budget)* and availability of leisure time *(time budget)* that are allocated to travel.

As case in point, the Figure below shows the dynamic of tourist flow in Moldova over a decade. The economic crisis and unstable political situation of the transition period resulted in sharp decrease in international tourist arrivals – from almost 360 thousands in 1991 to less than 11 thousands in 1993. Negative balance in the flows into and from Moldova has lasted clear through to the present. Undoubtedly, observed changes in climate are not the main driver of such an adverse situation.

Dynamic of tourism flow in the Republic of Moldova, thousands persons in the 1990s
(Based on 1990-2002 Moldova’s Yearbooks)



probability of any one particular outcome occurring. There is a demarcation in the transition from statistical uncertainty to scenario uncertainty at the point where a change occurs from a consistent continuum of outcomes expressed stochastically to a range of discrete possibilities, where choices must be made with respect to the options to analyze without allocation of likelihood.

Recognized ignorance is fundamental uncertainty about the mechanisms and functional relationships being studied. Nobody knows either the functional relationships or the statistical properties and the scientific basis for developing scenarios is weak.

Total ignorance is the other extreme on the scale of uncertainty, which implies a deep level of uncertainty to the extent that 'we do not even know that we do not know'. In essence, this is *reducible ignorance* in van Asselt and Rotmans (2002) continuum of uncertainties.

Of course, assessing the influence and propagation of the various types of uncertainty, particularly their qualitative aspects, remains a challenge, and further work is required in this area. For instance, in the opinion of Norton *et al.* (2006), the W&H framework (Krayer von Krauss *et al.,* 2006) is valuable in stimulating further thoughts about the role of uncertainty in model-aided decision-making, but is incomplete in the discussion of concepts and hence is difficult to apply within an interdisciplinary framework, as well as insufficiently grounded in methodology and thus difficult to apply in operational content. In the answer to Norton's *et al.* remark, Krayer von Krauss and co-authors expanded their discussion of the uncertainty analysis framework and detailed their position. Firstly, their ambition was…"to establish a comprehensive and coherent typology of uncertainty, described by a unified vocabulary, in the hopes that it can be used by practitioners to systematically diagnose and communicate the complete range of aspects of uncertainty that can characterize decision support activities" (p. 90); secondly, major uses of the framework are for "…bringing attention to potential sources of uncertainty that are relevant for decision-making, not suggesting how uncertainty assessment should be carried out. Developing such suggestions is a logical next step, for which the insights from the W&H framework can be a useful starting point" (p. 93).

The variety of different developed and applied approaches to assess and manage uncertainty have their strengths and weaknesses.

In principle, this situation is good. Ha-Duong *et al.* (2007) argue that there are strong reasons to use different methods to assess uncertainty or, in other words, it is better to have controversy rather than seek one universal approach to uncertainty management. This notion can be correct because the issues met with by social scientists have a different nature from those met with by natural science. "Critically for an interdisciplinary panel, there is a deep cultural divide between traditional experimental sciences methods and social sciences methods. Experimental sciences seek to determine precise objective frequencies based on a large body of observations, assuming that experiments are reproducible. Social sciences have rarely replicated controlled experiments or even complete observations, and often the most adequate available description of knowledge is narrative" (Ha-Duong *et al.,* 2007, p. 9). Sociology adds uncertainties due to human choice caused by the lack of comprehensive scientific understanding of the systems that determine climatic changes and associated impacts. Although there are other opinions on this question[21], more than a century of philosophical discussion on uncertainty has shown that available divisions must be respected. Uncertainties in natural systems are causal – the past determines the future; the human systems are intentional, so the arrow of time can be reversed – long-term goals can determine the present. As a result, the nature of data, indicators and analyses used in the natural sciences is generally different from that used in assessing technology development or the social sciences.

---

[21] For example, Schneider (2002, p. 445) wrote: *"I believe there is no in principle difference between natural and social sciences in this regard"*

Nevertheless, a distinction between these two methods has never been a hard rule. For example, there is a large experimental branch in economics. On the other hand, in the natural science of climate, which is largely an observational science, experimentation with the climate system is impossible. Thus, "saying that experimental sciences tend to take a 'hard' (precise, objective and causal) approach of knowledge, while social sciences tend to be on the 'soft' (imprecise, subjective and intentional) side is of course only a general tendency" (Swart *et al.*, 2009, p. 6). When speaking about IPCC activities, its first working group (WGI) focuses on the former, WGIII on the latter, and WGII covers aspects of both.

The above-quoted authors also promote emphasis on the distinction between findings based on observations, those based on models and those based on future scenarios including human choice. However, in all cases, both objective and subjective sources of information can be precise or imprecise. Imprecision occurs in the objective setting when the sample size is small and in the subjective setting when experts are deeply uncertain and cannot quantify risk.

4.4.4 Dealing with uncertainty and risk

4.4.4.1 Integrated Assessment, decision making, modeling

Uncertainty analysis should be decision focused, instead of being presented in a vacuum (Moss, 2007). Areas of high uncertainty must be acknowledged by researchers and policymakers alike, who instead of focusing on this uncertainty should emphasize crucial issues and ranges of possible developments (Litre and Mekjian, 2008). Although the precautionary principle implies that the lack of full scientific certainty should not be used as a reason for postponing measures to prevent threats of serious irreversible damage or environmental degradation, the processes of estimating, combining, and communicating uncertainties are central to conducting useful assessments, the making of decisions, and modeling the future.

Dealing with uncertainty is principally at the core of ***Integrated Assessment****,* including environmental assessment as well. Practitioners in IA realize this, although van Asselt and Rotmans (2002) noted:

- ☑ Not all uncertainties can be adequately addressed with existing methods and tools. This especially holds for uncertainty in model structure and uncertainty due to behavioral and societal variability, value diversity, technological surprise, ignorance and indeterminacy;
- ☑ Uncertainty is usually treated as a marginal issue, as an additional physical variable or as a mathematical artifact;
- ☑ The current methods merely involve evaluation of the impacts of 'certain uncertainties', i.e. uncertainties for which estimates or probability distributions are available, and give no indication of the magnitude and sources of individual underlying uncertainties, while the aggregated uncertainty measures are difficult to understand for decision makers and other audiences.

Lee (2006), 'bridging' the gap between theory and practice in integrated assessment, supplements these concerns. In particular, within the assessment an uncertainty arises in a number of different ways, partially discussed in a previous subchapter, for example, due to exogenously determined conditions of the future (e.g., relating to technological, socio-economic or environmental conditions), due to limitations in current scientific and other forms of knowledge (e.g., in causal-chain analyses), and due to conflict and the lack of stability in values held within society. Accordingly, responses to these uncertainties range between those, which are technical (e.g., incorporating some form of probability analysis into the assessment methodology) and those, which are procedural (e.g., specifying the processes and the role of stakeholders within them and the uncertainties that are to be handled within the assessment process itself). These two approaches are sometimes presented as rival solutions, but a preferred option may be a hybrid of the two.

Dupuy and Grinbaum (2004) suggested three components in dealing with uncertainty in broad based issues such as climate change: (1) gauging the types of uncertainty correctly; (2) taking into account cognitive barriers, and (3) dealing with ethical problems.

Under different ***typologies of uncertainty*** the authors mean respectively such areas as *epistemic* uncertainty due to a lack of knowledge and *deterministic* chaos that places limits on the precision of predictions.

In turn, a ***cognitive*** barrier to objective decision making arises in three ways. Firstly, people have a preference for certainty in outcomes they can influence, choosing smaller but certain benefits over larger benefits associated with some degree of risk even where on average the latter option should be to their advantage. Similarly, there is a preference to choose situations in which there is some information even if that information might be unreliable. And, at last, a cognitive barrier to effective decision making comes from people's believing that the worst is going to occur, as shown in cases where accurate predictions have been ignored. Similarly, the recognition of a risk existence appears to be determined by the extent to which solutions are perceived to exist[22].

Ethical issues in dealing with uncertainty relate to responsibility for decisions. There are different views as to the level of responsibility of scientists, and they may change, depending on when such judgments are made, what changes actually occur and how serious their impacts are. The approach called for is one in which the public and scientists are both consciously engaged in an ongoing normative assessment of scientific understanding of the issue under study.

In the **modeling** process an uncertainty enters various issues. In formal modeling Asselt and Rotmans (2002) distinguish between uncertainties in model quantities, uncertainty about a model's form and uncertainty about model completeness/adequacy. The focus of a modeling exercise in decision support activities is typically in the response of a system to outside forces (external changes or policy changes) and the system's performance (i.e. the resulting values of the outcomes of interest) in these future contexts (Walker and Marchau, 2003; Walker *et al.,* 2003).

---

[22] G. Morgan identifies three forms of cognitive bias as (See: Manning *et al.,* 2004, p. 13):

• *Availability* – probability judgment is driven by ease with which people can think of previous occurrences of the event or can imagine such occurrences;

• *Anchoring and adjustment* – probability judgment is frequently driven by the starting point which becomes an 'anchor';

• *Representativeness* – people judge the likelihood that an object belongs to a particular class in terms of how much it appears to resemble that class.

A much-used analytical tool to deal with the deep uncertainties of the unknown and unknowable future is development and use of ***scenarios***. Here, great care must be taken because any scenario is based on a coherent and internally consistent set of assumptions about key relationships and driving forces (e.g., technology changes, prices, etc.). Different scenarios reflect the variety of alternative economic, environmental, social, and technological conditions that may exist in reality, including variations in the behavior of people. These conditions act on the system, leading to its changes and, ultimately, to changes in the outcomes of interest. Within the decision support exercise, alternative scenarios may manifest themselves as alternative model formulations, as alternative sets of input data, or as both. Policies represent the alternative mechanisms for affecting the system that are under policymakers' power (e.g., changes in prices, regulations, infrastructure, etc.). Although the policies themselves may be well defined and not uncertain, the ways the system actually changes in response to the policy changes is often highly uncertain. For example, although scenarios play a prominent role in policy debates over climate change, the questions continue about how best to use them (Groves and Lempert, 2007)[23].

Policy analysts use the best-estimate models based on the most up-to-date scientific knowledge to examine the consequences that would follow from the implementation of each of the possible policies in each scenario. The 'best' policy, called a *robust* policy, is the one that produces the most favorable outcomes across the scenarios. The problem with this approach is that the resulting policy is best for specific scenarios, but this is fairly certain not to occur, since any given scenario has zero probability of actually occurring. More important, the resulting policy has implications for the future that would actually occur, but were probably not examined in the course of the analysis and were not generally revisited later as the future unfolds (Walker and Marchau, 2003).

4.4.4.2 Uncertainty in risk analysis

In the already mentioned in this book interview[24], Stephen Schneider said: *"You cannot address the problem of what to do, which is risk management, without addressing the problem of risk, which is probability times consequence. This was important to me because I knew that if we did not tell governments how likely climate change is, they would not listen to us about doing something about it"*.

Uncertainties analysis plays a key role in ***risk management*** and ***risk assessment*** strategies aiming to identify unpredictable regimes. They propagate through every step of an assessment and are the largest barrier to establishing the levels of risk (Jones, 2000). Linking uncertainty to risk is to improve communication between climate scientists and the potential users of information they can provide. The concept of risk is especially useful when dealing with problems that are easily classified and easily measured. Under the assumption that a set of valid models is available, one can forecast and usefully represent

[23] Groves, D.G. and R.J. Lempert, 2007: A new analytic method for finding policy-relevant scenarios. *Global Environmental Change* **17**: 73–85; van Vuuren D., K. Riahi, R.H. Moss *et al.*, 2010: Developing new scenarios as a common thread for future climate research, 27 p. Available at: *http://www.ipcc-wg3.de/meetings/expert-meeting-and-workshops/WoSES*

[24] Snell, M.B., 2009: TNR Q&A: Dr. Stephen Schneider. *The New Republic,* November 9, 2009, p. 4

what will happen at a particular point in space and time. With applicability of these hypotheses, the expected errors in predicting the future outcomes are negligible.

The concept paper for the uncertainty and risk (Manning and Petit, 2004) posed as a general coordinating principle that consideration should also be given to how users might manage uncertainties in situations where it is possible to assign a distribution of probabilities to a given set of possible outcomes. Following to the broadest definition of risk as a combination of the likelihood of an outcome or event and some quantitative measure of their consequences, many analysts consider a risk as a simple product of probability and consequence.

In such meaning, risks are broadly used for estimating uncertainties in decision making for environmental and other issues. For example, Schneider (2002, p. 443) insists that "it is simply very difficult for policy makers to have a 'consequences alone' definition of risk…in which only ranges of plausible scenarios are given 'independent of the question of how likely they are to occur' – that is, no probabilities are attempted to be attached to each of them". This undoubtedly creates "…the potential for misunderstanding or misuse of the scenarios by interests" (*Ibid,* p. 450). Approaching climate change in this context enables users to more easily relate its effects to other risks, and to integrate decisions on climate change with existing decision making frameworks for dealing with risks in which a range of outcomes can be considered with their probabilities and consequences. However, this perspective also shows that being faced with uncertainty it is not sufficient to identify only the most likely outcome, with the exclusion of other, perhaps less likely but more consequential outcomes (Manning *et al*., 2004).

A number of different approaches to assessing risk, from formal and quantitative to largely personal responses based on experience and perceptions, deal with uncertainty in one way or another, and the qualitative and contextual aspects are both important. Where the propagation of uncertainty is a concern, a 'disintegrated' analysis can be undertaken where each of the elements within an integrated framework is assessed separately.

Bazerman (2006) discusses the concept of ***predictable surprise,*** defining this term (p. 180) "as an event or set of events that catch an organization off-guard, despite leaders' prior awareness of all of the information necessary to anticipate the events and their consequences". As an example, the author uses the events of September 11, 2001 in New-York. Moreover, most policy- and decision-makers recognize growing systemic weaknesses in their fields of responsibility that have the potential to grow into a major crisis over time. Recent natural disasters, e.g., last-years floods in Central and Eastern Europe, suggest that individuals and organizations are unlikely to respond efficiently, effectively, or swiftly to avert a predictable surprise. In his paper, Bazerman argues that disasters resulting from climate change also are a predictable surprise. Most results of predictable surprises come from the failure to confront cognitive, organizational, and political barriers to change.

In particular, cognitive barriers for the failure to respond to climate change are based on psychological research and can be explained in part by common patterns of decision making. Frequently, people rely on simplifying strategies, or cognitive heuristics, that lead them to make predictable errors in different fields, including medicine, law, business, and public policy. Bazerman (2006) examines five common cognitive patterns of decision making to explain the human failure to respond effectively to climate change:

1. *Positive illusions* that lead to conclusion that a problem doesn't exist or is not severe enough to merit action. People view themselves, the world and the future in a considerably more positive light than is objectively. Although positive illusions have a number of benefits, such as enhancing and protecting self-esteem, increasing personal contentment, and helping to persist at difficult tasks and cope with aversive and uncontrollable events, they also reduce the quality of decision making, preventing from responding to predictable surprises.
2. *Egocentrism* or interpretation of events in an egocentric, or self-serving, manner. In a climate case, the egocentrism leads to searching for who must be blamed for climate change. So, the developed countries largely blame emerging nations for burning rainforests, overpopulation and economic expansion. In contrast, the emerging nations blame the West for emissions caused by its past and present industrialization and excessive consumption. In fact, both views are biased in a self-serving manner. Egocentrism leads all parties to believe that it is honestly fair for them to bear less responsibility for reversing climate change than an independent adviser would judge. Thus, the problem is also caused not by a desire to be unfair but by the inability to interpret information in an unbiased manner.
3. *Overlay discounting the future* when, rather than evaluating options from a long-term perspective, people tend to focus on or overweight short-term considerations. Sometimes the most common argument is that it would be too costly to respond to the problem, and such "…progression of denials – from 'There is no problem' to 'We are not responsible' to 'It's too expensive to fix' – result in small benefits for the current generation in exchange for high costs to future generations" (*ibid,* p.185).
4. *The omission bias and the status quo,* or maintaining the status quo and refusing to accept any harm, even when it would bring about a greater good. To create a greater good, one must often accept tradeoffs that require the infliction of small harm. Psychological tendency to pay more attention to losses than to gains lead many to turn down the job, preserve the status quo, and forego a net gain. However, a desire to avoid inflicting any new harm results in more probability to make 'errors of omission' (inaction) than 'errors of commission' (causing harm).
5. *Vividness* or judging the frequency with which an event occurs by the availability of its instance. Usually, events whose instances are more easily recalled will appear more frequently than events of equal frequency whose instances are more difficult to recall. The effect of this 'availability' heuristic is that decision-makers overweight vivid events and don't want to invest in preventing a problem that has not been personally experienced or witnessed through vivid data. In particular, the lack of vividness can prevent addressing the climate change. To wait when harms will become vivid leads to dramatic destruction.

Other barriers in preventing 'a predictable surprise' extend beyond the human mind, e.g., those that occur at an organizational and political level. Prevention of predictable surprises requires leaders to enhance the capacity of their organizations to recognize emerging threats, prioritize action, and mobilize available resources to mount an effective preventative response. *"A failure to prevent a predictable surprise can result from the lack of any of these three components of effective action,"* – Bazerman (2006, p. 190) concludes.

Yohe G. (2004, p. 285) believes that "…adopting a risk-based precautionary perspective in the evaluation of short- and medium-term climate policy would have a number of advantages over the implicit cost-benefit perspective embodied in the question 'what are the benefits of climate policy?" First, adaptation responses can easily be incorporated into examinations of the effect of mitigation on the risk of intolerable impacts for locations where understanding of those processes is most well developed. Secondly, adopting a risk-based approach makes it clear that these two policy options can work complementary in reducing risk rather than as substitutes working on one or other side of the cost-benefit calculus. The advantage here is that a risk-based perspective allows discussions of how to integrate adaptation and mitigation to move beyond simply looking for 'win–win' options (adaptation improves mitigation or vice versa) into looking for synergies in simultaneously reducing exposure (mitigation) and sensitivity (adaptation).

In recent years, the risk analysis community has made tremendous progress in dealing with a wide array of practical and theoretical issues and has developed an in-depth understanding of processes of risk communication and decisions about what risks are deemed acceptable or unacceptable by different people. The risk community realized that a new kind of risk issue – *Integrated Risk Governance* – will become increasingly salient in the future; the combination of risks makes it difficult to deal with any of them in isolation (Jaeger and Shi, 2008). It is clear also that in order to develop knowledge on integrated risk governance, it would be appropriate to start by focusing on a few selected fields.

4.4.4.3 Learning as a way to diminish uncertainty

Learning plays a prominent role in the international environmental and climate policy debate on uncertainty (Kolstad and Ulph, 2008; O'Neill and Sanderson, 2008; O'Neill *et al.*, 2006). However, there has been far less attention to the learning process itself. O'Neill and Sanderson (2008, p. 88) define learning "as the acquisition of new information that leads to changes in the characterization of uncertainty, whether that change is a reduction in uncertainty, an increase, or a shift in the mean without a change in the variance of an uncertainty distribution".

Learning is a crucial feature of the climate change issue. Here, O'Neill *et al.* (2008) have formulated several questions the answers to which are not merely of academic interest, but play a prominent role in the climate policy debate. These questions are: *How much, and how fast, might we realistically expect to learn about particular elements of the climate change issue? Will new information reduce uncertainties or increase them? How should affect the expectations of future learning today's policy decisions?*

Incorporating the potential for learning into climate change decision analyses can be important for a number of reasons. Agents that learn about the changing outlook for climate conditions can develop adaptation strategies that reduce the costs of climate impacts. In addition, it is possible that the potential for future learning could affect current policy decisions. Analyses of learning inform research priorities by identifying not only which uncertainties in the climate system would, if reduced, yield the largest benefits to today's decisions (Keller *et al.*, 2008), but also by identifying the kinds of actions that might be taken to facilitate such learning (Baehr *et al.*, 2007). Learning also applies to the development of institutions to respond to the climate issue, including international agreements and legal frameworks to support them. Investing in such institutional development now will allow faster and more flexible policy responses to new information in the future. The same argument applies to new technologies: if we do not invest in different options we may well preclude those (O'Neill *et al.*, 2006).

The question of whether to act now or wait to learn more is central to the debate over climate change policy. Kolstad and Ulph (2008, p. 126) noted that "…what complicates things for climate policy is that uncertainty itself is changing—we are learning about the science and economics of the problem as time passes. Furthermore, we are taking active steps to increase our knowledge of the processes". It is often argued that a *'learn-then-act'* approach only makes sense if, for example, the accumulation of GHG emissions is reversible, so that if we make a policy 'mistake', we can undo the effects of the decision. But the accumulation of GHG is viewed as irreversible, so that by the time we learn that climate change is a serious issue we may have built up such their concentrations that will be faced with drastic consequences that cannot be readily undone. Namely this irreversibility in the climate process has lead to calls for implementing the precautionary approach. With respect to uncertainties in environmental protection, Kolstad and Ulph define the precautionary principle as a statement "…that when environmental risks are uncertain, not well understood and irreversible, then regulatory actions should be biased towards avoiding those risks, rather than approaching the problem as a standard case of decision-making under uncertainty".

4.4.5 Managing an uncertain future climate

Climate change has largely 'killed' stationarity and an idea that natural systems fluctuate within an unchanging envelope of variability – all that has been at the heart of infrastructure design and planning, insurance pricing, and numerous political decisions. Decision makers now have to contend with the changing climate compounding the uncertainties they already faced. Policy making for adaptation itself also needs to be adaptive, with periodic reviews based on the monitoring of new information (Word Bank, 2010). In other words, *"uncertainty about the course of future change in climate – on all scales – and uncertainty about how societies will respond to this change presents new challenges for the way individuals, organizations and societies make decisions. It also makes it difficult to design effective, equitable and effective policies which will achieve the goal of the UNFCCC"*, – Dessai *et al.* (2007, p. 1) are sure. Much less widely appreciated is the potential to change over time our current understanding of the uncertainty associated with climate change. *"How fast and in what way uncertainty might change is only beginning to be explored, despite the fact that it has potentially important implications for today's policy decisions as well as for setting priorities in climate change research"*, – O'Neill echoes (2008, p. 1).

The global warming controversy has been to a large degree a debate among scientists, policy analysts and politicians about how to deal with uncertainty that abounds in climate change. Part of it relates to an imperfect understanding of the mechanisms at work; another part relates to the stochastic nature of important systems, a third – to the long lead-times of cause and effect. Unquantifiable sources of uncertainty, with the potential to influence global climate, include feedback effects due to changing atmospheric chemistry, the effects of altered land surface cover and ecosystems, social disasters occurring on a global scale, and so on. In spite of very high confidence that further anthropogenic emissions will continue to change atmospheric composition throughout the centuries, there is less confidence about how exactly the climate will change in the future, and lesser confidence still about the adjustments it will induce to natural and human systems (Jones, 2000; Dessai *et al.*, 2007).

Two major risks have been put forward (Froyn, 2005). One is the risk of significant human and ecosystem impacts from large-scale climate change and potential environmental problems of immense dimensions. The other is the risk of incurring large economic costs now for policies that might slow global warming or mitigate its impacts, while there is considerable uncertainty about the effectiveness of the policies as well as the severity of the problem. However, regardless of which strategy policy-makers choose to confront climate change, the considerable uncertainty with respect to the outcome will remain. Given the wide range of uncertainties, it is not surprising that debates within the two domains of human response—adaptation and mitigation—are deeply contentious and irresolvable (Manning *et al.*, 2007).

Toll (1999) has analyzed various aspects of the role of uncertainty in GHG emission-reduction policies in the integrated assessment model that coupled simple models of economy, climate, climate impacts, and emission abatement. He found that uncertainties are large and grow over time. At that, uncertainties about climate change impacts are more serious than uncertainties about emission reduction costs, so that welfare-maximizing policies are stricter under uncertainty than under certainty. If uncertainty is not adequately managed, the use of projected ranges in climate impact assessment results in its propagation.

The process of uncertainty accumulations throughout the process of climate change prediction and impact assessment has been described as the 'cascading pyramid of uncertainties', or the 'uncertainty explosion' (Jones, 2000; Schneider, 2002). If an assessment is continued through to economic and social outcomes, even larger ranges of uncertainty can be accumulated, and the diapason of projected possible impacts becomes commonly too large for the practical application of adaptation options. This 'accumulation' of uncertainties complicates significantly the problem for policy- and decision makers to assess the real 'dangerous anthropogenic interference with the climate system', that involves, as in Fig. 4.13, a cascade of uncertainties in emissions, carbon cycle response, climate response, and impacts.

Therefore, Jacoby (2004, p. 291) thinks that "choices about climate policy require the formation of a link between actions that could be taken and the climate change effects they might prevent". It is a lengthy chain, and the first link is the physics, chemistry and biology of the climate system, sometimes termed as ***ecological uncertainty***[25], and the human and natural systems with which it interacts. Uncertainties here create serious problems for those trying to reduce human interference with the climate system. The difficulty is not just in quantifying the physical aspects of climate change, but also in the differences among relevant groups in their perceptions of the risks that such analysis may reveal. Even more troublesome, Jacoby (2004) sees the need to pursue the analysis to the regional level, where most of climate change effects must be studied and where uncertainty grows substantially.

---

[25] Pindyck, R.S., 2000: Irreversibilities and the timing of environmental policy. *Resource and Energy Economics* **22**: 233–259 *(Quoted from* Castelnuovo *et al.*, 2003)

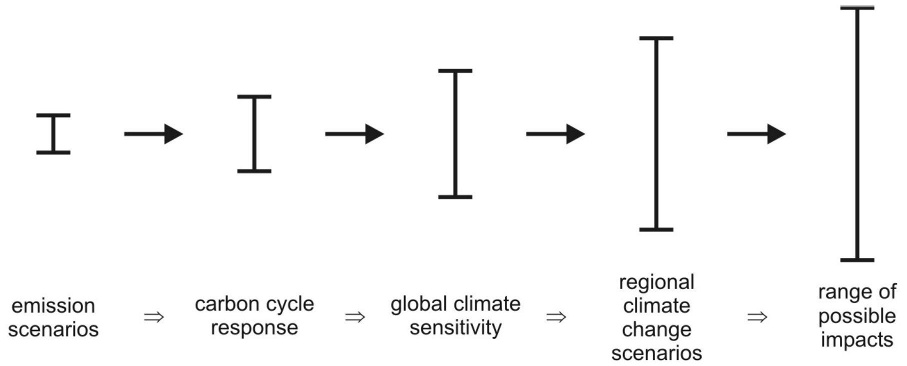


Fig. 4.13 The range of major uncertainties, typical in climate change impact assessments, showing the 'uncertainty explosion' as these ranges are multiplied to encompass a comprehensive range of future consequences, including physical, economic and social impacts and policy responses. *Source:* Adapted from Schneider (2002)

Finally, even with certain knowledge of future regional climate conditions, there remain limits to our knowledge of adaptive response and ultimate impact, particularly for unmanaged ecosystems.

Dessai *et al.* (2007) divide those who argue that policy needs 'robust' climate science (Patrinos and Bamzai, 2005) – an argument that favors more scientific research over policy action – and those who argue that uncertainty should not be used as a justification to do nothing because, on the contrary, uncertainty provides a reason to take specific policy action in the near term (Yohe *et al.*, 2004). Between these two positions there is a range of views about the implications of uncertainties for different types of policy responses – from mitigation to adaptation (Stern, 2006). However, although uncertainty about climate change has received growing attention in recent years (e.g., IPCC, 2007a; Manning *et al.*, 2004), much of this has focused on the description of its scientific manifestations in the climate system (Carter *et al.*, 1999), and to a lesser extent in climate change impact assessments. Moreover, "because climate change is not just a scientific topic but also a matter of high policy, the good data and thoughtful analysis may be insufficient to overcome confusion that masquerades as uncertainty is caused by the clash of different interests, standards of evidence, or degrees of risk aversion/acceptance" (Moss 2007, p. 5).

The uncertainties and unknowns in climate change assessments and development of response strategies are multiple, and there are various ways of approaching it, each with its merits and shortcomings. In this context, as the most relevant sources of uncertainty, Schneider *et al.* (2007) named natural randomness, lack of scientific knowledge, social choice (reflexive uncertainty), and value diversity. An uncertainty in the climate change science influences decision-making by altering political discourse. Policy-makers rely on scientific evidence to add legitimacy to their actions, and when the scientific community does not know the answer to policy relevant questions it undercuts the legitimizing function that science can provide and becomes a publicly accepted justification for postponing action. In this case, "…the groups interested in maintaining the status quo in the climate change policy arena do not simply deny the problem exists, but rather claim that the science is too uncertain to base any actions upon" (Patt, 2007, p. 38). An assessment of climate change science requires careful consideration of the level of scientific understanding that applies to all of the key issues covered. Uncertainties affecting currently available scientific results need to be explained clearly and in ways that avoid confusion and assist policymakers and non-specialists to analyze decisions and to manage risks (Manning and Petit, 2003).

IPCC (Carter *et al.*, 2007) considers the reducing of uncertainty through improved knowledge as a primary aim of scientific investigations, even though such investigations do not necessarily lead to success. Usually, a phenomenon or process is described qualitatively before to be quantified with any confidence; some aspects, e.g., of socio-economic futures, may never be well quantified. Often a scientific advance will expand a bounded range of uncertainty as a new process is quantified and incorporated into the chain of consequences contributing to that range. In such cases, the apparent 'expanding' of uncertainty is largely because the underlying process is becoming better understood. The examples are the expanded range of future global warming due to understanding the vegetation response, or a widened range of likely impacts that can be incurred by incorporating development futures in integrated impact assessments, particularly if adaptation is not taken into account.

From the viewpoint of decision-making under uncertainty*,* Patt (2007) examines the distinction between *model-based* and *conflict-based* uncertainties. This distinction is an important issue because a reliance only on a technical model of decision-making may be insensitive to psychological, social, and political nuances of information. Including uncertainty in climate change models is difficult and time consuming, but progress should be made. On the other hand, when experts or groups of experts reach different conclusions about future outcomes but make different subjective judgments about the starting conditions and further development of the system, they are modeling, a conflict-based uncertainty arises. People may also react differently to statements about uncertainty, depending on whether these statements emphasize the presence of conflicting opinions. In order to design an effective communication strategy, it is important to understand the ways in which they do so. The author showed that from an economic decision-making perspective the two types of uncertainty are in many ways logically equivalent, yet from psychological and social perspectives they are quite different. An experiment on the communication of climate change uncertainty also suggests that the two framings of uncertainty differentially influence people's estimates of likelihood and their motivation to take responsive action. It is recommended that assessment panels pay close attention to the social features of uncertainty, such as conflict between experts. The conflict-based uncertainty gives 'signals' to the public that a particular issue is important and politically contested, and hence policy actions may be necessary.

Usually, people are of two minds about uncertainty: they crave predictions about the future, and the quest for prediction probably fills some deep human need; but they also recognize that predictions are inherently unreliable. Nevertheless, the traditional framework for assessing alternative climate-change policies rests on the assumption that we can predict the future (Lempert and Schlesinger, 2000).

As a result of the non-linear and stochastic aspects of uncertainty inherit in the climate system and its anthropogenic and natural forcing, the climate change prediction needs to be approached in a probabilistic way. This requires a characterization and quantification of the uncertainties associated with the sequence of steps involved in this process. The additional difficulties appear when the prediction is extending from the global to the regional scale (Giorgi, 2005). Every time we do a new step, we add more uncertainty. Therefore, although probability-based estimates are a powerful risk-management tool, they can have serious limitations when applied to a problem such as climate change. For example, whereas the *predict-then-act* approach has been used (often with great success) in numerous applications, climate change violates its postulates on two related counts (Lempert *et al.*, 2004). First, it is associated with radically diverse decision contexts, geographic and time scales, comprising many different types of policy problems and involving many different types of actors. Second, climate change is associated with deep uncertainty where decision-makers do not know or cannot agree on: (i) the system models, (ii) the prior probability distributions for inputs to the system model(s) and their interdependencies, and/or (iii) the value system(s) used to rank alternatives. Therefore, a growing discussion has occurred amongst climate change researchers about whether the likelihood of quantified amounts of climate change throughout the coming century can be estimated.

Dessai and Hulme (2004) have posed the question: Does climate adaptation policy need probabilities? In the scientific realm there are a large number of studies that deal with impact and adaptation assessments of climate change, which have become increasingly sophisticated in the recent years, but few were able to provide robust information for decision-makers and risk managers. This occurs, among other causes, because of the issue of uncertainties in climate change, driven by the wide range of potential impacts, adaptation measures and options, and so on. The different perspectives on probabilities also originate from the training and philosophy (i.e. the epistemological orientation) of the researchers doing the policy analysis and the conceptual division between biophysical and social vulnerability scholars that can be traced back to the division between the natural and the social sciences. These authors emphasize that social vulnerability scholars are more interested in the processes underlying vulnerability, which once identified and improved could facilitate adaptation to climate change. Biophysical vulnerability scholars are interested in modeling the impacts of climate change to the highest degree possible, which certainly requires probabilities (or some explicit representation of uncertainty), and then devising adaptation strategies to reduce exposure to the increased hazard. On the whole, probabilities of climate change could potentially be very helpful for anticipatory, planned and strategic adaptations.

In order to improve a decision-making process, the climate change, impacts, adaptation and vulnerability assessments, abbreviated as CCIAV, aim to understand and manage as much of the full range of uncertainty as is practicable – from GHG emissions through adaptation to vulnerability (Carter *et al.*, 2007). Generally, the impacts associated with an emissions pathway are estimated in two steps: first – the evaluation of resultant climate change; then – the evaluation of this change's effects on natural and socio-economic systems. The combination of uncertainties affecting these two steps causes the first 'cascade' in overall uncertainties, extended by the new ones surrounding future adaptive capacity and the limits to adaptive responses, resulting, finally, in the uncertainties within vulnerability considerations (Manning and Petit, 2003). Uncertainty that cascades throughout our understanding of the climate system exacerbates the difficulty of assessing the impact *cum* adaptation in every case, but especially when climate variability diminishes decision makers' abilities to detect secular change. Yohe *et al.* (1999) guess that if to add here the issues of (1) how decision-makers receive information that they deem credible and (2) how researchers can responsibly describe high consequence/low probability outcomes to decision makers, it becomes clear that an honest assessment of a large system's adaptive capacity can take years. As a result, it is unreasonable to expect that complete and timely analysis of each and every system can be accomplished.

Some categories of uncertainty in the climate change issue are amenable to quantification, while other kinds cannot be sensibly expressed in terms of probabilities, which are generally considered as the best 'language' for describing uncertainties (Moss 2007). Various typologies of climate change uncertainty and factors that contribute to it have been proposed; some typologies are contained in the IPCC guidance note[26] as well as in its other developments. The guidance defines a framework for the treatment of uncertainties across all IPCC WGs. This framework is broad because the WGs assess material from different disciplines and sources and cover diverse approaches to the treatment of uncertainty.

The IPCC special workshop on describing scientific uncertainties in climate change to support analysis of risk and options (Manning *et al.*, 2004) stated that any assessment of uncertainties and confidence must begin by identifying and explaining the determinants of uncertainty, including underlying assumptions together with any conceptual or structural limits in the methods used, as well as the sources of uncertainties that can be treated specifically by those methods. The workshop divided uncertainty into two broad classes: *statistical,* associated with parameter or observational values that are not known precisely (relevant variables and functional relationships are known but values of key coefficients are not), and *structural,* where important relationships between variables or their functional forms may not have been identified correctly. Assessing structural uncertainty is generally more difficult and can normally only be done to a limited extent through comparison, for example, of models with observations or with one another (Corobov and Overcenco, 2007). Existing GCMs cannot even crudely quantify uncertainty at a regional scale, and even the range of results from one or more modeling studies *(the ensemble of models)* does not necessarily span the full range of uncertainty (Box 4.15). Meanwhile, an estimate of the uncertainty in a climate-model-based prediction of twenty-first century temperature rise is a potentially valuable tool for policy makers and planners (Knutti *et. al.*, 2010; Tomassini *et al.*, 2010; Ruosteenoja *et al.*, 2007; Stott and Kettleborough, 2002).

There are also important differences between descriptions of uncertainty. Some sources of uncertainty can be reasonably represented by probabilities, whereas others are more difficult to characterize in this way (Schneider *et al.*, 2007). The natural randomness in the climate system can be characterized by frequentist (or objective) probabilities, which describe the *relative frequency* (usually referred to as *likelihood*) of a repeatable event under known circumstances. There are limitations to the frequentist description, given the climate system is non-stationary at a range of scales and that past forcing factors cannot be perfectly known. Defined as the chance of event occurrence or outcome, *likelihood* can be a valuable construct where results are available from formal probabilistic analyses or can be expressed in a probabilistic way. Such language is familiar to those working with risk analysis using probability distribution functions.

---

[26] See *http://www.ipcc.ch/meetings/ar4-workshops-express-meetings/uncertainty-guidance-note.pdf*

Box 4.15 *Comparison of observed baseline (1960-1990) surface air temperature in Moldova with the simulated in different GCMs experiments*

The reliability of GCM simulations in their description of Moldova's present-day climate was tested through the mean, absolute and mean squared differences between simulated and observed monthly values, considering these differences respectively as mean *(ME)*, mean absolute *(MAE)* and standard *(SdE)* errors of modeling. *MAE* and *SdE* measure the magnitude of differences (the smaller value the "better" – conventionally! – model); *ME* measures a bias (how much a model's error is close to zero). The analysis of errors was supplemented by the analysis of correlations between simulated and observed values. The results of the comparison are presented in the Table below.

All simulations have strong ($r > 0.98$-0.99) and statistically significant ($p < 0.001$) correlation with observed values, thus correctly reflecting the annual course of mean surface temperature in Moldova. However, differences between simulations and observations for individual months and models are in the range from 0.2-0.3^{o}C to more than 7^{o}C, with very subtle annual or seasonal regularities. Proceeding from *ME*, the ECHAM, CGCM and GFDL could be named as the 'best' models, but proceeding from *MAE* as such are the two first and CCSR, and proceeding from *SdE* – the CCSR, CSIRO and ECHAM. Averaging over the ensemble of GCMs – as one way to diminish, at least partially, uncertainties peculiar to the models – gives more reliable estimations of observed regional climate (see the last column).

Comparison of observed (1960-1990) and modeled air temperatures in Moldova

Month	Difference (modeled minus base, ^{o}C)						
	Had	*CGCM*	*CSIRO*	*ECHAM*	*GFDL*	*CCSR*	*Ensemble mean*
January	-2.21	2.40	2.01	1.86	0.58	-3.14	0.25
February	-4.55	1.07	1.72	-0.08	0.5	-2.63	-0.66
March	-3.54	-0.53	3.76	-0.91	-0.79	-1.94	-0.66
April	-3.81	-2.71	3.57	-2.43	-1.72	-3.06	-1.69
May	-3.11	-1.83	3.19	-1.97	-0.67	-2.69	-1.18
June	-1.05	1.08	1.80	-0.30	2.05	-2.69	0.15
July	0.27	3.55	3.99	1.68	6.94	-1.35	2.51
August	-0.16	3.78	4.89	1.82	7.52	-0.91	2.82
September	-2.15	2.36	2.73	1.39	4.47	-0.96	1.30
October	-2.54	1.47	1.09	0.52	1.80	-1.70	0.11
November	-3.86	1.16	0.27	0.45	-0.16	-2.30	-0.74
December	-3.69	2.39	0.92	0.47	-0.95	-4.39	-0.87
Mean error	-2.53	1.18	2.50	0.21	1.63	-2.31	0.11
Mean abs error	2.58	2.03	2.50	1.16	2.35	2.31	1.08
Standard error	1.54	2.00	1.41	1.43	3.10	1.01	1.42
Correlation, r	0.995	0.978	0.993	0.988	0.979	0.996	0.993
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note: 1. The description of GCM can be found in IPCC (2007b); 2. Shadings – models with the best performance.

Source: Corobov and Overcenco, 2007

Let us reproduce some of Pittock's *et al.* (2001) arguments. Sometimes, a risk-management approach does not require to assess the probability of a particular amount of GHG emission or global warming at a concrete future time, but rather to estimate the *likelihood* of exceeding a certain critical impact threshold. This integrates the probabilities from the least climate change up to its critical level, and is much more robust with respect to the underlying assumptions. Without probability estimates, engineers and planners will be left needing to foster resilience and adaptive capacity, hedge their bets, delay their decisions, or else gamble on whether humanity will go down high or low emissions development pathways as they adapt design standards and zoning to climate change. It is far more sensible to establish cumulative probability distributions to allow optimally focused adaptation plans. Impact assessments are also particularly susceptible to ballooning uncertainties because of the limits of prediction.

Thus, probabilistic methods and the use of thresholds are two ways in which these uncertainties are being managed (Carter *et al.*, 2007).

However, the *reliability of knowledge* about uncertain aspects of the world (such as the 'true' value of climate sensitivity) cannot be empirically represented by frequentist probabilities alone. The inherent need for probabilistic analyses in a risk-management framework becomes problematic in situations with a considerable lack of data – another key ingredient for probabilistic assessment. As one method to characterize uncertainties due to a lack of scientific knowledge, the IPCC (Carter *et al.*, 2007; Schneider *et al.*, 2007) propose Bayesian (or subjective) probabilities, which refer to the *degree of belief* or *level of confidence* in a science community that available models or analyses are accurate. Such subjective uncertainties are generally determined by a combination of the amount of evidence or information available and the degree of consensus in the interpretation of that information.

Several other approaches to deal with uncertainty in managing the future climate and assessment of response strategies are discussed in different chapters of IPCC AR4. For example, based on available research, Carter *et al.* (2007) named the participatory approach resulting in learning-by-observation and learning-by-doing, which has a particular strength in vulnerability and adaptation assessment (Box 4.16). Stakeholder participation establishes credibility, and stakeholders are more likely to 'own' the results, increasing the likelihood of successful adaptation.

When making policy choices with uncertainty in areas characterized by disagreement among experts, a *value judgment* will have to be made about what counts as evidence (Froyn, 2005), although physical, chemical, and biological uncertainty makes it difficult to evaluate the *costs and benefits* associated with environmental policy interventions together with the effectiveness of instruments to confront climate change. Value diversity (such as different attitudes towards risk or equity) cannot be meaningfully addressed through an objective probabilistic description and is often assessed through sensitivity analysis or scenario analysis, in which different value systems are explicitly represented and their associated impacts contrasted.

Therefore, along with considering the different aspects of uncertainty, many models have been built for evaluating the *cost of uncertainty*. Castelnuovo *et al.* (2003, p. 291) see a 'common' approach in the attempts to quantify the value of 'early knowledge', or benefits of resolving the uncertainties about climate change sooner rather than later. Another perspective is the possibility to evaluate the outcome of a given action under different future scenarios proposed for a user. A third approach is to describe how an uncertain, but possible, future and irreversible event can influence present decisions. Here, the uncertainty stems from the agents' ignorance of the global temperature level required to trigger a 'catastrophic' event that, once occurred, brings about a dramatic fall in social welfare (utility levels).

Box 4.16 Participatory approaches in dealing with uncertainty in adaptation & vulnerability assessment

Participatory approaches establish a dialogue between stakeholders and experts where the experts can explain the uncertainties and the ways they are likely to be misinterpreted, the stakeholders can explain their decision-making criteria, and the two parties can work together to design a risk-management strategy. Because stakeholders are often the decision-makers themselves, the communication of impact, adaptation, and vulnerability assessment has become more important. Adaptation decisions also depend on changes occurring outside the climate change arena. If the factors that give rise to the uncertainties are described, stakeholders may view that information as more credible because they can make their own judgments about its quality and accuracy. People will remember and use uncertainty assessments when they can mentally link the uncertainty and events in the world with which they are familiar. The assessments of climate change uncertainty are also more memorable, and hence more influential, when they fit into people's pre-existing mental maps of experience of climate variability, or when sufficient detail is provided to help people to form new mental models. This can be aided by the development of visual tools that can communicate impacts, adaptation, and vulnerability to stakeholders, while representing uncertainty in an appropriate manner. For examples, one can name *Flood Ranger* – an educational flood management game (see: *http://www.discoverysoftware.co.uk/FloodRanger.htm*) or *InfoCrop* – a dynamic simulation model for the assessment of some environmental impact on agro-ecosystems, proposed by Aggarwal *et al.* (2006).

Source: Adapted from Carter *et al.* (2007)

Lempert and Schlesinger (2000) argued that no 'optimum' policy is likely to support the consensus needed for political action, and the optimum policy is a poor foundation on which to build a climate change strategy. Any recommenddation of such a policy is vulnerable to attack from others who hold, or choose to hold, alternative expectations of the future. Even if forceful leadership combined with dramatic external events impel acceptance of one climate-change policy, any optimum action could still be inadequate if the unexpected event occurs. The answer they propose is that society should seek strategies that are *robust* against a wide range of plausible climate change futures. Robust strategies also provide a more solid basis for consensus on political action among stakeholders with different views of the future, 'guaranteeing' reasonable outcomes no matter whose view has proved to be correct.

The logic of these authors' is the following.

Any research in the traditional framework for assessing alternative climate-change policies resting on the assumption that one can predict the future begins when a set of alternative actions might be taken. A model, let us assume mathematical, allows describing the consequences of each action; some metric, such as monetary units, allows ranking the relative preferences for various consequences. Analysts use this framework to predict the consequences of each action, and thus recommend the 'optimum' response, i.e. action that is better than all alternatives. Thus, this framework treats uncertainty by estimating the likelihood that different futures will come to pass. Rather than predict a specific outcome of any action, it summarizes all possible consequences of an action with an average (expected) value. The alternative, which on average performs better than all others, becomes the optimum policy.

The prediction-based policy analysis has numerous virtues, but for many problems, such as those posed by climate change, this approach can be misleading because its underlying premise of what is known about the future is not true. Rather than find the optimum strategy based on predictions, researchers can now systematically and analytically evaluate alternative policies against a wide range of plausible scenarios and, thereby, directly address the real task that faces climate-change decision makers, crafting strategies that are robust in the face of an unpredictable future and work reasonably well no matter what the future brings. New computer technology has provided analysts with the means to systematically propose and evaluate such approach to the threat of climate change.

Hallegatte (2009) gives five examples of practical strategies (Table 4.16) that can be proposed within the decision-making frameworks that aim at favoring robustness and including uncertainty information in adaptation strategies, lists several adaptation options in different sectors, and indicates if these options fall into one of the large categories of these strategies. Hallegatte considers these examples as an illustration, but he also aims to indicate which adaptation options are most able to cope with the high level of uncertainty inherit in climate change. Here, *no-regret* strategies yield benefits even in the absence of climate change. The aim of *reversible/flexible* choices over the irreversible ones is to keep the cost of being wrong about future climate change as low as possible. The strategies with *safety margins* reduce vulnerability at null or low costs. Such strategies can be used, for example, in sea level or water resource management. *Soft strategies* option, such as institutional or financial tools, can be efficient practically in each section. Strategies that reduce *decision-making time horizons*, for example, by shortening the lifetime of investments, reduce uncertainty and corresponding costs. Taking into account *conflicts/synergies* between strategies try to diminish the side-effects of adaptation strategies that can be either negative or positive.

Table 4.16 Examples of adaptation options to climate change in various sectors under conditions of uncertainty and their assessment for different strategies

Sector	Example of adaptation option	No regret strategy	Revers-ible/flex-ible	Existence of cheap safety margins	Soft strategy	Reduced decision horizon	Synergies with mitigation	Ranking
Agricultur	Developing crop insurance	+	+		+			1
	Irrigation	+	–	+				2
	Forestry with shorter time of rotation	–	–			+		2
	Development of resistant crops	++						1
Coastal zones	Coastal defences/sea walls	+	–	+				2
	Easy-to-retrofit defenses		+	+				1
	Enhanced drainage systems	+	–	+				2
	Restrictive land-use planning	+	+	+	+			1
	Insurance, warning and evacuation schemes	++	+					1
	Relocation and retreat	–	–		+			3
	Creation of risk analyses institutions and long-term plans	+	+					1
Health & housing	Air conditioning						–	3
	Improved building standards	+		+			+	1
	R&D on vector control	+						1
	Improvements in public health systems	++						1

Table 4.16 (continued)

Sector	Example of adaptation option	No regret strategy	Revers-ible/flex-ible	Existence of cheap safety margins	Soft strategy	Reduced decision horizon	Synergies with mitigation	Ranking
Health & housing	Air conditioning						–	3
	Improved building standards	+		+			+	1
	R&D on vector control	+						1
	Improvements in public health systems	++						1
Water resources	Institutionalization of long-term perspectives	++	+		+			1
	Water loss reduction	++						1
	Demand control and water reuse	++	+		+			1
	Water storage capacity increase	+	–	+				2
	Desalination and water transport	+	–	+			–	3
Human settlements	Climate proofing of new building and infrastructure	+		+			+	1
	Climate proofing of old building and infrastructure	+	–				+	2
	Improvement of urban infra-structures	++	–	+			+	2
	Restrictive land-use planning	++	+	+				1
	Flood barriers, storm/flood proof infrastructure	+	–	+				2
	Development of early warning systems	++	+		+			1

Note: 1. Adaptation option is a *no-regret* strategy in all situations (++), in some situations only (+), or if it would entail significant losses in the current climate (–); 2. For other strategies, '+' or '–' mean acceptability or unacceptability of an option in given strategy. *Source:* Hallegatte, 2009

4.4.6 Communicating uncertainty and risk

Climate change raises many special issues for communicating its essence to the broader community. Attempting to communicate this complex issue (especially to the non-special community) inevitably leads to their simplifications and reduction in detail (Manning, 2003). Such irreducible effectively approximations and assumptions are containing in any science pertaining to real world policy. "If that is true, then there will always be a need to introduce some element of interpretation and judgment in explaining the science and its implications. That is, there will always be some subjective elements in the work" (Risbey 2007, p. 12). Because current understanding of future climate change and the processes that contribute to them are incomplete and fraught with uncertainty, every assessment of climate change issues is also faced with the need to characterize and communicate uncertainties in the state of our understanding, and part of the information needed by decision makers is descriptions of uncertainty.

The analysis of uncertainty in climate research has raised fundamental questions about the most appropriate way to represent or quantify uncertainties in the outcomes and then to communicate quantified uncertainties to decision makers (Webster, 2003).

The sequence of the IPCC reports provides a comprehensive study of the evolution of formal uncertainty communication in the climatological community[27]. As was shown in Chapter 1, in representing uncertainty the IPCC distinguishes between '*likelihood'* and '*level of confidence'*. 'Likelihood' has a frequentist connotation and refers to a probabilistic assessment of some well-defined outcome having occurred or expected to occur in the future; a 'level of confidence' is a subjective expression of uncertainty that was introduced in the IPCC AR4 via scale and is based on the degree of understanding in the expert community using a probabilistic formulation. In traditional use, likelihoods are based on existing data (from observations or models) and can be applied to all cases where the classical definition of probability based on past counts applies. Levels of confidence can be applied when such data is incomplete and subjective judgment is required. However, the combination of these two metrics to assess information, as Risbey and Kandlikar (2007) note, may engender confusion when low confidence levels are matched with very high/low likelihoods that have implicit high confidence. Part of the difficulty is that the degree to which different quantities in the assessments are known varies tremendously. Other concerns appear when attempting to construct probability distributions over socio-economic scenarios that Hall *et al.* (2007) consider as fuzzy linguistic constructs. They try to address these concerns by adopting an imprecise probability approach.

Moss (2007) guesses that uncertainty in policy settings, first of all, requires acknowledgement of the difference between 'discovery-driven basic research' and 'science for decision-making.' While the former is oriented towards hypothesis testing and statistical confidence, the latter seeks to characterize and apply the best information, available to improve specific decision-making in a particular location and point of time. His principal bench-mark (*ibid*, p. 5) is that "decision makers often do not have the luxury of waiting for information to improve but will, if they are creative and capable, design decisions that are robust to the range of uncertainty with which they must contend. They are also well advised to structure decision making processes that enable them to review and adjust their strategies over time, as new and improved information becomes available".

As an example, Moss names the observed asymmetry between the high US public concern of climate change issue and the low public perception of scientific 'certainties' and consensus. The public uncertainty about what the scientific community believes is in a stark contrast to the actual evolution of views within the scientific community about what, and with what level of confidence, is really known. What seemed to receive disproportionate attention in the media is not the vast amount of information that is known with moderate to high confidence, but rather the perception that there is so much uncertainty in the quality of the available information base. This uncritical focus on

---

[27] The history of treating and management of uncertainties by the IPCC is well demonstrated in Ha-Duong *et al*. (2007) and Swart *et al.* (2009).

uncertainty contributes undoubtedly to the public's misperceptions about the degree of consensus in the scientific community or to assessing the quality of climate change information as only fair or poor. There is often public confusion between what is uncertain but knowable, and what may actually be unknowable or unpredictable.

The cited author considers the continuing improvement in the scientific assessment and communication of uncertainty to the public and decision makers as a key component of climate change policy. He is convinced that climate science for managing an uncertain future climate should evolve into important ways enabling to provide information relevant to local/regional adaptation decision-making and to setting mitigation targets and policies. An improved understanding of the decision-making context drives not only the type of information provided, but also the schedule and format of delivery. Close involvement of users is seen as particularly important in establishing the clear understanding of provided information and the trust between users and producers, thus improving the efficacy of decision support efforts.

The author demonstrates graphically (Fig. 4.14) a set of four qualitative uncertainty terms defined by two key characteristics (dimensions): the amount/quality of information and the degree of consensus among knowledgeable experts. A key aspect of this presentation is the inclusion of a 'traceable account' for how judgments and levels of confidence were established for the primary findings: careful descriptions of important lines of evidence used, standards of evidence applied, approaches to combining/reconciling multiple lines of evidence, explicit explanations of methods for aggregation and critical uncertainties.

Two causes of the improper situation in public perception of uncertainty could be named.

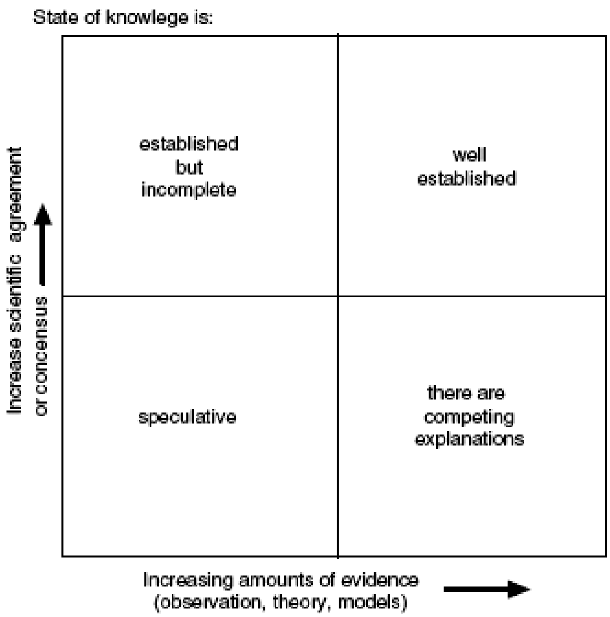


Fig. 4.14 Conceptual framework for qualitative uncertainty terms. *Source:* Moss, 2007

1. The choice of *language* is critical in describing uncertainties in ways that will be properly understood (Manning *et al.*, 2004). For example, the successful communication of climate information (be it a seasonal forecast or the prediction of a long-term warming trend) is complicated by the uncertainties attached to the forecasts (Marx *et al.*, 2007). Lemos *et al.* (2002) believe that climatic forecasts, presented in the language of probabilities, are often not perceived as such. Probabilistic information is difficult to assimilate because people do not think probabilistically nor do they interpret probabilities easily. So, from a purely technical or statistical perspective, an unlikely event, even with a low probability of occurrence, can in fact occur, but decision- or policymakers, using forecasting information as a risk-reducing tool, must have an appropriate understanding of this probabilistic information's meaning.

2. People often rely on intuitive decision-making processes, or heuristics, in solving complicated problems of judgment and decision-making. Generalizing different opinions, the IPCC states that in many cases these heuristics are surprisingly successful in leading to sound decisions under information and time constraints (Carter *et al.*, 2007). However, in other cases they can lead to predictable inconsistencies or errors of judgment. For instance, people consistently overestimate the likelihood of low-probability events resulting in choices that may increase their exposure to harm.

What to do? Marx *et al.* (2007) developed perhaps the most comprehensive proposals on the communication of uncertain climate information that are briefly summarized below as follows.

Communication of climate uncertainty may be improved by better understanding how people learn uncertainty and how climate-related decisions are influenced by uncertainty. Two very different processing systems or two ways in which people process information – experiential versus analytic processing – are a central distinction in understanding this problem. *Experiential processing* relates current situations to memories of one's own or others' experience. *Analytic processing*, by contrast, includes mechanisms that relate the current situation to processed ensembles of past relevant experience and, thus, can easily and naturally express statistical constructs such as probability. Experiential processes are akin to the 'concrete operations' (understanding of cause and effect), while analytic processes are an example of 'formal operations' (abstract thinking, or operations on ensembles of concrete experiences). Usually, as was mentioned already, in practice there is no sharp separation between experiential and analytic processing, and decision making integrates both. Nevertheless, Marx and co-authors think that the role of analytic processes in the understanding of climate uncertainty and in decisions involving such information has often been overestimated, while the role of experiential processes has been ignored. A better appreciation of experiential processing may point towards improved communication strategies.

Based on the observation that experiential and analytic processing systems compete, and that personal experience and vivid descriptions are often favored over statistical information, they suggested (with our minor adaptation) the following research and policy implications:

1. Communications, designed to create, recall and highlight relevant personal experience, and to elicit affective responses, can lead to more public attention to, processing of, and engagement with forecasts of climate variability and climate change. Vicarious experiential information in the form of scenarios, narratives, and analogies can help the public and policy makers imagine the potential consequences of climate variability/change, amplify or attenuate risk perceptions, and influence both individual behavioral intentions and public policy preferences.

2. Ideally, communication of climate forecasts uncertainty should encourage the interactive engagement of both analytic and experiential processing systems in the course of making concrete decisions about climate, ranging from individual choices about, e.g., what crops to plant in a given season to broad social choices about how to adapt to global warning on the whole.

3. A second way is a group and participatory decision making. The group processes allow individuals with a range of knowledge, skills and personal experience to share diverse information and perspectives and work together on a problem. Therefore, groups should include at least one member trained to understand statistical forecast information to ensure that all sources of information—both experiential and analytic—are considered as part of the decision-making process.

4. Because risk and uncertainty are inherent dimensions of all climate change projections and related decisions, the analytic products like trend analysis, probabilities, and ranges of uncertainty ought to be valuable contributions to stakeholder decision-making. Decision makers must listen to personal and collective experience, and both analytic and experiential systems should be considered in risk communications. Otherwise, many analytic products will fail to influence on decision making, and the latter will continue to rely heavily on personal experience in planning the uncertain future. The challenge is to find innovative and creative ways to engage both systems in the process of individual and group decision-making.

5. There are limitations of heuristics of the experiential system. While ways of presenting information about climate risks that engage the experiential processing system have clear benefits, they also have their downsides that argue for careful usage. If people have ‘a limited budget to spend on worry’, with an increased concern about one type of risk, their worry about other risks frequently decreases. In other words, raising concern about some aspect of a situation comes at the cost of potentially reducing concern about another. The costs of worry appear to be cumulative, and the pool of worry appears to take time to regenerate.

The last conclusion is well supported by the experience of transition countries where current general political and economic uncertainties, and risks often prevail over climatic risks and worries. Really, *“those who stated greater worry about political risk worried less about climate risk”*, – Marx *et al.* (2007*,* p. 55) argue.

Wilbanks (2003, S. 149), integrating climate change and sustainable development, also guesses that though “avoiding the more alarming kinds of climate-related futures is a central part of the challenge to institutional and technological dimensions of sustainable development, but whether or not these futures actually lie ahead is still uncertain. Impacts are certain, but their magnitude, pace and distribution are uncertain”. It is difficult to accept a high level of uncertainty if possible impacts, both negative and positive, must be examined in a multi-stress context, under conditions where financial and policy resources are limited at all scales. Wilbanks sees a possible answer in using the current concerns about climate change to stimulate more work on the larger envelope of challenges to sustainable development. Another approach is to focus examinations of ways to increase long-term resiliency to climate change impacts on current stresses at a relatively localized scale, with full awareness of how historical experience with climate variability has interacted with such stresses. This opens up opportunities for seeking policies that offer clear co-benefits for other aspects of the sustainable development process.

Thus, future climate is uncertain whether because our scientific understanding of the climate system functioning remains incomplete or because the evolution of future climate is dependent upon human actions. The uncertainty about the behavior of future climate on all scales and uncertainty about societies’ response to the change in climate presents new challenges for the way individuals, organizations and societies make decisions, creating the difficulties to design effective, equitable and efficient policies which will achieve the goals of the UN FCCC (Dessai *et al.*, 2007).

4.5 Evaluation of policy instrument and policy programs

4.5.1 Evaluation in a policy cycle

Usually, the goals of evaluations are to learn from experience, to provide an objective basis for assessing the results of the work, and to provide accountability in the achievement of its objectives (IEG, 2009). Results of monitoring and evaluation might lead to a reformulation or even an abolishment of policies. Evaluations are important not only for verification of the results but also for an enhanced understanding of ongoing policy processes and technical change (Harmelink *et al.*, 2005; Megdal *et al.*, 2005; Neij *et al.*, 2005).

From the World Bank's position (IEG, 2009), with the growing emphasis on the assessment of effectiveness of financial aid and the need to measure the results of development interventions, it is no longer acceptable for governments and official development agencies to simply report how much money has been invested or what outputs have been produced. Parliaments, finance ministries, funding agencies, and the general public are demanding to know how well development interventions achieved their intended objectives, how results compared with alternative uses of these scarce resources, and how effectively they contributed to broad development objectives. These demands have led to an increase in the number and sophistication of impact evaluations. In the most favorable cases, the evaluations improve the efficiency and effectiveness of ongoing programs, help formulate future policies, strengthen budget planning and financial management, and provide a rigorous and transparent rationale for the continuation or termination of particular programs. However, many evaluations, depending on the availability of funds, the interest of donors or the approaches and methods used, often do not fully provide their potential contribution to the program or policy being evaluated.

Policy evaluation is an essential element in any policy cycle. In a perfect cycle, at first, policies are formulated, at the next step they are implemented, and after implementation they should be ultimately monitored and evaluated to show their effects (Fig. 4.15). Evaluation of *policy instruments* and *policy programs*[28], along with their design and implementation, is a core issue for climate policy. An interest in processes and methods used for evaluation has been enhanced by the national commitments to the Kyoto Protocol. In particular, the procedure of evaluation is essential for the comprehensive identification of advantages and disadvantages in the design of different policy instruments in a real world where to confront climate change "no genuine global policy instruments are implemented" (Johansson, 2005). As an example we can look at the principal dichotomy of climate policy – adaptation vs. mitigation – that creates certain

[28] If to follow Neij *et al.* (2005), in the discourse below a '*policy instrument*' means a technique for governance; and a *'policy program'* can include one or combinations of several instruments

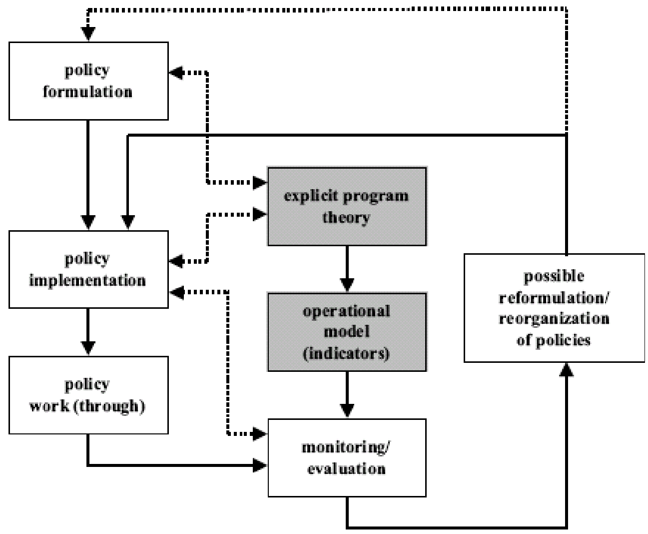


Fig. 4.15 Outline of a policy cycle and the role of program theory in policy cycle and evaluation. *Source:* Harmelink *et al.*, 2005

conflicts between efficient pollution reduction and industrial development. This in turn leads to the development of policy instruments, which are often compromises between two differing directions in fighting climate change. Undoubtedly, in some cases, without appropriate evaluations of this kind of situation the result could be ineffectual political programs.

Criteria such as political feasibility and legitimacy, environmental and cost effectiveness are certainly key issues for successful policy implementation. So, a cost equalization would direct abatement measures to areas where they are least costly. The potential for different instruments to provide such cost equalization is therefore the important evaluation criterion. Furthermore, an efficient policy instrument should have low administrative costs. Many policy instruments also require costly monitoring systems. Johansson (2005) sees one main reason for why so many policy instruments, designed to combat climate change, are ineffective in the difficulty to implement unified climate policies. Although general economic instruments can have major advantages on a global scale, they risk failing when implemented at regional or country levels. *"Compromises between theoretical efficiency and practical feasibility therefore seem to be necessary"*, – concluded Johansson (*ibid*, p. 1461).

Harmelink *et al.* (2005) guess that evaluating the key factors behind the 'success and failure' of climate policies or individual policy instruments *(ex-post policy evaluation)*, for example, in energy efficiency boils down, in principle, to answering the following two questions:

- ? What was the contribution of policy instruments in reaching policy targets, or *effectiveness of policy instruments?*
- ? What was the cost effectiveness of policy instruments, and could targets have been reached with lower costs, or *efficiency of policy instruments?*

These questions can be answered at two levels: (i) *the programme level* – in the case of the evaluation of the effect and effectiveness of a policy instruments package aimed at reaching a specific target; and (ii) *the instrument level* – in the case of the evaluation of the effect and effectiveness of one specific policy instrument.

However, Tol and Yohe (2007a, p. 430) are of the opinion that "the determination of appropriate climate policy is controversial because it is driven, at least in part, by the choice of a decision-making framework. This choice, in turn, depends on alternative views of not only how the world should work, but also how it actually *does* work". Their concerns are supported by the results of the Netherlands assessment (de Bruin *et al.*, 2009; Fussel, 2009). This expert assessment aimed at conducting an inventory and prioritization of 96 adaptation options in 7 climate-sensitive sectors of the Netherlands. The inventory showed that even in a country with high economic, institutional and technical capacity it is not currently feasible to prioritize national-level adaptation options based on a social cost-benefit analysis because of methodological difficulties and insufficient quantitative data. The costs and benefits of the adaptation policies can be estimated with reasonable accuracy for only a limited number of options because for the majority of them knowledge gaps exist, data are missing or their reliability is insufficient. The evaluation also requires an analysis of the administrative and policy context at the level appropriate for specific adaptation options (a local, regional, national and international level, or the level of ecosystems under study). De Bruin *et al.* (2009) suppose that multi-criteria analysis based on expert judgment and qualitative indicators can help prioritizing the national-level adaptation options, but this analysis also detected strong conflicts between priority and feasibility criteria.

There are numerous possible responses to climate policy instruments, but the number of executed studies is still limited. Although the ex-post evaluation of climate change and energy policies has much in common, most researchers focused on 'final effects' by way of energy savings and CO_2 reductions (see, e.g., Attali & Tillerson, 2005). Substantially less research is aimed at systematic evaluation of other aspects of climate change policies. The several methods presented below are a short illustration of the current vision to address this problem.

4.5.2 Some methods of policy analysis

4.5.2.1 Program theory and logic model analysis

The use of *program theories* and *logic models (PT/LM)* for evaluation, monitoring, and program refinement has a rich history in a variety of fields. Application of these tools to evaluate and improve energy efficiency programs has been growing over the last decade. A short overview of the state-of-the-art methods of logic model development is provided by Megdal *et al.* (2005). Some of their findings relate to the theme presently under discussion.

Program theory is a theory or model that describes the underlying assumptions about how a program is expected to work and how it causes intended or observed outcomes. ***Logic model*** is a diagram that describes the key logical (causal) relationships among the program's elements and problem solutions, thus defining the measurement of success and helping to portray the program theory. The logic model can also be used to help tell 'the story' behind how the program expects to be able to meets its ultimate goals, including *who*, *how* and through *what* mechanism. In doing so, the gaps and questions that still need to be addressed can be identified. The elements of a logic model describe and place the causal sequence of program activities, outputs, immediate and longer-term outcomes. Indicators derived to measure each of these elements and their tracking can be used to assess program success.

An evaluation design and program theory can work hand-in-hand to be able to evaluate the difference between *theory failure* (incomplete or inaccurate theory) and *program failure* (poorly designed or implemented operational procedures)[29]. Schematically, the differences between the two failures are shown in Fig. 4.16. In the first case, the assumptions that the causal mechanisms that create attitudes or behaviors are not valid are only partially correct, or key theoretical components are missing. The program is implemented as planned, but the causal link to final outcome does not occur. The program theory needs to be changed and the program needs, accordingly, to be refined. In the second case, if the evaluation identifies program failure, the theory appears to be correct; however, the program implementation had problems that did not allow having the anticipated outputs and initial subsequent outcomes.

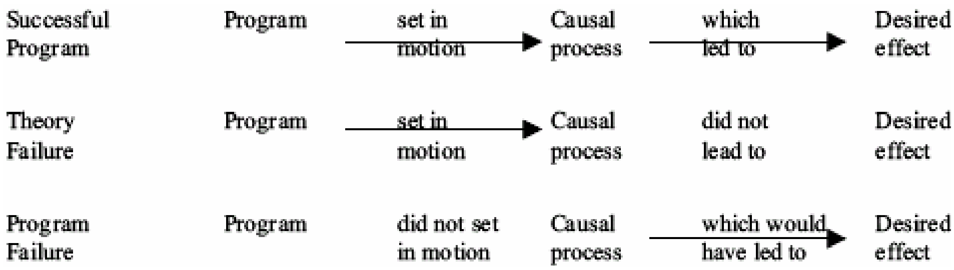


Fig. 4.16 Theory failure and program implementation failure. *Source:* Megdal *et al.*, 2005

In other words, if the causal process had occurred, the outcome might have occurred but program implementation problems did not create this process. Making a program's theory and logic explicit is important for effective program implementation and evaluation, especially when it includes or is dominated by market transformation goals and objectives. Being important for all types of program evaluations, it is especially important for complex programs and those with long-term market change goals.

The principal logic model format is shown in Fig. 4.17. Based on best practices, Megdal *et al.* (2005) include the following elements in program logics:

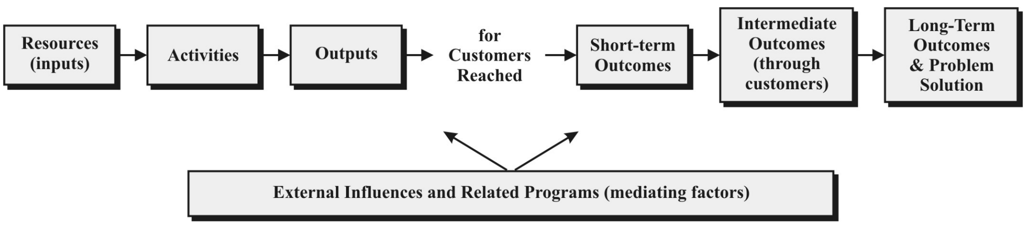


Fig. 4.17 Basic Logic Model format. *Source:* Megdal *et al.,* 2005

[29] Megdal *et al.* (2005) based on: Weiss, C.H. 1998: *Evaluation: Methods for Studying Programs and Policies*. Prentice Hall: Upper Saddle River, NJ

- *Key program resources/inputs* – program funding, internal and contractor staffing, sources and magnitudes of leveraged funding/partnerships, etc.;
- *Activities* – internal and contractor program implementation tasks, outreach/marketing and delivery mechanisms, etc.;
- *Customers and partners* – who the program works for and with: customers receive products and services directly from the program and its partners and change behavior or take action that translates into program outcomes;
- *Outputs* – internal and implementation contractor services, products, training/support being provided to target customers or market actors, etc.;
- *Outcomes* – short, intermediate, and longer-term anticipated results/benefits/market changes from program activities, many of which come directly from the program's stated measurement indicators and appropriate/targeted portfolio-level goals and objectives, including how these contribute to overarching policy goals;
- *Perceived external influences* – recognizing the influence that market actors, barriers, other programs, state, regional and national activities or circumstances may have on a program's logic, and
- *Measurable indicators and explicit, researchable issue,* drawn from the logics.

The cited authors see the following steps in the development of the logic model:

- To collect information through documents and, perhaps, establish a stakeholder workgroup;
- To define the problem and context for the program;
- To define elements of the logic in a table;
- To develop a diagram of logical relationships;
- To verify the program theory/logic with stakeholders; comparisons with implementation results;
- To use the logic model to develop or confirm performance measures for program planning, monitoring and evaluation.

Once a program has been systematically described in terms of resources, outputs, outcomes, and long-term impacts, the procedure for developing a program theory is a systematic one. Many PT/LM leaders and teachers have found that one of the best ways to develop a program theory is to start with the long-term outcomes and work backwards to resources. Several things are likely to happen as this is being worked upon, and it is likely that gaps in the causal relationships between actions and expected effects will be found as well as places where the program theory and the program design may need improvement.

4.5.2.2 The theory-based policy evaluation method

The theory-based approach is not new and has been used numerous times to evaluate policies. One of the descriptions of the *theory-based policy evaluation* is provided by Harmelink *et al.* (2005). Their vision of this method placement in a policy cycle was shown in Fig. 4.15: *application of the theory-based approach in ex-post policy evaluation means that the whole policy process is unraveled to evaluate the effectiveness and efficiency of its different steps*. Through this unraveling, insight is gained on "where something went wrong in the process of policy design and implementation" and "where the keys are for improving the effectiveness and efficiency". Policy makers should formulate an explicit program theory on how the newly introduced policy instrument will show its effects both in the steps of policy formulation and policy implementation. Afterwards, the policy should be monitored and evaluated to check if the applied theory was correct or needs to be adapted and, if necessary, be followed by the reorganization or restructuring of the policy itself.

In practice, theory-based policy evaluation boils down to establishing a plausible theory on how a policy instrument (or a package of instruments) is expected to lead to improvements of planned activities. The practical framework of such an evaluation includes several successive steps (Harmelink *et al.*, 2005):

1. Characterization, or description of the policy instrument, including its targets and the period of activity, target groups and policy implementing agents, available budget and information on initial expected effectiveness, and so on;

2. Drawing up a policy or program theory that includes all assumptions on the way policy instruments should reach their targeted effect. Sometimes the policy theory is clearly described in official documents and is well known to the policy makers. In these cases one can speak about an 'explicit policy or program theory'. However, in most cases the theory for a specific policy instrument is not clearly described and is drawn up based on experiences with similar instruments, and we should speak about an 'implicit policy or program theory'. Drawing up a policy theory includes documenting all implicit and explicit assumptions in the policy implementation process, and mapping the cause-impact relationship, including the relationship with other policy instruments.

3. At the next step, the program theory is translated to concrete (quantifiable) indicators. Indicators are drawn up for each assumed cause-impact relationship to 'measure' if this relationship actually took place and if the change that took place is due to the policy instrument implementation (i.e. the policy instrument was the causal force). This step also includes the development of necessary 'instruments' to evaluate effectiveness and efficiency. The cause-impact relationships and the indicators are visually reflected in a flowchart.

4. Further, the policy theory is verified and, if necessary, adjusted through interviews with policy makers, implementing agents and other actors involved in the implementation and monitoring of policy instruments.

5. Finally, conclusions are drawn regarding the effectiveness and efficiency of using policy instrument and indicators, the analyses are made on the success and failure factors attributed to the analyzed instruments, and recommendations are formulated to improve its effectiveness and efficiency.

In the opinion of the quoted authors, the theory-based policy evaluation has several *benefits* in comparison with other ex-post evaluation methods because:

- ✓ The whole policy implementation process is evaluated, and the focus is not just on the final results;
- ✓ Through the development of indicators for each step in the implementation process the 'successes and failures' can be quantified to the greatest extent possible;
- ✓ By applying this approach we not only learn whether policies are successful or not, but also why they succeeded or failed and how they can be improved.

However, the method also has some *disadvantages*:

- It requires much monitoring data in order to establish the indicator for each step in the implementation process. As the method is mostly afterwards applied to the available data, often the correct data are not present because, for example, surveys did not ask the right questions;
- It is often difficult to account for interactions between instruments.

As one such example, Harmelink and co-workers (2005) proposed the policy theory on the Energy Premium Regulation (EPR) that was introduced in the Netherlands with the aim of motivating households to invest in energy efficiency measures (Fig. 4.18).

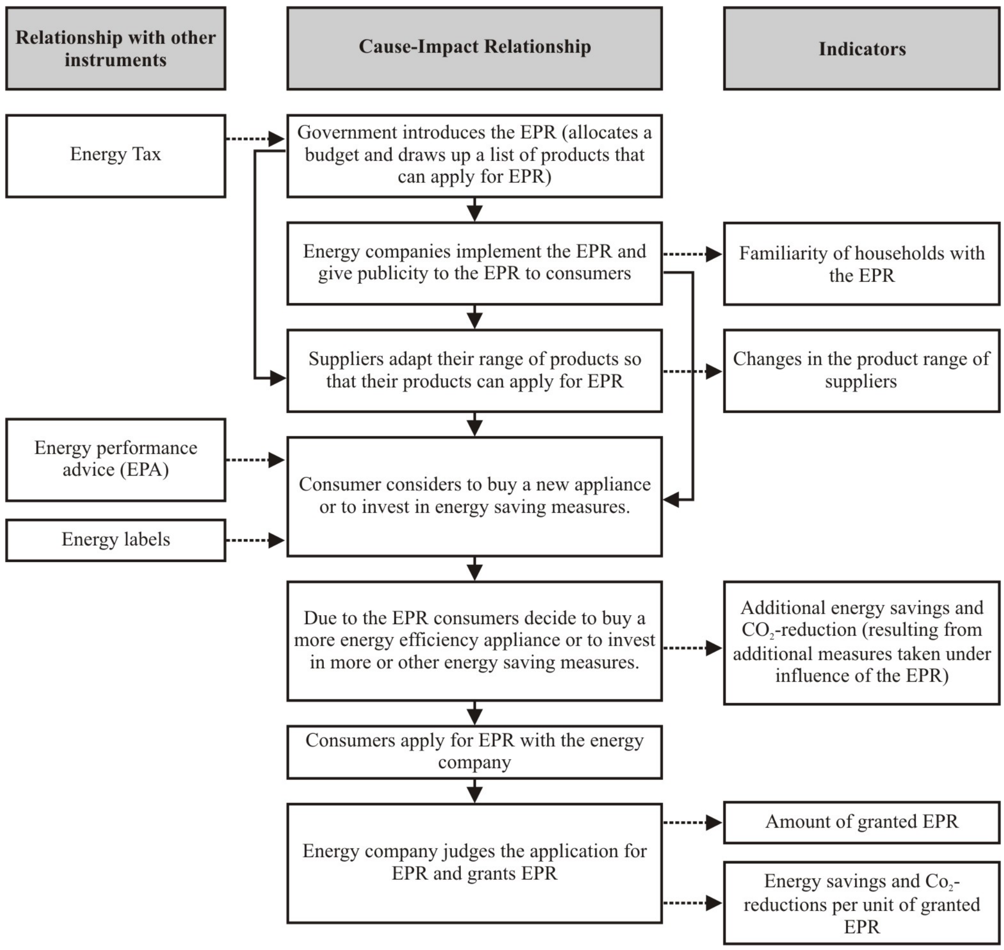


Fig. 4.18 The example of a policy theory on the Energy Premium Regulation (EPR) that should lead to energy savings and CO_2 reduction. EPR includes links with other policy instruments and indicators to 'measure' if assumed cause-impact relations actually occurred. *Source:* Harmelink *et al.*, 2005

4.5.2.3 Outcome evaluation based on socio-technical systems approach

Evaluations for verification of the results of policy instruments are often focused on *effectiveness*, which conventionally have been measured in terms of impacts, e.g., reduced emissions. Nonetheless, the conventional evaluation of analyzing impacts does not provide any information on *how* the policy instruments affect (or lack thereof) an ongoing policy process and the process of technical change. In particular, to capture the technical change, traditional evaluation approaches need to be further developed. Moreover, it is argued (Neij *et al.*, 2005; Shipworth, 2005) that in system analysis any technology cannot be separated from its social context. A technological change involves changes in the entire socio-technical system, i.e. in the technology itself, actors (organizations and individuals), institutions and the system's economic and political framework. In other words, "…evaluations of policy programmes, implemented for stimulation of technical change, need to address changes, i.e. outcome, in the entire socio-technical system" (Neij *et al.*, 2005, p. 1152). This socio-technical system's perspectives and ideas provide a broad theoretical framework for understanding how technology is produced, diffused and ultimately changes society as well as informs the application of specific research methods. As a theoretical framework, the socio-technical systems approach is well suited to the analysis of complex social, economic and technical changes, markedly differing from past models. It is a far more socially demanding process of engagement with end-users as co-designers in the development of a solution that greatly enhances its acceptance and diffusion within socio-technical systems in parallel with recent approaches to the study of policy formulation (Shipworth, 2005).

Neij *et al.* (2005) present an alternative framework for the evaluation of energy policy instruments and technical change that focuses on the outcome of policy instruments, i.e. changes in the system caused by the policy instruments, rather than the final impact achieved in terms of, e.g., emission reductions. To analyze these changes, they propose to apply *outcome indicators* and *outcome scope*. The model (Fig. 4.19) shows the important role of feedback between public policy program and society (unbroken line) and demonstrates how problems, needs, and issues, defined by the society, are the base for the outline of public policy program. At the program level political decision-makers set up *goals* for the program, its *objectives* and decide on *input*, e.g., resources (financial, human, time), and guidelines shaping the policy instruments. The *output* refers to what comes out of the governmental administration, such as subsidies, audits or trained personal. *Outcome* describes the response to policy interventions by actors and organizations and changes in the socio-technical system that may, in turn, have an *impact* on the society and environment, such as saved energy or reduced emissions.

*Evaluation*s (broken lines) can result in knowledge that redefines problems and needs, which in turn may lead to modified policy decisions and improved policy instruments. The evaluation of effectiveness, as well as the understanding of policy intervention, will improve if the evaluation also takes into account the outcome and the changes in the socio-technical system affected by the policy program.

To capture the changes in outcome, the use of '*outcome indicators'* is suggested, which relates to evaluation parameters that describe changes of core issues in a socio-technical system, i.e. in central aspects of the system that are vital for a technical change

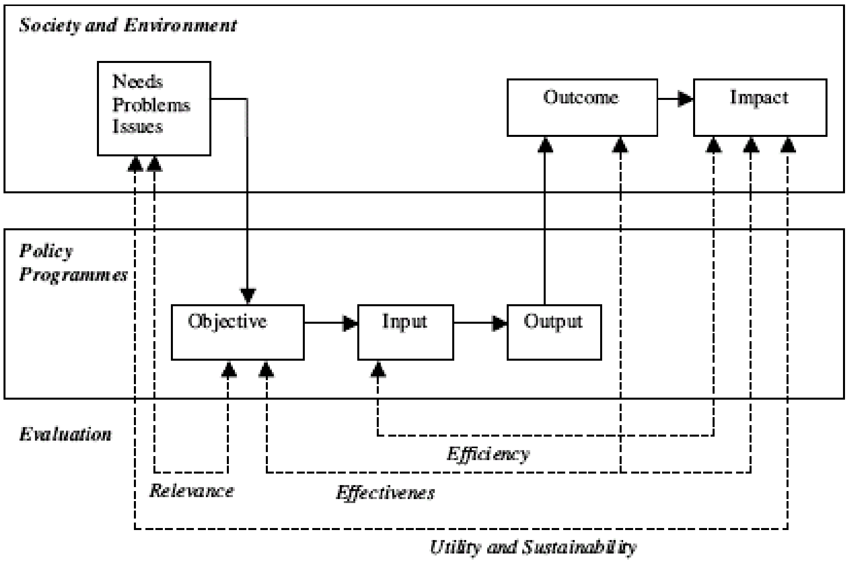


Fig. 4.19 Schematic model of a public policy process and evaluation. *Source:* Neij *et al.*, 2005

process. Based on the understanding of a socio-technical system given above, such vital issues should at least address changes in the technology, actors, institutions and the economic and political framework of the system (Neij *et al.,* 2005). Outcome indicators used for the analysis of actors and institutions describe, for example, public participation and changes in knowledge, behavior and awareness; outcome indicators of technology show changes in system's performance, cost, etc. The outcome indicators tell us where changes have been observed, what type of changes has occurred and about no changes in the socio-technical system.

However, the indicators should not only provide information about changes of isolated effects but also about the *outcome scope,* i.e. changes in the entire socio-technical system. The evaluations of isolated effects are not sufficient if the width of policy interventions is to be understood. An evaluation considering outcome scope may reveal that, e.g., the design of the policy instruments is too limited and does not cover essential parts of the socio-technical system – essential technology concepts, infrastructure, actors or organizations. It is also possible that the policy instruments address the relevant parts of the socio-technical system but still do not result in the intended effects.

Another important aspect of the outcome evaluation approach is that it allows taking into account *institutional changes*, i.e. established practice, rules, laws and regulations as well as common habits and routines.

Which outcome indicators to select for the evolution of policy program outcome depends on the kind of technology the policy programs focus on. Each technology relates to a specific socio-technical system with its own characteristics. Since socio-technical systems are dynamic and may change in a direction that was not foreseen, the actual outcome indicators selected for an evaluation may have to be changed over time. If they do not address relevant issues, there is a risk that the success or failure of a policy instrument cannot be fully understood.

The process of outcome evaluation. When applying a focus on the outcome of policy instruments and programs, outcome indicators need to be considered in each of the phases of the systematic evaluation approach that is usually divided into the processes of *planning*, *monitoring* and *assessment,* illustrated by Neij *et al.* (2005) in Fig. 4.20.

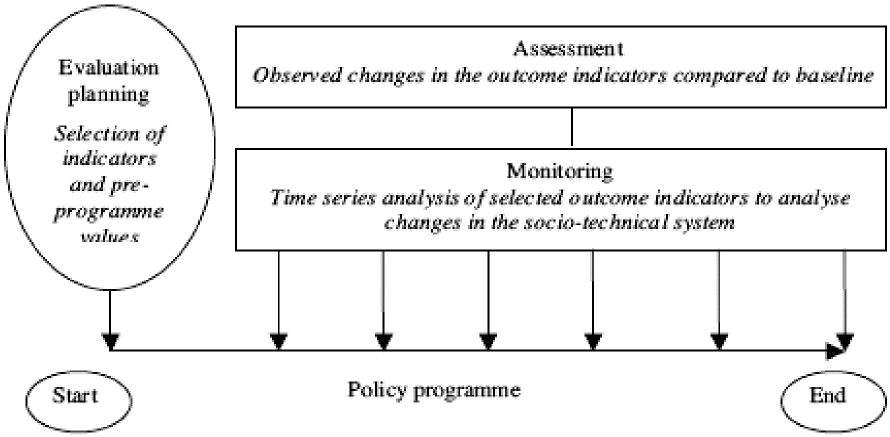


Fig. 4.20 Schematic structure of an evaluation based on outcome indicators. *Source:* Neij *et al.,* 2005

With the use of outcome indicators, the ***planning*** process of evaluation involves such issues as system characterization, the identification of relevant outcome indicators and the estimation of their pre-program values. The characterization of the socio-technical system is important since the process of technical change may be different for different types of technologies. During the planning process each socio-technical system must be seen as unique. Moreover, the selection of outcome indicators should reflect the individual characteristics of each subsystem, consider the possible dynamics of technology development and possible clusters of technologies, their compatibility, risks associated with technical change, critical development of actors, etc. The selection of the outcome indicators should also take into account the availability and quality of data and relevant methods of their collection.

The planning process also concerns trend analysis of the selected outcome indicators, the development of a *baseline estimation* of the potential outcome of the program and definition of the goal of the project. The development of the initial baseline, based on the selected outcome indicators, is of major importance and must to be central in the evaluation process because the baseline, which shows the autonomous change in the outcome indicators of the socio-technical system, will make it possible to analyze the actual effect of the policy instruments. The baseline may also be corrected over time due to changes in initial assumptions in any important underlying parameter (e.g., economic growth and effects due to other measures).

In the ***monitoring*** process Neij and co-authors include the systematic analysis of changes in the chosen outcome indicators describing changes in technology, actors and institutions over time. The scope and frequency of the monitoring process will have a cost. Moreover, the monitoring process also has a time aspect that will be different for different technology systems; the longer turnover effects may result in a slower process of technical change. A specific monitoring method will be required for each outcome indicator. Methods for the analysis of changes in actors' behavior may include interviews, consumers billing records, consumer surveys, end-use metering, short-term monitoring, etc. Methods for the analysis of technology and market development may also include interviews as well as market surveys, site visits, manufacturers' sales reports, product catalogues, price lists, product reports, etc. The methods used will depend on the socio-technical system and the selected outcome indicators.

The ***assessment*** phase, which is built on the results of the monitoring phase, includes evaluation of observed changes in the selected outcome indicators in relation to the baseline. The changes in the outcome indicators describe the important changes in outcome scope. These results can then be used to improve our understanding of success and failure regarding the impact of the program.

The proposed evaluation framework provides information about the continuous performance of policy programs and their combined effects on the introduction and dissemination of new technologies. This information is essential for an improved adaptation and implementation of any climate policy.

4.5.2.4 Assessing integrated mitigation-adaptation strategies

Settle *et al.* (2007) developed an integrated model to evaluate the mix of mitigation-adaptation strategies to reduce, cost-effectively, the risk of catastrophic climate change. The focus on catastrophic risk is a good example because its management presupposes both adaptation and mitigation. The authors simulated the dynamic model of global warming under different scenarios – business-as-usual (BAU), full mitigation world, and mitigation & adaptation world. They also allowed for non-cooperative, partial cooperative and cooperative solutions and focused on two sets of results that described: 1) the probability of having a catastrophe occurrence by the year 2100 across each of the scenarios, and the catastrophe damage avoided by adaptation; 2) the optimal mix spent on adaptation and mitigation for each country, and how this mix is changing over time.

The first result is shown in Table 4.17. As was expected, the greatest probability of catastrophe – 4.35% by 2001 – emerged from the BAU and adaptation-only scenarios. But while the odds are the same, the avoided catastrophic damages are not: the BAU avoided zero damages, whereas the adaptation avoided 50 and 23% for developed and developing nations respectively. The lowest odds of catastrophe (3.62%) emerged in the mitigation-only and continuous damage/full cooperation scenarios.

Table 4.17 Probability *(P)* of a catastrophe occurrence by 2010 and potential damage of a catastrophe avoided across scenarios

Simulation run	*P*, %	Avoided damage, %	
		Developed countries	*Developing countries*
Business as usual	4.35	0	0
Full mitigation	3.62	0	0
Full adaptation	4.35	50	23
Non-cooperative	3.64	18	8
Developed lead	3.64	16	8
Cooperative	3.63	15	2
Continuous damages, full cooperative	3.62	13	1

Source: Adapted from Settle *et al.* (2007)

Table 4.18 illustrates the second result – the optimal mix of adaptation and mitigation, how the

Table 4.18 Percentage of total budget allocated to adaptation across country types, scenarios, and time

Scenario	Time					
	2000	*2020*	*2040*	*2060*	*2080*	*2100*
	% of budget: developed countries/developing countries					
Non-cooperative	0.05/0.07	0.27/0.27	4.34/4.27	19.81/19.00	45.87/42.83	69.88/64.83
Developed lead	0.04/0.07	0.19/0.27	3.03/4.27	14.34/18.90	35.82/42.70	59.55/64.67
Cooperative	0.04/0.01	0.19/0.01	3.03/0.13.	14.23/0.67	35.47/2.13	58.68/5.36
Cooperative (continuous damages)	0.03/0.01	0.13/0.01	2.10/0.10	10.13/0.43	26.53/1.43	47.42/3.47

Source: Adapted from Settle *et al.* (2007)

mix changes over time as well as the difference between adaptation expenditures for developed countries under the non-cooperative, partial cooperative (developed countries leading), and the cooperative solutions both with and without continuous damages. The levels of adaptation cost fall when developed countries add the public good benefits to the developing countries into their objective function (developed lead). And even if the developing countries join the treaties (cooperative), there is a minimal impact on the developed country's level of adaptation. The results also showed the optimal adaptation budget for developing countries across cooperation levels. When developing countries act non-cooperatively, the developed nation's optimal adaptation expenditures remain almost constant. The behavior of developed countries does not drastically alter what is optimal from the developing countries perspective. Once developing countries cooperate with the developed world their optimal adaptation expenditures decrease.

Overall, the results suggest that adaptation to catastrophes is only a small fraction of the national climate protection budget when nations cooperate fully, when damages are both continuous and catastrophic, and when nations have a short planning horizon. Adaptation becomes more important relative to mitigation when nations are less likely to cooperate, when damages are mainly catastrophic (this implies the individual members of the nation adapt to continuous damages regardless of collective actions), or when the nation's planning horizon increases. Any condition increases the importance of adaptation as a policy option.

Chapter 5
Climate Change, Sustainable Development and Transition

5.1 Sustainable development as a problem

The concept of sustainable development takes on special importance. Bo Kjellén (2004) sees the main reason for this in the obvious fact that we are the first generation who can fundamentally influence the entire global system. These processes are accompanied by elements of uncertainty engendered by rapid changes that we cannot control, causing a feeling of world vulnerability and fragility. Although reinterpreted over time, economic development and the environment remain among the humanity's key concerns and aspirations. The nature of relationships between these prominent issues continues to generate debate. There is a wide consensus in both the science and policy spheres that world development is moving in an unsustainable direction. Social and environmental conditions have deteriorated in many places, and the integrity of life support systems have come under increased threat (Swart *et al.*, 2004). Many environmentalists claim that industrial expansion is the root cause of environmental degradation and should therefore be restrained. Moreover, Sen (2007) characterizes the consideration of the demands of development and the preservation of the environment in rather antagonistic terms as well established traditions in policy discussions. Attention is often concentrated on the fact that many of the deteriorating environmental trends in the world, including global warming and other disturbing evidence of climate change, are linked with heightened economic activities and tend to correlate with economic expansion. *"At a superficial level, it may well appear that the process of development is responsible for environmental damage"*, – concluded Sen (p. 28).

On the other side, environmental protagonists are frequently accused by development enthusiasts of being 'anti-development' since their activity, due to its allegedly unfavorable environmental impact, often takes the unwelcome form to processes that can raise incomes or reduce poverty (*ibid*). Many global institutions and national governments argue typically that only economic growth can provide the resources with which to tackle environmental problems. Moreover, many developing countries claim their right for development, using this right to justify the continued use of polluting industries and productions. Being poorer, they have no choice but to use out-of-date equipment and locally available resources. Taking loans in the international market to finance modern technologies may only exacerbate the problem of international debt and strengthen poverty and inequity. For these countries, the lack of creative thinking about development without pollution is a second problem (Gupta and Tol, 2003). Many also believe that there is an inverted-U shaped relationship (known often as an environmental Kuznets curve – *EKC*) between pollution and production, using this hypothesis as evidence of the ability of societies to decouple pollution from production. Arguments for such viewpoint are that a positive relationship between economic growth and pollution is seen only at the early stages of economic development, and as a country develops and the more basic needs of the population are met, individuals begin to demand the cleaner environment. Furthermore, since economic development provides increasing resources, with which to tackle environmental problems, the result is often the strengthening of environmental regulations.

However, whilst economic growth may facilitate some environmental improvements, this is not an automatic process and will result only from investment and policy initiatives (Cole, 1999). The 'battle lines' may or may not be very sharply drawn, but create the sense of tension that exists, in varying degrees, between the champions of development, on one side, and the advocates of ecology and environmental preservation, on the other (Sen, 2007).

A progress in meeting existing world development challenges and tackling the newer, like climate change and globalization, calls for a fundamental re-examination of the meaning of development. Accelerated social and cultural changes have turned upside down the former assumptions underpinning the social order and have configured a completely new situation in many parts of the world, particularly in developing and former socialist countries. In this context, rethinking the concepts of development and the very language of development has become an urgent task.

The present concept of sustainability is a response to evidence that current conditions and trends are not viable in the long run, and that the reasons for this are as much social and economic as they are biophysical or ecological (Gibson, 2006). However, there is no single relationship between economic development and the environment; the impact of economic development on the environment is clearly complex in nature, and this cross-cutting issue necessitates a high degree of policy coordination. Numerous concerns have centered on the common and some-times catastrophic failures of decision-making efforts, which failed to take into account key linked factors (Gibson, 2006). To leave a habitable planet for future generations requires the development of a widely shared paradigm that should be ecological from a scientific point of view. Already in the 1970s, the so-called Club of Rome[1] attempted to examine the limits to growth in a world with finite resources. In the 1990s, Cairns (1997) named two ways to respond to the possible biophysical limits of human society growth: the first – to deal with the unpleasant consequences of exceeding limits as they are encountered; the other – to adjust behavior now to pre-empt these consequences. The types of adjustments that may be necessary are the focus of the concept of sustainability.

5.1.1 A short excursus in the history of the concept of sustainability

Global policies in the environment and development are influenced by numerous factors. In an attempt to identify the most important sets of determinants, Selin and Linnér (2005) examined successive efforts on linking environment and development as well as the

[1] See materials available on the Club of Rome website: *http://www.clubofrome.org*

political and institutional background of the concept of sustainable development with respect to four sets of analytical perspectives, or analytical lenses. The emergence and influence of an international environment and development discourse they discussed concurrently with the three other: growing multilateralism and the building of new multilateral institutions; power politics including the influence of Cold War relations; and North-South politics and conflicts. In the 1980s many of the substantial environment and development related issues, discussed in the 1960s-1970s, fed into a sustainable development discourse, which was clearly linked to earlier debates and actions, and remains the dominate concept in environmental and development issues today. In many ways, the concept of sustainable development was in fact a direct response to the lessons drawn from failed past policy and implementation efforts. In particular, the diverse discourse of the 1960s-1970s was not structured around any single rallying concept that weakened its ability to focus debates and cooperation toward a common end goal.

The concept of sustainable development, which has come out of a number of preceding ecological events, in 1983 was picked up and popularized by the Brundtland Commission and formed the main issue of its 1987 report *Our Common Future* (UN, 1987). The report was followed by major international meetings. In particular, this challenge was reinforced at the UN Conference on Environment and Development (*Earth Summit*) in Rio de Janeiro in 1992 (UNCED, 1992) that issued several historically important documents, including: the Rio Declaration on Environment and Development; the detailed agenda of desired actions for change (*Agenda 21*); the UNFCCC; the UN Convention on Biological Diversity; and the Statement of Forest Principles. All these documents, although in different degrees, relate to this book’s contents. In particular, the Conference's primary product – Agenda 21 – specifies the issues and topics that need to be dealt with in any attempt to achieve sustainability and provides the principles that should be borne to bring humankind into harmony with the finite resources of the Earth by the middle of the twenty-first century. Being designed to prepare the world for the challenges of the 21 century, Agenda 21 tried to address poverty, hunger, disease, illiteracy and environmental degradations as a set of inter-related issues, representing the beginning of a global partnership for economically viable, socially just and environmentally sound development both for the present and for the future (Agenda 21, 1992; Cohen *et al.*, 1998; Weston, 1995).

In three year after the *Earth Summit*, Weston (1995) picked out four interrelated ideas from the concept of sustainable development:

- Meeting both present and future needs, which establishes the goal for sustainability;
- Meeting needs, which defines the goal for development;
- Maintaining consistency between population size and ecosystem productive capacity, which recognizes that there are limits and requirements for balance;
- Implementing a process of change that acknowledges the definition of needs and the requirements for attaining that a sustainable balance will change with situations, conditions and time.

The last idea means that the concept of sustainable development is open-ended because people have different needs to survive, different aspirations for their standards of living and quality of life, and different ecosystems’ productive and absorptive capacities.

Therefore, to better understand the concept, it is necessary to think in terms of global objectives, local goals, the circumstances under which individuals live and make their living, and their capacity to adapt to and change their circumstances to their advantage. There are finite requirements to ensure survival under different environmental situations and conditions (i.e., base-case) and more restrictive finite requirements (i.e., exactions) to attain a standard of living and quality of life better than just survival. In any case, the concept of sustainable development challenges present generations to stabilize their development needs so that they are consistent with the Earth's future, as well as with its present productive and absorptive capacities. Because these capacities are finite, the concept raises issues of equitable allocation of resources both among present generations *(intra-generational equity)* and between present and future generations *(inter-generational equity)* (Weston, 1995). The twin principles of the equity form the basis of sustainable development: improving the current welfare of all people, especially the poor and disadvantaged, and maintaining development options and opportunities for generations to come.

During the post-Earth Summit decades, the concept of sustainable development has permeated mainstream thinking, and in 2002 at the World Summit on Sustainable Development in Johannesburg (WSSD) the international commitment to sustainable development was reaffirmed[2]. The Summit made it clear that sustainable development had become a widely-held social and political goal and recognized that current development practices are taking the world towards a future in which it will be unable to sustain its growth. Any approach to development should allow the meeting of fundamental human needs, while also not destroying the base upon which future development depends, or in ways that preserve the life support systems of the planet. This understanding is the essence of sustainable development. As a concept, as a goal, and as a movement, sustainable development spread rapidly and now is central to the mission of countless international organizations, national institutions, corporate enterprises, sustainable cities and locales. Of course, it can be considered "more as an ambiguous integrative slogan than an operational term" (Wilbanks, 2003), or as "an intriguing and highly controversial concept" (Toth, 2003c, p. 254), or as "…something that can only be grasped as a 'fuzzy concept' rather than expressed in terms of an exact definition" (Giampietro, 2002, p. 262). However, it incorporates the notion that for continued human progress to be possible, any development must find pathways that both achieve economic goals while, at the same time, find a stable balance with a physical environment that is already under stress, utilizing political strategies that are equitable between nations and regions now, and between current actions and the needs of future generations. Strength of sustainable development lies in reconciling these real and perceived conflicts (Dobie, 2002; Kates *et al.,* 2005; NRC, 1999).

5.1.2 A structural model of sustainable development: definition and essence

It is easy to agree with Kates *et al*. (2005) that the Brundtland Commission's brief definition of sustainable development as *"...ability to make development sustainable—to ensure that it meets the needs of the present without compromising the ability of future*

---

[2] *The Johannesburg Declaration on Sustainable Development*, 4 September 2002. Available at: *http://www.housing.gov.za/content/legislation_policies/johannesburg.htm*

generations to meet their own needs" (WCED, 1987, p. 8) really is 'the standard definition' given its widespread use and citation. Although the Brundtland report itself does not cite this statement as 'a definition', but merely as "just one of many things the report says about sustainable development, and does not do full justice to the report be implemented" (George, 2001, p. 99), its malleability allows it to be put on the banner of sustainable development for different programs related to the environment (Kates *et al.,* 2005). As a contested idea with a wide range of meanings, it is used by big business, governments, social reformers and environmental activists, each with their own interpretation of what sustainable development means. Therefore, any examination of this concept interpretation should bear in mind the philosophy underlying the proponent's point of view (Giddings *et al.,* 2002). For example, the IPCC (Yohe *et al.,* 2007, p. 881) defines sustainable development in very conformity with the Brundtland definition, but has made some additions (*italic* added): "…development that meets the *cultural, social, political* and *economic* needs of the present generation without compromising the ability of future generations to meet their own needs". There are also many other alternative definitions and discourses, but none yet is universally accepted.

Let us consider two examples.

So, Swedish scientists (Broman *et al.,* 2000) proposed system conditions for sustainability that go beyond the Brundtland definition. In their opinion, to be sustainable the ecosphere must not be systematically subjected to:

- increasing concentrations of substances from the earth's crust
- increasing concentrations of substances produced by society
- impoverishing physical manipulation or over-harvesting; and
- resources must be used efficiently and fairly to meet basic human needs worldwide.

The first three conditions give a frame for ecological sustainability. For society to be sustainable, the fourth condition must be added. On the whole, these conditions present the first-order principles for sustainability because they are necessary for sustainability, they are sufficient for sustainability and do not overlap each other (Cairns, 1997).

In the second example, Giampietro (2002) advanced the new conceptualization of sustainable development that moves away from the definition in general application. He came from the perspective that believed that sustainability was often imagined as a formal, static concept that could be defined in general terms without the need of applying it to a specific situation. What Giampietro proposed was "…the ability of a given society to move, in a finite time, between satisfying, adaptable, and viable states" (p. 262). Such a definition implies that sustainable development has to do with a process *(procedural sustainability)* rather than with a set of once-and-for-all definable system-qualities *(substantive sustainability)*. From this point of view, sustainability implies the following points:

- governance and adequate understanding of present predicaments, as indicated by the expression: "the ability to move in a finite time";
- recognition of legitimate contrasting perspective related to the existence of different identities for stakeholders as indicated by the expression: "satisficing" as opposed to "optimizing";

- recognition of the unavoidable existence of uncertainty and indeterminacy in our understanding, representation and forecasting of future events, as indicated by the expression: “adaptable”;
- availability of sound reductionist analyses able to verify within different scientific disciplines the “viability” of possible solutions in terms of existing technical, economic, ecological and social constraints, as indicated by the expression: “viable”.

Most other definitions of sustainable development, to a different degree, emphasize the same critical elements: identifying what to develop and what to sustain, characterizing links between entities to be sustained and entities to be developed, and envisioning future contexts for these links (NRC, 1999; Yohe *et al.,* 2007)

The narrow use of the Brundtland report’s definition has led many to make erroneous interpretations, for example, to see sustainable development as having a major focus on intergenerational equity. However, Kates *et al.* (2005) showed that although the brief definition does not explicitly mention the environment or development, the subsequent paragraphs, more rarely quoted, are clear. As to development, the report states that human needs are basic and essential, that economic growth—but also equity to share resources with the poor—is required to sustain them, and that equity is encouraged by effective citizen participation. As to the environment, its statement is: “the concept of sustainable development does imply limits—not absolute limits but limitations imposed by the present state of technology and social organization on environmental resources and by the ability of the biosphere to absorb the effects of human activities*”* (WCED, 1987, p. 8). That is why Principle 3 of Rio Declaration (UNCED, 1992) – *“…to equitably meet developmental and environmental needs of present and future generations”* – is, in essence, a re-affirmation of the Brundtland Commission statement.

The Board on Sustainable Development of the US National Research Council (NRC, 1999) summarized its exhaustive review of different literature treatments of the sustainability concept. Fig. 5.1 shows the NRS’s expression of the inherent distinction between what the concept advocates and analysts sought to sustain, and what they sought to develop, the relationship between the two, and the time horizon of the future.

In the interpretation of this work by Kates *et al*. (2005) and Clark *et al.* (2005), the Board under the heading *“What is to be sustained?”* identified three major categories – nature, life support systems, and community – as well as intermediate categories for each, such as Earth, environment, and cultures. The Board found that an emphasis was most commonly placed on life support systems, which defined nature or environment as a source of services for the utilitarian life support of humankind. Over time, the studies of ecosystem services (Millennium Ecosystem Assessment, 2005) have strengthened this definition. In contrast, some of the sustainable development literature evaluated nature for its intrinsic value rather than its utility for human beings. There were also parallel demands to sustain cultural diversity, including livelihoods, groups, and places that constitute distinctive and threatened communities.

Similarly, there were three quite distinct ideas about *“What is to be developed?”*. Much of the early literature focused on economic development, with productive sectors providing employment, desired consumption, and wealth. More recently, attention has shifted to human development, including an emphasis on values and goals, such as increased life expectancy, education, equity, and opportunity. Finally, the Board also identified calls to develop society that emphasized the values of security and well-being of national states, regions, and institutions as well as the social capital of relationships and community ties.

Clark *et al.* (2005) also emphasized the different conclusions that had been reached in numerous debates and expended on an effort to answer the question about what society actually means when it declares sustainable development as a "high table" goal for the twenty-first century. Still, much of this debate share common concerns, while differing largely in their emphasis on what is to be developed, what is to be sustained, what should be the relation of the developed to the sustained, and over what period the relationship should hold. For example, a broad consensus can be discerned that sustainable development should be development that, over the next two generations, promotes progress "…to meet the needs of a much larger but stabilizing human population, to sustain the life-support systems of the planet, and to substantially reduce hunger and poverty" (NRC, 1999, p. 31). However, the concrete challenges of sustainable development are at least as heterogeneous and complex as the diversity of human societies and natural ecosystems. The original emphasis on economic development and environmental protection has been broadened and deepened to include alternative notions of development (human and social) and alternative views of nature (anthropocentric versus ecocentric). Thus, the concept maintains a creative tension between its few core principles and its openness to reinterpretation and adaptation to different social and ecological contexts (Kates *et al.*, 2005).

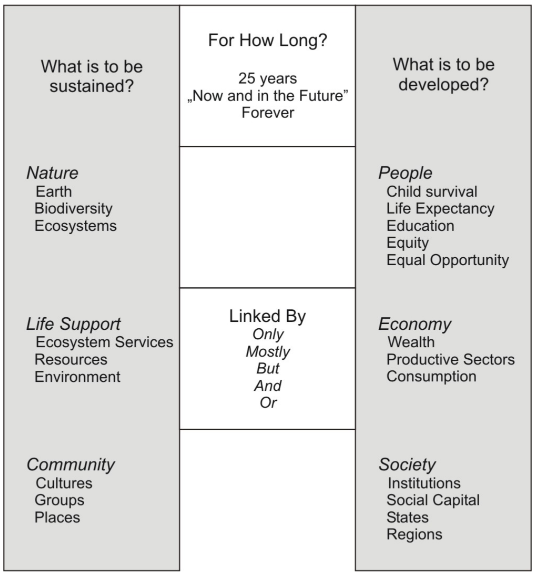


Fig. 5.1 Sustainable development: Common concerns, differing emphases. *Source:* Adapted from NRC (1999)

As a result, for some years there were lively debates about whether it is best to conceive of sustainability resting on two intersecting pillars (ecological and human), three (social, ecological and economic), five (ecological, economic, political, social and cultural), or even more (Gibson, 2006b). There are many other proposals for enhancements, such as the 'five capitals framework' (natural, human, social, manufactured and financial) or the suggestion that governance should also be added as an individual dimension. Colloquially, Hacking and Guthrie (2007, p. 6) named all these proposals as, essentially, attempts at "explaining the composition of the cake by cutting it into thinner slices".

However, while opinions and definitions of sustainable development vary widely, most call attention to the need to maintain resilience in environmental and social systems by meeting a complex array of interacting environmental, social and economic conditions, or three 'imperatives' for sustainable development (Swart *et al.*, 2004): *the ecological* (staying within biophysical carrying capacity), *the social* (providing systems of governance that propagate the values that people want to live by), and the *economic* (providing an adequate material standard of living for all). In the World Summit's expansion of the standard definition these imperatives were also considered as the now widely used three pillars of sustainable development: *economic, social*, and *environmental* (The Johannesburg Declaration, 2002). "The combination of socio-economic concerns and environmental concerns was guaranteed to be a contest field as the long standing debates within both socio-economics and environmentalism flowed into sustainable development with the added debate over the relation between socio-economic and environmental issues" (Giddings *et al.,* 2002, p. 188). As a result, many writers and practitioners (e.g., Shearlock *et al.*, 2000) have described sustainable development in terms of the intersections of three intersecting domains: social, environmental and economic (Fig. 5.2); here, the zone of their intersection represents sustainability.

However, this scheme presents severe conceptual difficulties when it comes to putting this idea into practice. Although the purpose of integrating the three spheres is to reconcile potential conflicts between social, economic and environmental goals of sustainable development, the three-pillar approach has done little to reduce the complexity of the concept and, moreover, has itself introduced a contradiction (George 2001, 2007). Three dimensions were originally introduced with the aim to identify areas in which these goals interact. However, to a certain extent, the opposite has occurred by allowing a distinction to be drawn not only between social and economic goals, but also between social and economic development. In adopting the term 'sustainable development', the Brundtland Commission argued that problems of human development (poverty, inequity, basic human needs) could not be separated from and indeed were causally connected with environmental problems of resource depletion, biodiversity, pollution and life support systems (Cohen *et al.,* 1998).

On the other hand, in the opinion of Giddings *et al.* (2002), the presentation of these three sectors, using the three interconnected rings model, is a conceptual simplicity. The classification of impacts into three convenient categories makes analysis more straightforward. The model usually shows equal sized rings in a symmetrical interconnection, presenting sustainable development as aiming to bring the three 'pillars' in a balanced way[3], reconciling possible conflicts among them, although there is no reason why this should be the case. Different perspectives can, and often do, give greater priority to one or the other. Assuming the separation and even autonomy of the economy, society and environment from each other is considered a weakness or limitation of this model. The

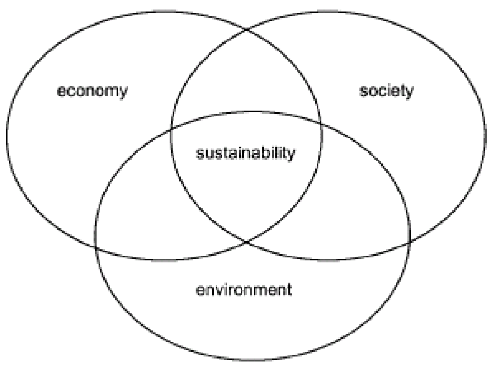


Fig. 5.2 Three domains of sustainable development. *Source:* Shearlock *et al.,* 2000

[3] For example, R. Weston (1995) considers the concept of sustainable development as a process of consensus-based decision making in which the impact of economic activities (the economy), the environment (ecosystems), and the health (well-being) of society are integrated and balanced

reality is that the economy dominates environment and society, or political reality gives primacy to the economy. Linnér (2006) also notes that sustainable development is not a consensus concept; it is seen to be fraught with conflicting interests and interpretations. Even though its three pillars are regarded as mutually supportive, weighing their respective functions and degrees of importance in each specific setting inevitably involves different trade-offs and classical ideological conflicts between economy, equity and environment.

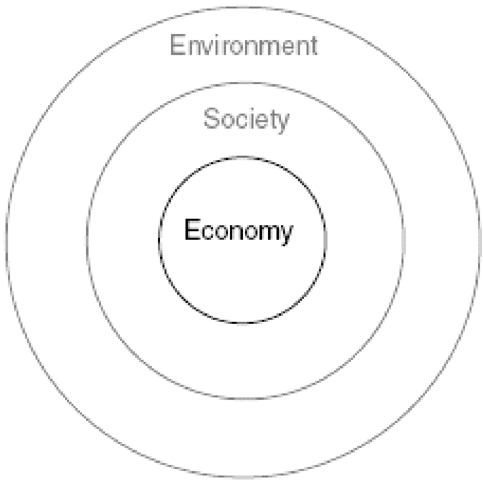


Fig. 5.3 Nested sustainable development-economy dependent on society and both dependent on the environment model. *Source:* Giddings *et al.,* 2002

Giddings *et al.* (2002) proposed, as a more accurate presentation of the relationship between society, economy and environment, the model where the economy is nested within society, which in turn is nested within the environment (Fig. 5.3). Placing the economy in the centre does not mean that it should be seen as the hub around which the other sectors and activities revolve. Rather, it is a subset of the others and is dependent upon them. Human society depends on environment, although in contrast the environment would continue without society. The economy depends on society and the environment, although society for many people did and still does (although under siege) exist without the economy. A key issue for sustainable development is the integration of different actions and sectors, taking a holistic view and overcoming barriers between disciplines. The 'nested' model rather than the 'three-ring' model encourages a conceptual outlook sympathetic to integration.

However, to draw together economic, social and environmental objectives, which interact with each other, into a single list does not integrate them. The art of planning for sustainable development is the art of planning the interactions in such a way as to achieve development that is sustainable (George, 2001). In this discourse Clement (2001) distinguishes three levels of integration. The *first order* treats the environment as a horizontal issue, often meaning in practice that the environment is assumed to feature as a component of other (economic) priorities. The *second order* is characterized by vertical integration, meaning that environmental objectives are expressed as a separate priority and given higher status, which facilitates monitoring. *The third order* integration comprises the adoption of a strategic approach to environmental issues, with a competitive purpose. Bringing together both horizontal and vertical integration ensures that the environment forms a fundamental component of the development strategy. With every year, the key role of the environment in economic development has becoming clearer and increasingly accepted that is facilitated by progress in advancing the overarching theme of sustainable development and broadening global awareness of economic impacts on the physical environment. Environmental integration is becoming both a familiar concept and a practical reality. Nevertheless, as Clement (2001, p. 86) concludes, – *"whereas it is widely assumed that sustainable development always acts as a catalyst for environmental gain,* *closer examination of specific programmes can reveal a different outcome. In some instances, the opposite appears to be true, and the launch of sustainable development initiatives has constrained environmental integration".*

Generally, Cohen *et al*. (1998) stated that where each domain is managed separately (the *conventional scenario*) development is unlikely to be sustainable. Learning how to manage the three domains in an integrated fashion (the *sustainable development* scenario) can overcome the inadequacies of conventional approaches. However, although these principles are easily stated, ensuring their application requires considerable change within societies and their governments. The co-management of economic, social and environmental domains with integration of activities across the three is a fundamental principle of Agenda 21.

Although *economic, ecological* and *human/social dimensions* are the pillars of sustainable development, and any reasonable policy requires the integration of these traditionally separate domains, each of them has its own distinct driving forces and objectives, expressed by Munasinghe (2003) in Fig. 5.4[4]. Furthermore, while the three pillars were rapidly adopted, there is no universal agreement as to their details (Kates *et al.*, 2005). Experience shows, that processes of economic and social development have, in many circumstances, strongly destructive consequences that must, along with strengthening the positive and constructive contributions of development, be clearly identified and firmly resisted. To resist and reverse many of these bad consequences is within human power if timely actions are taken (Sen, 2007).

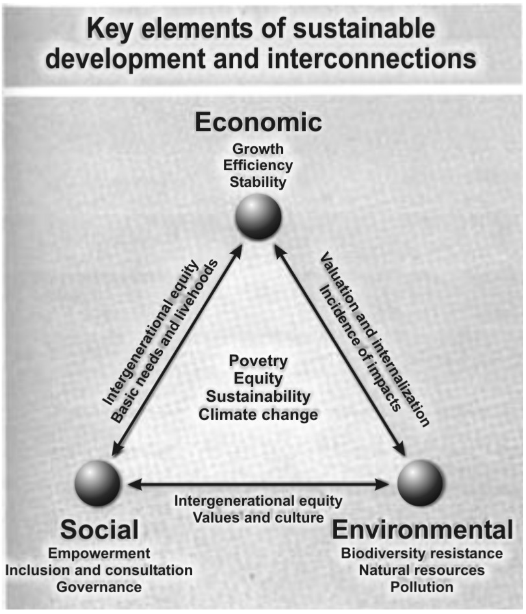


Fig. 5.4 Sustainable development triangle. *Source:* IPCC, 2007d; Munasinghe, 2003

In a thorough analysis of the problem, Kates *et al.* (2005) noted that opponents of sustainable development attack it from two opposing points of view: those who view the conception as a top-down attempt of the UN to dictate how people should build their lives, finding here a threat to individual freedoms and property rights, and those who view sustainable development as 'capitulation' implying development as usual. These authors consider the ability of sustainable development to be *a grand compromise* between those who are principally concerned with nature and environment, those who value economic development, and those who are dedicated to improving the human condition as an evident success of the conception. At the core of this compromise, the inseparability of the environment and development lies.

[4] The slightly adjusted version of this figure was used in the IPCC AR4 (IPCC, 2007d)

5.1.2.1 Economic dimension of sustainable development

It is clear that the *economic growth* issue is of critical concern to most countries, particularly developing and those in transition. The economic dimension is geared mainly towards improving human welfare (such as real income), primarily through increases in the consumption of goods and services based on the development of market, industry, services and employment (Shearlock *et al.*, 2000). The modern concept underlying economic sustainability seeks to maximize the flow of income that could be generated, while at least maintaining the stock of assets (or 'capital'), which yield these beneficial outputs. Economic efficiency plays a key role in ensuring both efficient allocations of resources in production and efficient consumption choices that maximize utility. Hence, sustainable development is and should be an economic concept (Munasinghe, 2003; Weston, 1995).

The valuation of '*capital'* stocks, which should be passed from one generation to the next, bases the *operational principle* of sustainability. In this context, Sadler (2001a) recognizes three types of capital as important: *man-made capital* — the machines, buildings and infrastructure supporting the production of goods and services; *natural capital* — natural resources and ecological processes which provide raw materials and comprise a life support system; and *social capital* — human capabilities, community networks and institutional systems — that permit a complex society and economy to function[5].

A problem, which we would like especially to emphasize here, is the necessity of *a contextual approach to consumption.* After a long period of abstract criticism on consumer culture, the general sociology has now taken up a more serious study of consumption. For a long time, within environmental sociology, the study of consumption behavior and lifestyles has been the domain of empirical researchers who in many cases were theoretically inspired by the social psychological model of human behavior (Spaargaren, 2003). However, consumption patterns are highly diverse and rapidly changing (Michaelis, 2003), and the diversity itself becomes often the source of new trends, for example in clothing, eating styles or leisure activities. That is why, during the 1990s, a number of efforts were made to clarify what is meant by sustainable consumption and how it fits with the sustainable development agenda. The UNDP devoted its 1998 Human Development Report to this issue (UNDP, 1998). In this report two primary concerns were identified: environmental impacts of consumption and the tremendous difference in levels of consumption between north and south. In developed countries, the fastest growing environmental damage and resource use are directly linked to households, lifestyles and consumption, requiring changes not only in technology but also in lifestyle. The latter, along with water consumption and land use, is responsible for the majority of GHG emissions. However, in spite of general agreement that lifestyles should be changed for environmental reasons, there are serious doubts on the feasibility of achieving this change. Social, political and cultural influences and norms are allied to existing technologies and practices. An indicative example is private cars, which have become deeply embedded in all aspects of modern society, more and more determining its lifestyle and even its culture.

---

[5] Of course, this is not the only classification. For example, we could name "5 capital" of Porritt (2005) who distinguishes *human, manufactured, social, natural* and *financial capital*

Michaelis (2003, p. 142) defines the conventional role of government in sustainable consumption policy-making (“leadership for sustainable consumption”) in one of two ways:

1. Government may seek to understand and influence consumer behavior through such measures as regulations and standards, market instruments and planning. Here, the government is viewed as manager of the system; consumers are understood as entities whose behavior is to some degree explicable and responsive to stimuli in predictable ways.
2. Government may seek to influence people to consume differently through information, education, media messages and other psychological measures. In these cases, government is behaving as an expert advisor, moral guide or surrogate parent.

The strategy of implementing sustainable consumption might include traditionally advocated measures, such as agricultural subsidies, energy efficiency standards, urban planning to reduce car dependency, and better public information about the ecological footprint of products and services. These measures are likely to be more widely accepted if they emerge from public discussion, rather than being imposed by bureaucratic governments. Trade and industry policies are also crucial. Perhaps one of the greatest challenges is finding ways to balance short-term economic competitiveness and stability with long-term sustainability and quality of life.

5.1.2.2 Environmental dimension of sustainable development

The definition of sustainability through the relationships between the environment and development comprises both a goal (*system conditions*) and a yardstick (*set of measures*) where the environment is a baseline condition. Environmental sustainability means that the critical resource stocks and ecological functions must be safeguarded, the depletion and deterioration of sources and sinks must be kept within acceptable levels or safe margins, and the losses of natural capital must be made good (Sadler, 2001b). As Magalhies (1998) argues, a development process really destroys natural capital and thus contains the roots of self-destruction in the long term. These so-called externalities of the development process are costs that are not appropriated by investors and are eventually shared by society as a whole. Sometimes, the destruction of natural capital is visible, like soil erosion or water pollution; other times, it appears as global externalities of the development process, such as GHG emissions. As a consequence, the development process *can be* unsustainable, leading to local, regional and global changes in the environment.

Some mistakenly consider the environment as the state of ‘nature’, reflected by such measures as the extent of forest cover, the depth of a groundwater table, and so on. Sen (2007) named two important reasons for the serious incompleteness of such an understanding.

First, the environment value cannot be just a matter of what there is, but also of the opportunities it offers, and in assessing the richness of the environment its impact on human lives must also be among the relevant considerations. The Brundtland Commission (WCED, 1987) clarifies this by focusing on sustaining the fulfillment of human ‘needs’. For example, any prevention of the extinction of species or the preservation of biodiversity are among the concerns of a responsible person's perspective on climate change; they are an integral part of the human development approach not so much because there is a 'need' of these species, but because it is a bad idea to let existing species disappear forever.

Second, the environment is not only a matter of passive conservation, but also one of active pursuit. We must not consider the environment exclusively in terms of pre-existing natural conditions, since it also includes the results of human creation. *"In thinking about the steps that may be taken to halt environmental destruction we have to search for constructive human intervention"*, – Sen insists (2007, p. 28).

A key practical question that remains is whether sustainable development is a program to implement or a general principle to adopt in implementing all other programs (Toth, 2003c). In turn, Jay *et al.* (2007) assert that the analysis of effects of proposed developments could be based on the concept of environmental resources, capacities and limits, rather than on relatively narrow assessments of the effects of proposals on their immediate environment. This could allow wider impacts, for instance on climate change, to be seen more clearly, and would enable the tracking of cumulative consequences of development in the context of no net environmental deterioration resulting from any given development. From this viewpoint, the supply-side principles of strong environmental sustainability (these crucial are described in Box 5.1) emphasize carrying capacity, maintaining biodiversity, ecosystem integrity and other resource based strategic planning approaches. Demand-side principles of strong sustainability address the limitations on the application of supply-side principles by taking a *precautionary approach* – a closely related concept, often used in environmental policy formulation to guide decision-making when there is uncertainty about the potential environmental impacts of proposed actions.

The *precautionary approach*, defined in Principle 15 of the 1992 Rio Declaration (UN, 2002), means that "[w]here there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation". A variety of versions of this principle are now in use, with differing implications for environmental assessment and decision-making. Some view the precautionary principle as an alternative to risk analysis, while others regard it as an ethical principle for particular decision situations. A strict form of the precautionary principle involves avoiding all actions that might cause serious or

Box 5.1 Supply-side principles for environmental sustainability

Avoid irreversible or serious environmental damage, including any contribution to cumulative global impacts (e.g.,as defined under the Kyoto Agreement).

Protect valued resources, heritage sites and critical ecological functions, as defined by national policies for nature protection and the Convention on Biological Diversity.

No net loss or deterioration of natural capital, which to become operational requires that environmental impacts are fully mitigated or otherwise offset by providing an equivalent or appropriate replacement for residual damage.

Renewable resources should be depleted (harvested or used) at a rate equal to their regeneration.

Non-renewable resources should be depleted at a rate equal to their replacement by renewable substitutes.

Waste emissions should not exceed the assimilated capacity of the environment or cause harmful effects to human health.

Source: Sadler, 2001a

irreversible environmental change. Weaker versions involve maintaining ‘safe margins’, which require the use of SEA and other instruments to err on the side of caution. In combination, demand-side principles (which extend the precautionary approach) can be applied to limit the causes of environmental damage at the source and thus reinforce sustainability (Sadler*,* 2001a; Toth, 2003c).

The environmental or ecological dimension focuses on protection of the integrity and resilience of ecological systems (Shearlock *et al.,* 2000). Economic considerations have always heavily influenced the national positions of the EC environmental protection policy, with its concerns that an emphasis on industrial pollution reduction could cause constraints on economic development (Soveroski, 2004). However, the advances are clear when considering the environment as a strategic factor in development, and it is no longer seen as an isolated sector. Instead, as we discussed above, the environment is perceived as a fundamental component of sustainable development and as a source of economic initiative. In particular, in regional environmental integration, Clement (2001) categorized the environmental baseline data under four thematic groups where:

- *Environmental quality* relates to natural environment, landscape, biodiversity, historic environment, air and water. Their characteristics have direct links to the regional economy through their attraction for tourists and potential investors. Accordingly, their protection and enhancement is fundamental to environmental sustainability.
- *Environmental management* comprises waste, energy and transport, each of which has direct and indirect impacts on the regional environment. As economic-related sectors with significance for business competitiveness, there is scope to influence these areas through the form of supported projects.
- *Land use* covers agriculture, woodland, derelict land and land-use change. Agriculture is important as a major activity with associations between environment and employment, and forestry contains economic potential, in addition to its role as an ecological resource.
- *Environmental performance* relates to increasing the competitiveness of industry by capitalizing on regional strengths. This involves specialist employment in environmental technologies and services, as well as the conversion of existing businesses to environmentally friendly working practices.

5.1.2.3 Social dimension of sustainable development

The differences in interpretation of sustainable development’s domains are most pronounced in characterizing the social pillar. Development is not a function of physical or natural capitals only, and other forms of capital are necessary for successful development to take place. These forms are human and social capital (Magalhies, 1998).

In particular, *social capital* theory refers to features of social organization that facilitate co-ordination and cooperation for mutual benefit. Social capital itself possesses three aspects: networks, norms and trust. The emphasis on *networks* is a focus on the relations between individuals, organizations and institutions. *Norms* are, by definition, types of accepted behavior that are engaged in without prior calculation of the detailed consequences. *Trust* defines the willingness to put oneself in potentially vulnerable situations in the belief that the other party will not take short-term advantage of this

(Devine-Wright *et al.*, 2001). So, the quoted authors argue that well-functioning social networks within regions can play a useful role in achieving sustainable regional development because they facilitate the speedy dissemination of novel information, expertise and resources across the region. Social capital plays a moderator role. Regions with high levels of social capital will be more successful in implementing sustainable development than those with low levels. Furthermore, tracing this relationship through time suggests that it will be mutually reinforcing: high social capital increases the success of sustainable development initiatives which, in turn, increase the stock of social capital in the region, and vice versa. This conclusion leads to a necessity for policy-makers and institutions, which are charged with implementing the sustainable development policy, to pay more attention to this question.

According to Munasinghe (2003), social sustainability seeks to reduce the vulnerability and maintain the health of social and cultural systems and their ability to withstand shocks. Enhancing human capital (for example, through education) and strengthening social values (like behavioral norms) and institutions are key aspects here. The weakening social values, institutions and equity reduce the resilience of social systems and undermine governance. The integral elements of this approach are preserving cultural diversity and cultural capital, strengthening social cohesion and networks of relationships, and reducing destructive conflicts. Kates *et al*. (2005) consider sustainable development as a *social movement* that is understood as "a group of people with a common ideology who try together to achieve certain general goals"[6]. They found three major variants of this process, each of which seeks to compensate for elements missing in the narrow focus on economic development. The first variant is simply a generic non-economic social designation that uses terms such as *social*, *social development*, and *social progress*. The second emphasizes human development as opposed to economic development: *human development*, *human well-being*, or just *people*. The third variant focuses on issues of justice and equity: *social justice, equity,* and *poverty alleviation*.

On the whole, the social domain focuses on the enrichment of human relationships, achievement of individual and group aspirations, strengthening of values and institutions, as well as addressing concerns related to social justice and promotion of greater societal awareness of environmental issues (Yohe *et al.,* 2007). Likely, the greatest challenge of the early third millennium will be to blend the creative energies of capitalism with the social objectives of equity and human development (Bezanson, 2004).

Sen (2007, p. 28), trying to answer the question: "Does the human development approach have something to offer to make us understand whether this apparent conflict between development and environmental sustainability is real or imaginary?", emphasizes the huge contribution that this approach can make by invoking the central perspective of seeing development as the expansion of substantive human freedom. He believes that in this broader perspective, "…assessment of development cannot be divorced from considering the lives that people can lead and the real freedoms that they can enjoy. Development cannot be seen merely in terms of enhancement of inanimate objects of convenience, such as a rise in personal incomes". However, once we appreciate the necessity of seeing the world in the broader perspective of the substantive freedoms of human beings, it immediately becomes clear that "…development cannot be divorced

---

[6] See: WordNet Search 3.0: *http://wordnetweb.princeton.edu/perl/webwn*

from ecological and environmental concerns". Important components of human freedoms and crucial ingredients of the quality of life are thoroughly dependent on the integrity of the environment, involving the air we breathe, the water we drink, the epidemiological surroundings in which we live, and so on. *"Development has to be environment-inclusive, and the belief that development and environment must be on a collision course is not compatible with the central tenets of the human development approach"*, – Sen concludes *(Ibid,* p. 29).

5.1.3 Environmental ethics and morality of sustainable development

5.1.3.1 Changing behavior and interventions: a short background

Any conception of sustainable development is impossible without making fundamental ethical and political choices. Different visions of the essence of sustainable development by different people result in differences in their behavior and actions. Discussing this problem, Buchdahl and Raper (1998) presumed that to some people *sustainable development* is sustained economic growth, where cycles of monetary boom and bust are avoided, and so long as technological advances keep pace with consumption of natural resources, they may feel assured that future generations will be able to experience an equal or improved standard of living. To others, a sustainable society must turn to renewable resources to enhance growth, whilst protecting those aspects of the environment that cannot be replaced. As a basic need of life, growth should continue, but not at the expense of future generations and the environment they inhabit. More radical environmentalists are ready to go further. They claim that human society is a part of the global environment, not a parasite upon it, and thus we should view our behavior (social and economic) as a subset of nature. Human needs are secondary to the natural order of things where there is equilibrium between life and death, growth and decay, and a society should strive for a *sustainable harmony of nature*.

To harvest the benefits for both human wellbeing (including human health) and environment, a dramatic change is required in planning and design of man-made infrastructures, cities, buildings and technologies. *"From being guided solely by maximizing short-term comfort, the design should be aimed at optimizing long-term comfort and wellbeing, by finding the proper balance where people are encouraged and pushed to get sufficient exercise in the daily life"*, – Norgard (2005, p. 250) notes. Europeans each consume at least fifty times more of nature's energy gifts than what they can possibly provide with their own body, even when working hard. Society's policies and individual behavior could be adjusted to integrate increased healthy use of what Norgard terms "human body energy" with decreased use of what he calls "nature's external energy".

Buchdahl and Raper (1998) suppose that such a plurality of opinions arises out of varying *attitudinal, ethical* and *metaphysical* positions, which people adopt regarding the environment. Those that place more emphasis on social and economic needs tend to adopt human-centered (anthropocentric) and instrumental systems of values. Those who prefer environmental protection at the expense of human growth are proponents of non-anthropocentrism and intrinsicalism where Nature is valued for its own sake. If sustainable development is to succeed, it is crucial to take into account the different ethical rationales from which the varying concepts of sustainability are constructed. In other words, we should speak about the *environmental ethics of sustainable development*. Only through understanding and appreciating the natural value of the global environment we can be guided as to what would make a morally acceptable course of actions to achieve sustainable development.

Again, a major paradigm shift and fundamental changes in ethics, human behavior, and lifestyles are necessary. In particular, cultural anthropologists have shown that beside their usefulness, another function of goods is to be meaningful. The concept of lifestyle, introduced by Max Weber, denotes a pattern of behaviors and a set of values that are common to a social group (Bartiaux, 2003). Most advocates of sustainable development recognize the need for changes in human values, attitudes, and behaviors in order to achieve a sustainable transition that will meet human needs, while maintaining the life support systems of the planet (NRC, 1999). According to Leiserowitz *et al.* (2004) these three concepts signify:

- *Values* – expressions of, or beliefs in, the worth of objects, qualities, or behaviors. They often invoke strong feelings and are typically expressed in terms of good or bad, better or worse, and desirability or avoidance. Values define or direct us to goals, frame our attitudes and provide standards against which the behavior of individuals and societies can be judged. Values are also relatively abstract and trans-situational.
- *Attitudes* refer to the evaluation of a specific object, quality, or behavior as good or bad, positive or negative. Attitudes often derive from and reflect abstract values.
- *Behavior* refers to concrete decisions and actions taken by individuals and groups, which are often rooted in underlying values and attitudes.

Thus, concepts of sustainable development, as a mix of economics and morality, should stimulate an approach to moral behavior as to an economic issue (Weston, 1995). The power of an individual to do harm, irrespective of causes or motives – through knowledge of science and technology, the general desire for individual freedom and the inadequate moral behavior standards of a few – creates undue risks for communities. The need exists not only to change human attitude away from that of ‘conquering’ nature toward that of adapting to and leveraging the value of the free goods and services that nature provides, but also to provide incentives and disincentives for good and bad behavior, respectively.

IPCC (2001a) sees two reasons why lifestyles are an issue of climate policy: (1) consumption patterns are an important factor in climate change since they have become an essential element of lifestyles in developed countries; (2) many promising domains for substantial environmental improvements through technological change also require changes in lifestyle. Lifestyles are not just a matter of behaving this or that way, but are basically an expression of people’s self-esteem. To this extent the issue is not only that individuals need to change their behavior, but that they need to change themselves. This tends to be underestimated in policy considerations, but must be accounted for when such changes become relevant with respect to climate change. Otherwise, discrepancies between people’s environmental consciousness and behavior are deplored but not understood.

5.1.3.2 Determinants of behavior

In general, a distinction is made between structural and psychological strategies for behavior change (van Elburg, 2005). *Structural strategies* are aimed at changing the circumstances in which choices are made and affect people's opportunities, for example, via financial-economic instruments, legislation and enforcement or physical changes (environmental alterations, technological innovations, provision of facilities, etc.). *Psychological strategies* are aimed at changing people's knowledge, awareness, attitudes, norms, values and perceptions via information, education, communication and modeling. Examples are information campaigns, prompts, goal setting, feedback and commitment. Considering psychological strategies for behavior change, van Elburg argues that consumers are prepared to change their behavior if the consequences of the change are beneficial for them personally, if the type of desired change can be easily fitted into and adapted to their daily routine and is not too difficult for implementation, if the 'new' desired behavior can be initially tried out and, finally, if consumers receive positive feedback about the consequences of their behavioral change. The importance of these conditions in realizing behavioral change differs in many cases not only per specific target group, but often even per member of the group (e.g., per household). In general, it can be said that the chance for individual behavioral change increases if specific interventions fit into the consumers' personal circumstances.

Smith and Pett (2005) express the field, in which these specific *external* and *internal* interventions influence, for example, energy-related behavior of householders, as a 'cloud of uncertainty' where relationships between variable interventions are unclear. The external variables include, e.g., heating systems, energy supply characteristics and passive advice/training. The internal variables, peculiar to the individuals themselves, are demographic factors such as age and presence of children, household size and employment status, as well as the residents' previous knowledge (experience) and interactive advice provision. This meant that the indicator 'user's behavior' had to be defined and classified in terms of both comfort *(Desired Results)* and efficiency *(Behavior Style)*.

Thus, any intervention to change both the behavior of individual and organization should be preceded by the identification of *behavior determinants*.

Green and Kreuter (1999)[7], in their model, sometimes referred to as the PRECEDE-PROCEED model, describe three general categories of factors or determinants that affect environmental behavior[8], with different influence of each, as follows:

(1) *Predisposing factors* – the internal antecedents to behavior belonging to an organization (decision maker); they relate to the motivation of behavior (predispose

---

[7] Green L. and M. Kreuter, 1999: *Health Promotion Planning* (3^{ed}), Mountain View, CA. This book is quoted here following to Bruel and Hoekstra (2005) and Egmond and Lulofs (2005)

[8] Initially the model was designed for planning and evaluation of interventions changing the behavior of individuals. Egmond and Lulofs (2005) adapted it for the change of behavior of organizations. They explained this assumption by the following logic: (1) organizations, by definition, are sets of individuals with common interests and with supporting coordination mechanisms; (2) a change in the behavior of an organization is preceded by a change in its attitude; (3) the behavioral attitude of an organization reflects the behavioral attitude of the dominant coalition of individuals within the organization

the behavior) and include awareness and knowledge, social and subjective norms, attitude, self-efficacy and intention.

(2) *Enabling factors* – the external antecedents to behavior belonging to the situation and allowing new behavior to be realized; they are conditions of the environment and facilitate the performance of action. Enabling factors relate to resources (financial, technical, organizational, etc.), new knowledge and skills.

(3) *Reinforcing factors* – those consequences of an action that determine whether the actor receives positive or negative feedback and support afterward. Reinforcing factors include feedback of peer organizations, advice and feedback by experts, feedback by powerful and significant organizations (e.g., authorities offering subsidies with a stimulating purpose and enforcing obligations), and feedback of customers.

The PRECEDE-PROCEED model provides a framework to study and to find the behavior-explaining factors by surveying the target groups. It is based on the assumption that if we change the organizational and situational determinants of behavior, we eventually induce behavioral change. It also assumes that above-listed clusters of behavioral determinants and empirical study can reveal what the relevant determinants are for a specific behavior of a specific target group.

Egmond and Lulofs (2005) sketched the relationships between the various factors in Fig. 5.5. They believe that developing a policy that stimulates organizations to change their behavior depends highly on knowing the planning determinants of their behavior and on knowing what methods effectively influence those determinants to stimulate such a change. They also assume that normally most of the organization's problems or needs are routine and are solved in a routine way following standard protocols. This is what they call '*habitual behavior*'.

Bruel and Hoekstra (2005), aimed at answering how to stimulate owner-occupiers to save energy, have found that 'predisposing' and 'enabling' determinants rather than 'reinforcing' determinants are most influential on the behavior of this target group. Furthermore, they identified two different segments within the group – low-income and high-income ones – with different behavioral determinants. Low-income groups are mainly influenced by predisposing determinants, like awareness, attitude and knowledge. The higher-income groups can mainly be influenced by enabling determinants. Also, in contrast to the low-income group, policy instruments are most effective in changing the behavior of the high-income group.

Finally, Fischer (2003) considers behavior of a 'collective consumer' when the collective actions involve two or more individuals contributing to a collective effort on the basis of mutual interests and the possibility of benefits from this effort. Based on cases where those 'mutual interests' and 'benefits' consist in more sustainable patterns of electricity use, the author tries to show some problems determining the readiness to make a contribution in change of collective behavior:

- The *motivation problem* that stems from the fact that any individual electricity conservation effort will only have a marginally small effect on environmental protection;
- The *free rider problem* that exacerbates a motivation problem. People hesitate to participate either in the hope of getting a free ride, or out of fear that others might take advantage of their actions;

– The *information problem*. The individual usually neither knows the precise impact of his (her) consumption on natural resources, nor the size or regeneration rate of those resources, nor the prospective behavior of the other users (will they co-operate or not?). This lack of information makes it difficult to do an informed choice;
– The *investor – user problem.* In the situation, which involves investment, a collective action can help to overcome this dilemma allowing for communication, thus providing participants with information about others' behavior, and enabling them to combine their knowledge in order to get a better picture of the resource status and possibilities of sustainable use.

Thus, collective consumer action offers a promising potential for supporting sustainable development because it is easier for collective actors to make large contribution, and their actions may produce indirect positive effects.

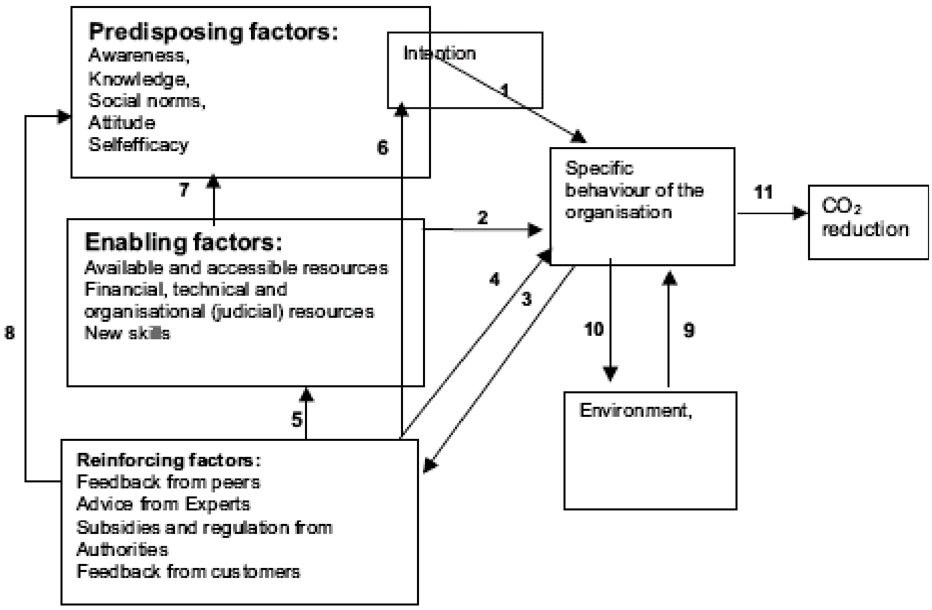


Fig. **5.5** Determinants and behavior. *Comments:* With the decision to implement the solution, an intention (arrow 1) takes root. This intention may suffice to start a new behavior, but it will not be completed unless the organization has the resources and skills to carry out the behavior. If a problem is new or does not regularly occur, then a specific search for solutions starts. After the intention to implement is made, and if no barriers occur, the actor deploys organizational resources (2) to enable the action that results in the deployment of the behavior (3) followed by an emotional, physical or social reaction to the behavior (the *reinforcing factor*) (4). Reinforcing strengthens directly the behavior as well as the search for mobilization of future resources (5) and intention (6). The availability of resources heightens the awareness and other factors predisposing the behavior (7). Similarly, rewards and feedback from behavior make it more attractive on the next occasion and today's reinforcing factor becomes predisposing factor tomorrow (8). The behavior has effect on the environment (10), e.g., investments in energy conservation can lead to its price reduction, and the environment in turn influences the behavior (9). After implementation, the actor seeks for confirmation of the decision by feedback from peers or experts (arrows 3 and 4). The change in behavior, for example in energy use, will effect CO_2 reduction (11). *Source:* Egmond and Lulofs, 2005.

5.1.3.3 Policy instruments to change behavior and consumption

Green analysts argue that sustainable economic growth requires fundamental changes in consumer lifestyles and preferences, and that consumers and communities should voluntarily adopt a low consumption lifestyle, often termed ‘voluntary simplicity’ or a policy of ‘sufficiency’. There is an increasing amount of academic literature in the last few years on the whole question of ‘sustainable consumption’, and the relationship between income levels and consumption particularly at the household level. The destruction of natural capital is often blamed on the excessive consumption of energy and resources by the world’s wealthiest countries. Because global aggregate consumption doubles every 20–25 years (Young *et al.*, 2006), the societies are urged to turn away from this ‘self-destructive path’ (Herring, 2003) and to adopt new lifestyles based on lower consumption. In 1972 the Club of Rome’s infamous report “The Limits to Growth”[9] presented some challenging scenarios for global sustainability. Turner (2008) compared these scenarios with historical data, collated for 1970–2000. The comparison showed that observed data most closely match the key features of the report’s business-as-usual scenario (so-called the ‘standard run’ scenario), which projects the collapse of the global system midway through the 21st century. Turner’s comparison is well within uncertainty bounds of nearly all the data in terms of both magnitude and the trends over time. Given the complexity of numerous feedbacks between sectors incorporated in the Club of Rome’s model, Turner considers “instructive that the historical data compare so favorably with the model output” (p. 410). The presented comparison lends support to *The Limits to Growth* conclusion that the global system is on an unsustainable trajectory unless there is substantial and rapid reduction in consumptive behavior, in combination with technological progress.

With the recent global re-emergence of sustainability on the public and political agendas, a new round of initiatives, debates and politics on environmental reforms might be faced. However, according to Spaargaren and Mol (2008), the contours and context of the agenda of such reforms are notably different from those, materialized in the 1990s – primarily shaped by and oriented at the productive sectors and their devastating unsustainability. Currently, the focus is shifting to consumption and citizen–consumers. Increasingly, people have become aware that consumption consists not just of a set of environmentally relevant practices, which involve significant resource depletion and polluting emissions; they also has come to recognize that citizens–consumers are social actors who can and have to make a difference with respect to the environment. In any ‘society of consumption’ many are unwilling or not convinced to curtail their consumption for the sake of preserving natural capital. Moreover, people often associate greater income and consumption with increased happiness and health, while there is no link between the two above a certain level. A healthy and sustainable society may be possible at relatively modest income levels. Recent studies have shown that consumers whose behavior lowers the negative impacts on the environment do not often justify their practices by environmental concerns (Fischer, 2003).

---

[9] Meadows D.H., D.L. Meadows, J. Randers, W.W. Behrens_III, 1972: *The Limits to Growth: A Report for the Club of Rome’s Project on the Predicament of Mankind,* Universe Books, New York.

Thus, in the recent upsurge of environmental concerns worldwide, sustainable consumption issues are more prominent than before on public and political agendas. But formulation of policies for the greening of lifestyles and consumption patterns is not an easy task, as consumption has become a global phenomenon and nation–states have lost their authoritative monopoly. With respect to the greening of *global consumption,* Spaargaren and Mol (2008) investigate the problem of 'environmental governance towards sustainable consumption' as a complex issue for two closely interlinking reasons: (1) we can no longer deny that globalization processes are shaping the environmental reform agendas in multiple ways, although much debate exists as to how and to what extent that is the case; (2) the role of the nation–state and national environmental politics have undergone profound changes, resulting in a loss of autonomy, power and authority. While in the early 1990s the nation–states (or their networks) have been the primary actors through which most environmental reforms took shape, this is no longer the case today. Nation–states in the global network society have to reinvent their political roles and cannot but share responsibilities for the governance of environmental flows with economic and civil-society actors, both at the local and global levels.

Spaargaren and Mol argue that, in the context of a globalizing world of networks and flows, sustainable consumption policies have to be conceived of in terms of deterritorialized politics and programs, which rely also on non-state environmental authority. In reflecting the role of citizen–consumers in politics for the greening of global consumption, the authors presented three basic concepts: ecological citizenship, political consumerism, and life-politics (Fig. 5.6).

The concept of *ecological citizenship* refers to the participation and orientation of citizens towards political discourses on sustainable development. Citizens rightly demand to be free from environmental risks inflicted on them by others, inside or outside the territory of the nation–states they belong to, and argue for environmental security in a similar vein as implied in the debates on national security. That is why the cross-border pollution and global risks are and have been for a long time at the centre of environmental politics.

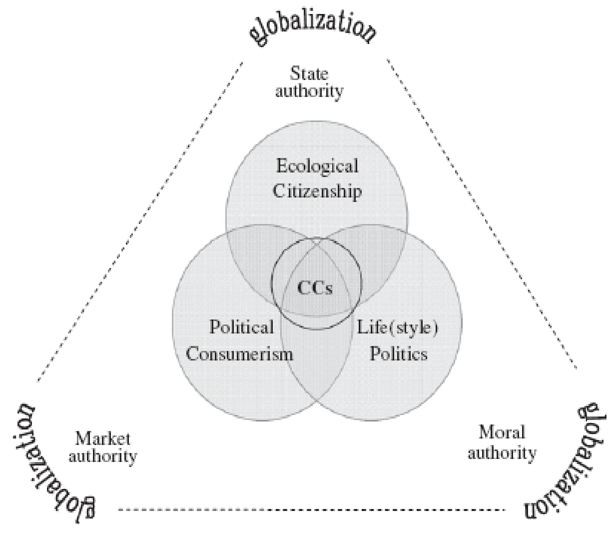


Fig. 5.6 Forms of environmental authority and corresponding roles of citizens-consumers (CCs) under conditions of globalization. *Source:* Spaargaren and Mol, 2008

Political consumerism articulates citizen–consumer authority in the private consumption domain. Although globalization does not by itself lead to a loss of power for end-users at the lower end of production–consumption chains and networks, this concept draws attention to the need for new forms of power and authority that citizen–consumers can use in the context of globalised markets.

Lifestyle politics are primarily about civil-society actors and dynamics beyond state and market. *Life-politics* are *life-world* politics and as such are directly connected to the morals and choices that are implied in ordinary consumption routines. All individuals are confronted with the impacts of globalization in a direct and concrete manner, and lifestyle politics are important for sustainable consumption policies primarily because they deal with individual affairs without disconnecting the private and the personal from the public and the global.

Spaargaren and Mol believe that exploiting these concepts for their particular strengths and weaknesses can help improve analyses of globalizing sustainable consumption and the crucial roles of differently empowered citizen–consumers in that respect.

Politicians and policy makers are very wary, however, of advocating reduced consumption as a means of limiting environmental damage. Instead they advocate mainly technical measures to reduce, for example, harmful emissions, allowing for increased economic growth driven by increasing consumption. Thus, if consumption and consequent degradation of nature cannot be curtailed through efficiency, then alternative policies are substitution or reduced consumption. The consumer receives heightened attention when it comes to environmental protection and sustainable development. Environmental psychologists have investigated consumer choice, among other types of ecologically relevant behavior, and a number of psychological factors influencing sustainable behavior have been identified.

Within the domain of the above discussed PRECEDE-PROCEED model (Green and Kreuter, 1999) a governmental policy to influence actors' behavior can be realized through certain intervention strategy using a mix of *policy instruments.* Here the model's authors distinguished four types of policies: regulatory, financial and communicative instruments, and structural provisions. Those all are broadly accepted in policy science (e.g., Bruel and Hoekstra, 2005; Egmond and Lulofs, 2005; Egmond *et al*., 2005) and in different ways influence behavior. In particular, *regulatory* instruments are mainly based in the mechanism of force; *financial* instruments are characterized by financial gain; *communicative* instruments influence behavior by persuasion and seduction, and *physical* provisions work by force and as facilitators.

Egmond *et al.* (2005) has analyzed the various instruments in terms of their influence on the determinants of behavior, identified their 'active ingredients' and presented the results in the form of the table (Table 5.1) where in the first column these four types of policies are subdivided into specific instruments.

As an example, let us consider the work of Egmond and Lulofs (2005) who analyzed, from a behavioral change viewpoint, the differences between the early and mainstream markets, and in what way the existing policy instruments differ in influencing the behavior of both markets' actors. In particular, they found:

- *Judicial instruments* prescribe behavior and set norms. Legislation creates an external motivation; new law and legislation create a norm for the desired behavior of the whole target group and consolidate the intended policy effect;
- *Economic instruments* aim usually to influence financial considerations in such a way that an organization will behave in an environmentally favorable way. They provides advantage and disadvantages as well as make environmental issues part of the economic traffic by giving them an economic value. Examples are emission trade and tax differentiation;

- *Communicative instruments* transfer knowledge for the purpose of persuasion, convincing or tempting. These instruments can also be used in combination with and to support other types of instruments;
- Some *physical provisions*, such as infra-structural provisions in the field of spatial planning, clearly influence behavior. At an individual level, behavior is influenced by *technical steering*.

Table 5.1 Instrument table of the intervention strategy to influence actors' environmental behavior: the active ingredients of matching policy instruments and determinants in the PRECEDE-PROCEED model

Policy instruments	Determinants of environmental behavior													
	Predisposing						*Enabling*				*Reinforcing*			
	Awareness	Knowledge	Social norms	Subjective norms	Attitude	Self-efficacy	External financial resources	External technical resources	External org. resources	New skills	Feedback of peer organizations	Feedback of experts	Feedback of authorities	Feedback of customers
Regulatory														
General lows and rules			2		1								1	
Specific permits			2		1								1	
Enforcement	1		2	1	2		1	1					2	
Covenants &agreements	1		1	1	2						2		1	
Financial														
Subsidy	1				1		2						1	
Levi	1				1		2						1	
Tax differentiation					1		1						1	
Financial constructions					1		2		1	1		1		
Communicative														
Information & promotion	2	1	1	1	2	1		1		2	1	1	1	1
Training		2				1		1	2	2		1		
Personal advice		2			1	2		1	2	1		1		
Demonstration	1	1			1	2		1		1	1	1		
Benchmarks	1			1							2	1		2
Physical provisions														
Infrastructure provisions	1				1	1		2	1					
Technical behavioural steering	1				1	1		2	1					

Note: Grey cells indicate that there is an effect on a determinant; a number in a cell means: *2* – a primary effect; *1* – a secondary effect. *Source:* Adapted from Egmond *et al.* (2005)

Thus, law and legislation, as policy instruments, changing a reinforcing and/or enabling factor, don't work in a one–dimensional way. Economic instruments can be considered as 'active ingredients' of policies because the perception of advantages and disadvantages of alternatives plays a major role in a decision-making process; the governmental policy prioritizes some of these alternatives. Therefore, policy instruments can influence this process in several ways: (1) by increasing the information within the organization about alternatives and the involved momentary and future costs and benefits of those alternatives; (2) by changing the costs and benefits of them; and (3) by influencing the appreciation of involved costs and benefits (Egmond and Lulofs, 2005).

Finally, and in many ways most importantly, sustainable development is defined in practice. The simple triangular relationships between the sustainability's components are of course convenient in terms of the presentation of governments' policies and ideas. But the real world is much more complicated, with a practically unlimited number of factors influencing policy making at all levels. Beyond the daily concerns facing governments and individuals there are profound movements that shape the realities of an era and permeate almost all expression of ideas and almost all activities in societies, including governments' policies (Kjellén, 2004). *"If the concept cannot be defined in practical terms, its practicability in the future is no greater than it is now"*, – George (2001, p. 96) notes. *"The complexities and contradictions in the current understanding of sustainable development,* – continues the author (*Ibid,* p. 125), – *conceal underlying tensions that must be resolved before the concept can become a reality. These include the need for economic growth to maintain the stability of an unconstrained market economy; the tendency of such an economy to depress incomes to subsistence levels somewhere in the world; the potential for economic globalization to remove the distinction between the high-income countries at the core of the international trading system and the low-income ones in its periphery; the inability of market forces to manage global public goods without enforceable global laws; the historical tendency of resource scarcity to trigger resource wars; and the tensions between belief systems that have evolved differently in different parts of the world".*

Practice includes many efforts at establishing goals, creating indicators, and asserting values. Additionally, it includes developing social movements, organizing institutions, crafting sustainability science and technology, and negotiating the grand compromise among those who are principally concerned with nature and environment, those who value economic development, and those who are dedicated to improving the human condition (Kates *et al.*, 2005; Yohe *et al.*, 2007). Researchers and practitioners in merging fields, such as *sustainomics* (Munasinghe, 2003) or *multiple-criteria decision making* (Holz *et al.*, 2006) seek to increase our understanding of how societies can do just that.

5.1.4 Regional versus global

Experience makes it clear that both the ends and the means of sustainable development need to be tailored or tuned to the context of particular places. This is, in part, because the basic ecological, climatic, and social structures that define sustainability needs and opportunities vary from place to place (Clark, 2005). It is also partly because some of the greatest threats to sustainability derive from "multiple, cumulative, and interactive stresses" (NRC, 1999, p. 8) that intersect in particular ways in particular places.

Clearly, socio-ecological systems can be interpreted as hierarchical systems, made up of some combination of international, regional, national, subnational, and local systems. This hierarchy of levels is not arbitrary, since established institutional relations are visible at each of the levels. Moreover, spatial scales are often intimately connected with the temporal – a fact long established by basic research on hierarchical systems (Young *et al.*, 2006). Nevertheless, the debate as to how sustainable development can be achieved is mainly focused on three levels of the geographical scale. At an *international level*, organizations such as the World Commission on Environment and Development (WCED, 1987), UNEP or UNDP have warned of global pressures such as rising population, poverty and environmental degradation, etc. At a *national level*, many countries create their own sustainable development policies and strategies in response to international demands. The importance of introducing sustainable development *at local level* is reflected in Chapter 28 of Agenda 21, which deals with the introduction of Local Agenda 21 initiatives by local communities; this activity has resulted in most local authorities formulating their own plans and strategies. A level that appeared to some authors (e.g., Shearlock *et al.*, 2000) as missing from this debate – '*missing middles'* in Khagram *et al.* (2003) terminology – was that of sustainable development at a regional level, although it has become increasingly clear that much of the interaction between nature and society, most significant for sustainable development, occurs namely here. Khagram *et al.* (p. 290) argue that threats to and opportunities for sustainable development "do not emerge primarily at global or local levels, but at intermediate scales where both broader trends and the particularities of place come together. Similarly, sustainability is most often achieved by actions that address immediate challenges, while focusing on longer-term goals through a series of intermediate range 'sustainability' transitions". However, in the opinion of other authors (Shaw and Kidd, 2001), the 1990s witnessed a re-emergence of regional level planning and governance, in addition to the emergence of sustainability. This trend has been underpinned by a number of factors, with sustainability considerations also featured in the background. Thus, it is now widely accepted that to achieve a more sustainable world the actions are required at a variety of spatial and governmental levels.

Many reasons point to the importance of a relatively ***local scale***. In particular, Wilbanks (2003) argue that process relationships are often too complex to be described at a larger scale, too difficult to keep grounded in direct observations, and too likely to be separated from actual experience. The great variety of circumstances at a more local scale offers an opportunity for learning more about causes, consequences, and alternative strategies. Additionally, many of the problems and solutions being addressed by Agenda 21 have their roots in local activities, and the participation and co-operation of local authorities will be a determining factor in fulfilling its objectives. Local authorities construct, operate and maintain economic, social and environmental infrastructure, oversee planning processes, establish local environmental policies and regulations, and assist in implementing national and subnational environmental policies. As the level of governance closest to the people, they play a vital role in educating, mobilizing and responding to the public to promote sustainable development (Devuyst, 2000).

A ***regionalization*** is increasingly perceived as having an important role in the broad debate on how best to approach sustainable development. This focus is justified (1) by the function of regions as intermediaries between national and local levels, and (2) by the growing consensus that sustainability will become an essential criterion in future regional development (Clement, 2005). With this new perspective, the immediate challenge facing policy-makers is how the concept of sustainable development can be applied productively at the regional level, securing an appropriate balance between environmental, social and economic factors. Yin et al. (2000, p. 22) broadly defined regional sustainable development as "…the long-term use of regional resources which is economically viable, socially desirable, and environmentally non-degrading". This term encompasses all activities and instruments that promote sustainable development within regional economic initiatives, from new forms of partnership and stakeholder involvement to innovative planning and integration methodologies (Clement, 2005). In practice, regional sustainable development assumes different forms both among and within countries, with various approaches and distinctive features, time scales, tools and techniques. Looking at current European practices, a number of scenarios are already apparent, varying by country and regional priorities.

Devine-Wright *et al.* (2001) made three core assumptions on regional effectiveness in implementing sustainable development initiatives, the first two of which are common ingredients of a sustainability approach:

- Implementing sustainable development involves diverging from the 'business as usual' scenario. It is assumed that sustainable development involves innovation, changes in behavior, perceptions, procedures, organizations, technologies, and so on.
- Implementing sustainable development is not possible by any one single individual or organization. Instead, it is necessary for individuals and organizations to effectively work together in identifying and achieving change.
- Implementing sustainable development, from a regional perspective, can benefit from a systems view of the flows of information and resources within networks of interacting individuals, organizations and institutions.

Based on these assumptions, Devine-Wright and co-authors analyzed the role of networks in facilitating the uptake and adoption of innovative sustainable development practices, considering the regions as social systems. In the list of theoretical approaches to networking and innovation they included theories of social capital, innovations systems and actor networks. In common, these theoretical approaches offer systemic views that are useful in conceptualizing the way in which regional sustainable development takes place. The idea that sustainable development requires an *integrated consensual approach* by relevant stakeholders is now accepted wisdom within sustainable development policy-makers and practitioners. No local authority, for example, can achieve sustainable development on its own and requires an integrated effort between all stakeholders, that is, the network of individuals, communities and organizations that make up a location, region or nation.

However, the world has been changed dramatically since the closing years of the 20th century, with the end of the Cold War and dramatic increases in global flows of private capital and information. Information and telecommunication revolutions helped create a more interconnected and interdependent world where international trade, private investment and financing are dominant forces, growing faster than national economies. This new situation, referred to as ***globalization***, has become a dominant socioeconomic process affecting every country and integrating not just the economy but also culture, technology, and governance. The planet is moving in such a way that disparate divisions, which always separated human beings over the World, are finally disappearing (Tong *et al.*, 2002; UNDP, 2002). *"Globalization has fundamentally altered the world economy, creating winners and losers. Reducing inequalities, both within and between countries, and building a more inclusive globalization is the most important development challenge* *of our time"*, – Kemal Dervis, UNDP Administrator, is forced to acknowledge (UNDP, 2007b, p. 2).

Although there are no simple – much less generic – indicators of globalization, there is widespread agreement that globalization is a defining feature of our times, and the problem of its 'measurement' cannot be solved in general terms. But some initial observations about the basic character and scope of globalization will help to set the stage for an analysis of the links between globalization and socio-ecological resilience and vulnerability. In the opinion of Young and co-authors (2006), the current wave of globalization is characterized by a combination of magnitude, spatial reach, and pace that has no counterpart in the history of the planet where one can observe four generic features that stand out prominently—changes in connectedness, speed, scale, and diversity.

With its new challenges and risks, as well as with the new opportunities it offers, globalization is neither inherently good nor bad. Rather, it is a phenomenon that humanity can and must influence with a key challenge to learn and use it to generate more equitable and sustainable outcomes.

On the one hand, globalization is shaping a new era of interaction among nations, economies and people, offering great opportunities for human development. Entailing deregulated trade and foreign investments and increasing the contacts between people across national boundaries, globalization generates new wealth and rapid technological improvements, offering unparalleled opportunities to fuel economic growth and advance human and sustainable development.

On the other hand, globalization is fragmenting production processes, labor markets, political entities and societies. It is likely to exacerbate the rich-poor gap and has considerable impact on the poor. The gains from global growth are being highly unequally distributed, and the benefits of growth are not reaching large parts of the population. It has been found that about four-fifths of humanity must get by with only 20 per cent of global GDP. The richest two percent of the world's adult population owns more than half of global household wealth; the bottom 50 percent of adults own barely one percent. In 2007, over a billion people had almost no income – the equivalent to a dollar a day or less per person (UNDP, 2007b). Globalization can further undermine the welfare through worldwide competition, technological innovation leading to product or commodity obsolescence, and damaging subsidies in the agricultural markets of developed nations. Globalization creates new threats to human security (e.g., financial volatility, political and cultural insecurity, and environmental degradation) because the wider the gaps grow the more difficult it will be to close them. Addressing today's inequalities is the most important development challenge of the 21 century.

Thus, along the positive, innovative and dynamic aspects, globalization also has negative, disruptive, marginalizing aspects (Table 5.2).

The pressure of the modern civilization and population growth on the global environment, which cannot be neglected much longer, is one more challenge of globalization processes (Millennium assessment, 2005). There is no doubt that the environment is part of the concerns surrounding globalization. The additional economic growth, created by globalization of markets, has to be made compatible with the requirements of the earth system functioning in terms of climate, biodiversity, etc. An important challenge to policy formation today is to give these new concerns their proper place in relation to other, more established policy objectives, for example, the traditional responsibility of the governments for maintaining economic and social sustainability (Kjellén, 2004). Globalization adds complexity to the management of common-pool resources because increased interdependence makes it more difficult to find equitable solutions to development problems.

Table 5.2 Potential impact of globalization on human society

Benefits	*Threats*
Great opportunity for human advance (e.g., new technologies, increased foreign trade, expanding Internet links)	Financial volatility (e.g., the economic crisis in East Asia investments between 1997 and 1999)
More commitment to a global community (e.g., global markets, ideas, technology, growing interdependence of people's lives)	Socio-cultural insecurity (e.g., greater insecurity in jobs & incomes, depressed indigenous cultures)
Greater global cooperation & action (e.g., global convention against environmental degradation)	Health & environmental insecurity (e.g., environmental degradation & epidemic spreading such as HIV/AIDS)

Source: Tong *et al.*, 2002

Tong *et al.* (2002) highlighted two categories of global environmental issues: those involving the global commons and those of worldwide importance, but not directly involving the global commons (Table 5.3). Global commons issues, involving major components of the earth system, such as the atmosphere, climate, oceans, and so on, can be effectively addressed only if all societies are involved. Bezanson (2004) sees three significant clusters of opportunities that can be considered as a possible start on this path: (1) the trend towards increasing recognition and acceptance of a global interdependence that goes beyond the economic factors of globalization; (2) the rise of local initiatives as people and communities around the world demand more control over their lives; and (3) the growing realization of the importance of knowledge and innovation.

Table 5.3 Characteristics of global environmental issues

Category	*Features*	*Consequences*	*Mitigation*
Global commons: Climate change Ozone depletion Marine pollution	Release into the environment and cause global changes in the biophysical systems	Substantial impacts on economy and human health	Accomplished only through coordinated actions among nations
Worldwide importance: Loss of biodiversity Freshwater depletion Ecosystem degradation	These local/regional problems grow in scope and scale	Serious cumulative impacts on the life-support system	Addressed on a regional basis, but multilateral agreements often required

Source: Tong *et al.*, 2002

Thus, societies are interested in the consequences of globalization for the structural characteristics of socio-ecological systems at various scales, clearly distinguishing between global social change and global environmental change; consideration of the interactions between the two generates what can be called 'a truly new systemic phenomenon' (Young *et al.*, 2006). In particular, globalization increases the mobility of economic and political power, both upwards (toward new global centers) and downwards (toward increasingly specialized nodes in global networks). In turn, global environmental change could be systemic (e.g., climate change) or cumulative (e.g., aggregate loss of biological diversity), but "what is more, the large-scale environmental changes that mark the present era are increasingly anthropogenic in origin" (*ibid,* p. 307).

5.1.5 Sustainability assessment

5.1.5.1 Clarifying the problem

This section focuses on some methodological developments in the research on sustainable development (sustainability) assessment. If in conventional decision-making the trade-offs between narrowly biophysical or ecological considerations and competing social and economic objectives may be made outside the assessment framework, then in a sustainability assessment all policy commitments and development goals are considered together, and trade-offs – addressed directly. The past few years have brought numerous sustainability assessment initiatives in various forms and under various titles, applied at different levels and in various combinations of actors (Cherp *et al.*, 2004; Clive, 2001; Devuyst, 2000; Gibson, 2006a, b; Rotmans, 2006; *etc.*). Nevertheless, Hacking and Guthrie (2007) note that there is little consensus regarding the meaning of sustainability assessment, and a number of various terms are used in the literature to define it. Furthermore, some planning and/or decision-support techniques, which are used, are not labeled as 'assessment' but achieve similar outcomes, being the assessment techniques used in practice.

Devuyst (2000, p. 68) defines ***sustainable development assessment*** *(SDA)* as "…a formal process of identifying, predicting and evaluating the potential impacts of a wide range of relevant initiatives (such as legislation, regulations, policies, plans, programmes and specific projects) and their alternatives on the sustainable development of society". Thus, by its basic nature, SDA involves the evaluation of multiple policy objectives. This process is lightened by the fact that although sustainable development as an essentially contested notion is defined in many ways, there are a number of commonalities, even in diverging interpretations, upon which the notion of sustainable development can be implemented in practice. These commonalities lie in attempts to integrate the broad range of developmental, environmental and social dimensions in a short- and long-term timeframe (Halsnaes and Markandya, 2002; Rotmans, 2006). The overall challenge is to make the tensions between different levels and dimensions explicit and to develop policy strategies to alleviate them. SDAs are especially important at the sub-national and project levels.

Gibson (2006a, p. 172) distinguished *four major components* in the direct translation of basic consensus on sustainability into implications for sustainability assessment. In his opinion, the processes of a sustainability assessment must:

Table 5.4 Core generic criteria for sustainability assessments

Criterion	*Requirement*
Socio-ecological system integrity	Build the human–ecological relations to establish and maintain the long-term integrity of socio-biophysical systems and protect the irreplaceable life support functions upon which human and ecological well-being depends
Livelihood sufficiency and opportunity	Ensure that everyone and every community has enough for a decent life and that everyone has opportunities to seek improvements in ways that do not compromise future generations' possibilities for sufficiency and opportunity
Intragenerational equity	Ensure that sufficiency and effective choices for all are pursued in ways that reduce dangerous gaps in sufficiency and opportunities (in health, security, social recognition, political influence, and so on) between the rich and the poor
Intergenerational equity	Favour present options and actions that are most likely to preserve or enhance the opportunities and capabilities of future generations to live sustainably
Resource maintenance and efficiency	Provide a larger base for ensuring sustainable livelihoods for all, while reducing threats to the long-term integrity of socio-ecological systems by reducing extractive damage, avoiding waste and cutting overall material and energy use per unit of benefit
Socio-ecological civility and democratic governance	Build the capacity, motivation and habitual inclination of individuals, communities and other collective decision-making bodies to apply sustainability requirements through more open and better informed deliberations, greater attention to fostering reciprocal awareness and collective responsibility, and more integrated use of administrative, market, customary and personal decision-making practices
Precaution and adaptation	Respect uncertainty, avoid even poorly understood risks of serious or irreversible damage to the foundations for sustainability, plan to learn, design for surprise, and manage for adaptation
Immediate and long term integration	Apply all principles of sustainability at once, seeking mutually supportive benefits and multiple gains

Source: Adapter from Gibson (2006a)

1. Force the decision-makers to give serious primary attention to sustainability requirements in their potentially significant initiatives. For this, the processes must (a) apply decision criteria, which establish meeting the core requirements for progress to sustainability as the main test of proposed purposes, options, designs and practices, and (b) put the application of sustainably-based criteria at the centre of decision-making, not only considering this as one advisory contribution among many.
2. Recognize seriously the interdependencies and seek for multiple reinforcing gains, assisted by setting a comprehensive agenda that covers the full suite of core requirements for moving towards sustainability. It is also crucial to establish a firm guidance for trade-off decisions to ensure that sacrifices are made only where there is no viable 'less bad' alternative.
3. Provide the means to specify the sustainability decision criteria and trade-off rules for specific contexts through informed choices by the relevant parties/stakeholders.
4. Apply these insights in the following elements of SDA process:
   - identifying appropriate purposes and options for new or continuing undertakings;

- assessing purposes, options, impacts, mitigation, enhancement possibilities, and so on;
- choosing (or advising decision-makers on) what should or should not be approved and done, and under what conditions;
- monitoring, learning from the results and making suitable adjustments through implementation to decommissioning or renewal.

A range of basic sustainability requirements or generic criteria that help to measure progress or make choice should be considered in a sustainably-oriented decision-making process. The list of such core obligations, proposed by Gibson (2006a), is shown in Table 5.4.

In response to the need for improved methods for SDA, in 1996 the International Institute for Sustainable Development *(IISD)*[10] brought together an international group of researchers and practitioners to review progress and synthesize insights from relevant efforts. This meeting that took place in Bellagio, Italy, resulted in the so-called *Bellagio Principles for Assessment toward Sustainable Development* (Box 5.2). These principles are an important basis for any attempt to assess sustainability (Hardi and Zdan, 1997). Some existing tools for SDA, with reference to local authorities, can be found in Devuyst (2000).

5.1.5.2 Integrated sustainability assessment

Many approaches to sustainability oriented assessments, from the project to strategic levels, have been started by separate addressing the social, economic and ecological considerations, interests and initiatives of sustainable development, and then have struggled with how to integrate these separate findings. The problem was generally exacerbated by the corresponding division of governmental mandates between these individual bodies, by the separated collection of data and training of experts in the three fields. Sometimes, the combined effect was not in the mere absence of integrative expertise, data and authority, but in an entrenched tendency to neglect the interdependence of these fields (Gibson, 2006b). The need of *Integrated Sustainability Assessments* (ISA) to support the development of integrated policies is a challenge not only for policy- and decision-makers but also for science (Halsnaes and Markandya, 2002; Rotmans, 2006). Here, the integrated assessment methods are desirable to obtain a scientific understanding of sustainable development and climate change interactions, playing a key role in analyzing the powerful sectoral and macroeconomic adjustment policies having widespread effects throughout the economy (Munasinghe, 2003).

Rotmans (2006, p. 38-39) proposes to consider the *Integrated Assessment* as "…the science that deals with an integrated systems approach to complex societal problems embedded in a process-based context". Simultaneously, in his opinion, ISA is closely related to Sustainability Impact Assessment (SIA): while the latter is focused on the short-term and very practical issues, the prior is a broader, explorative, forward-looking and long-term oriented issue. The two are positively correlated and should go hand in hand. The requirements, which sustainable development demands from the next generation of ISA tools and instruments, can be captured by means of the so-called *"Triple-I"* approach: innovative, integrated and interactive. Rotmans explains necessity of such an approach as follows:

[10] See: *http://www.iisd.org/*

Box 5.2 The Bellagio Principles for Assessment toward Sustainable Development

Principle 1: Guiding Vision and Goals

Assessment of progress toward sustainable development should:

- be guided by a clear vision of sustainable development and goals that define that vision.

Principle 2: Holistic Perspective

Assessment of progress towards sustainable development should:

- include review of the whole system as well as its parts
- consider the well-being of social, ecological, and economic sub-systems, their state as well as the direction and the rate of change on that state, of their component parts, and the interaction between parts
- consider both positive and negative consequences of human activity in a way that reflects the costs and benefits for human and ecological systems in monetary and non-monetary terms

Principle 3: Essential Elements

Assessment of progress towards sustainable development should:

- consider equity and disparity within the current population and between present and future generations, dealing with such concerns as resource use, over-consumption and poverty, human rights, and access to services
- consider the ecological conditions on which life depends
- consider economical development and other, non-market activities that contribute to human/social well-being

Principle 4: Adequate Scope

Assessment of progress towards sustainable development should:

- adopt a time horizon long enough to capture both human and ecosystem time scales, thus responding to the needs of future generations as well as those current short-time decision-making requirements
- define the space of study large enough to include not only local but also long-distance impacts on people and ecosystems
- build on historic and current conditions to anticipate future conditions – where we want to go, where we could go

Principle 5: Practical focus

Assessment of progress towards sustainable development should be based on:

- an explicit set of categories or an organizing framework that links vision and goals to indicators and assessment criteria
- a limited number of key issues for analysis
- a limited number of indicators or indicator combinations to provide a clear signal of progress
- standardizing measurement wherever possible to permit comparisons
- comparing indicator values to targets, reference values, ranges, thresholds, or directions of trends, as appropriate

Principle 6: Openness

Assessment of progress towards sustainable development should:

- make the methods and data that are used accessible to all
- make explicit all judgments, assumption, and uncertainties in data and interpretations

Principle 7: Effective Communication

Assessment of progress towards sustainable development should:

- be designed to address the needs of the audience and the set of users
- draw from indicators and other tools that are stimulating and serve to engage decision-makers
- aim, from the outset, the simplicity of structure and use of clear and plain language

Principle 8: Broad Participation

Assessment of progress towards sustainable development should:

- obtain broad representation of key grass-roots, professional, technical, and social groups, including youth, women, and indigenous people – to ensure recognition of diverse and changing values
- ensure participation of decision-makers to ensure a firm link to adopted policies and resulting action

Principle 9: Ongoing Assessment

Assessment of progress towards sustainable development should:

- develop a capacity for repeated measurements to determine trends
- be iterative, adaptive, and responsive to change and uncertainty because systems are complex and change frequently
- adjust goals, frameworks, and indicators as new insights are gained
- promote development of collective leaning and feedback to decision-making.

Principle 10: Institutional Capacity

Continuity of assessing progress towards sustainable development should be assured by:

- clearly assigning responsibility and providing ongoing support in the decision-making process
- providing institutional capacity for data collection, maintenance, and documentation
- supporting development of local assessment capacity.

Source: Hardi and Zdan, 1997

I*nnovative* – because the paradigmatic basis of these models will be different, following the new evolutionary paradigm, and more oriented towards the dynamic behavior of individual and collective actors, explicitly incorporated into the IA tools. The new paradigm involves inter- and trans-disciplinary system innovation and transition, adaptation and social learning processes, and complexity principles as self-organizing behavior, chaotic behavior and emergent processes.

I*ntegrated* – because of the better integration of different strands of knowledge at different spatial and functional scale levels, and the integration of quantitative and qualitative knowledge.

I*nteractive* – because the influence and role of stakeholders becomes more important and manifests itself in both the conceptual and implementation phases of the ISA tools, but also in the use of these tools, realizing that multiple stakeholders perceive a problem from different perspectives and therefore act differently, which needs to be reflected in the ISA tools and instruments.

Gibson (2006b) proposed a second possible solution to take sustainability as an essentially integrative concept and to design sustainability assessment as an integrative process. His solution would entail a package of regime and process design features, centered upon ones that:

- build the sustainability assessment into a larger overall governance regime designed to respect interconnections among issues, objectives, actions and effects though the full interrelated set of activities from broad agenda setting to results monitoring and response;
- design assessment processes with an iterative conception-to-resurrection agenda, aiming to maximize multiple, reinforcing net benefits through selection, design and adaptive implementation of the most desirable option for every significant undertaking strategic or project level;
- redefine the driving objectives and consequent evaluation and decision criteria to avoid the three conventional categories, to ensure attention to usually neglected sustainability requirements, and to focus attention on the achievement of multiple, mutually reinforcing gains;
- establish explicit basic rules that discourage trade-offs to the extent possible while guiding the decision-making on those that are unavoidable;
- provide means of combining, specifying and complementing these generic criteria and trade-off rules with attention to case- and context-specific concerns, objectives, priorities and possibilities;
- provide integrative, sustainability-centered guidance, methods and tools to help meeting the key practical demands of assessment work, including identifying the key cross-cutting issues and linkages among factors, judging the significance of predicted effects and weighing overall options and implications;
- ensure that the decision-making process facilitates public scrutiny and encourages effective public participation.

Hacking and Guthrie (2007), in their comparison of assessment and para-assessment approaches, consider integration as one feature of the sustainability assessment process. They argue that features of assessment processes are more important than their formal labeling. To support this idea, these authors identified key features, which are typically associated with SD-directed[11] forms of assessment, and then compiled them into three main categories, proceeding from the degree to which:

1. Sustainable development themes are mainly covered – *comprehensiveness*;
2. The assessment techniques that are used and/or the themes that are covered are aligned/connected/compared/combined – *integratedness*;
3. The focus/perspective is broad and forward-looking – *strategicness*.

The *features* reflect the overall effect of the assessment context and process; the *categories* form the axes of a three-dimensional space within which the various forms of assessment can be located (Fig. 5.7). The resulting framework allows comparing the assessment approaches by considering the features they encompass rather than the terminology used. In other words, 'unpacking' the features according to the axes enables comparison of the assessment options on the basis of their substance rather than semantics that is especially helpful in a field where the use of terminology is inconsistent and, sometimes, confusing.

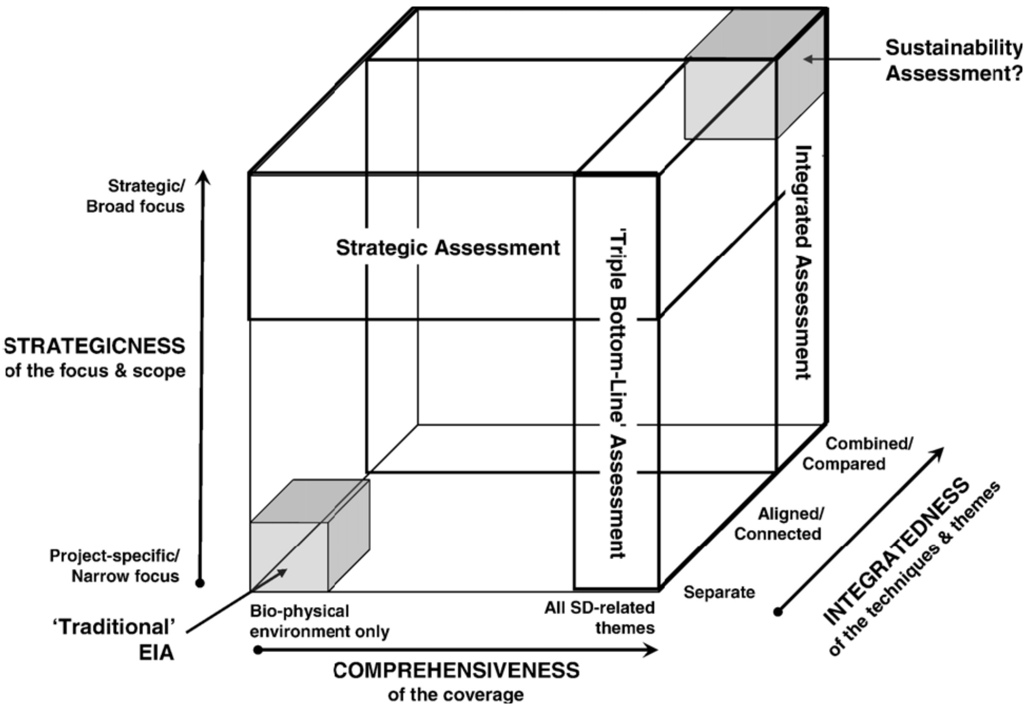


Fig. 5.7 Spectrum of SD-directed features within the assessment process. *Source:* Hacking and Guthrie, 2007

[11] Hacking and Guthrie (2007) used the term 'SD-directed assessment' only for the sake of brevity instead of 'assessment that contributes to directing the planning and decision-making process towards achieving sustainable development'.

Fig. 5.7 disposes the relative positions of three techniques – Strategic Assessment, ‘Triple Bottom-Line’ (biophysical, social, economic dimensions) Assessment, and Integrated Assessment – having certain inconsistency in their use in literature. For example, whereas Sustainability Assessment/Appraisal is sometimes used to refer to specialized forms of Strategic Assessment, which only encompass features in the most ‘advanced’ corner of the framework, Hacking and Guthrie (2007) prefer to use this term to refer to the spectrum covered by the overall framework. Integrated Assessment is also a necessary but not sufficient condition for Sustainability Assessment.

The features encompassed by each axis are outlined as follows[12]:

Comprehensiveness aims at extending the sustainable development coverage beyond the purely biophysical (‘zero’ corner of the framework). ‘Non-biophysical’ themes may be motivated by different stimuli, for example, by understanding that the biophysical environment cannot be successfully managed independently from social and economic matters and/or by increasing awareness that the coverage of assessments should correspond to these three principal pillars of sustainable development.

Integratedness within assessments can include the integration of the assessment techniques, e.g., EIA and SIA, and/or the integration of the assessed themes, e.g., biophysical and social. Fig. 5.8 illustrates the interconnection between the two integrations.

As is well known, the practitioners have endeavored to separate out and elevate the theme(s) of importance to their discipline. Such ‘preferences’ result in the establishment of *thematically-focused* forms of assessment, for example, Social Impact Assessment for social scientists or Environmental Impact Assessment for a natural field. It is also possible to extend the thematic coverage by using theme or discipline-specific techniques in parallel, without much interaction between them when interconnected phenomena are presented as discrete[13]. However, for example, as we already have quoted, “…to draw together economic, social and [biophysical] objectives into a

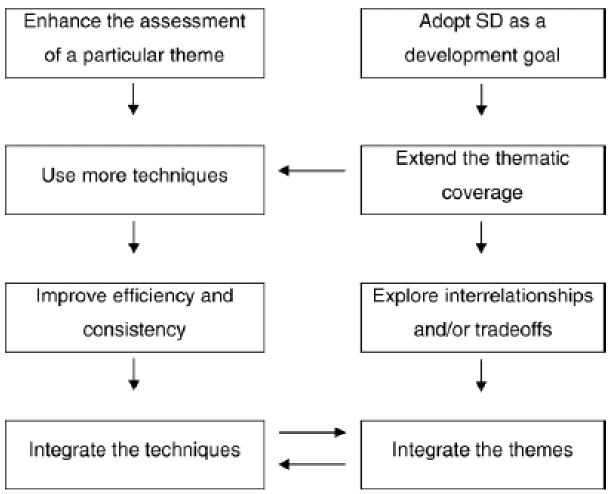


Fig. 5.8 Interconnection between technique and theme integrations. *Source:* Hacking and Guthrie, 2007

[12] In the source (Hacking and Guthrie, 2007) this outline is followed by relative references to the used literature that are omitted in our narration

[13] For example, because in practice, for the purpose of development planning, it is difficult to deal with the concept of sustainability in its entirety, Magalhies (1998) proposed to split it into at least four dimensions: social, economic, environmental, and political. An assessment of each dimension must be made before a comprehensive assessment is done. Also here, the planner and the decision-maker will have to make choices

single list does not integrate them" (George, 2001, p. 99). The recognition that these systems are interconnected leads to the conclusion that the pursuit of sustainable development requires considering all linkages and interdependencies. As a result, integration of the sub-themes within a theme (e.g., land, water, air, etc.) is usually attempted and sometimes is mandatory.

Integration between major themes is more challenging. Although theme integration can drive technique integration, they are not the same. As shown in Fig. 5.8, the technique integration can be pursued without the former being an independent objective.

Strategicness of the focus refers to the features that characterize the degree of 'emphasis on strategy' within assessment at any level. In other words, strategicness should be determined by the features of the assessment rather than the level at which it is initiated (Hacking and Guthrie, 2007). The key features that usually determine the *strategicness* are: the explicit goal, the 'benchmark' used, the spatial and temporal coverage, and the extent to which alternatives, cumulative impacts and uncertainty are considered.

In particular, widening the spatial and temporal coverage is the most tangible way of broadening the focus of assessments and is strongly promoted. "Assessment of progress towards sustainable development should adopt a time horizon long enough to capture both human and ecosystem time scales, thus responding to the needs of future generations as well as those current short-term decision-making requirements, and define the space of study large enough to include not only local but also long distance impacts on people and ecosystems" (Hardi and Zdan, 1997, p. 2). Really, sustainability assessment should focus on the long term where ecological, social and economic imperatives tend to coincide. In practice, however, the short term imperatives that are driven by powerful economic and political interests are difficult to resist. Therefore, an assessment will be helpful only if the sustainability criterion is imposed in ways that stress the long term and prevent ecological sacrifices for a short-term gain.

It is also argued that *uncertainty* is an inevitable and inherent feature of SD-directed assessment and, in many respects, is the 'price that must be paid' for improving the assessments (Hacking and Guthrie, 2007). An increase in uncertainty is associated with wider thematic coverage, longer timescales, greater use of participatory and interdisciplinary techniques, and so on. Sometimes, the level of uncertainty drives the focus of assessment. Munasinghe (2003), linking climate change and sustainable development, shows that if material growth is the main issue, and relevant data are available, while *uncertainty* is not a serious problem, the focus is more likely to be on optimizing economic output, subject to (secondary) constraints to ensure social and environmental sustainability. Alternatively, "…if sustainability is the primary objective, conditions are chaotic, and data are rather weak, then the emphasis would be on paths which are economically, socially and environmentally durable or resilient, but not necessarily growth optimizing" (p. 89).

5.1.5.3 Sustainability planning appraisal

Planning for sustainable development has turned out to be a complex problem. Magalhies (1998) saw the first cause of this in the necessity for the decision-makers, involved in the process, to agree on their understanding of sustainable development. Further, politicians and decision-makers talking about sustainable development won't always change their mindset and practices. Sustainable development also involves the need for conciliation and conflict resolution as well as for political sustainability as a requirement in the planning process.

The concept of sustainability appraisal of policies, plans and programs has grown out of the Rio commitments (UNCED, 1992) where it was agreed that each government should adopt a national sustainable development strategy (NSDS) aimed at the implementation of Agenda 21. This document in Chapter 8 calls on governments to "review the status of the planning and management system and, where appropriate, modify and strengthen procedures so as to facilitate the integrated consideration of social, economic and environmental issues". The World Summit on Sustainable Development (UN, 2002) reiterated this requirement. *"The purpose of integrating the three spheres is to reconcile potential conflicts between them…Any objectives that define sustainable development must reconcile potential conflicts between social, economic and environmental goals"*, – Clive argues (2001, p. 96). Although there is no single, universally applicable methodology for sustainability appraisal, he also generalized two visions of this question:

(i) In the type of activity where the main focus of the appraisal is an environmental assessment the term *sustainability appraisal* is often referred to Sustainability Impact Assessment (SIA) – shorthand for saying that impacts in all three spheres of sustainable development are evaluated. The prime aim of such an appraisal is to identify mitigation measures through which adverse impacts might be minimized or avoided.

(ii) If a planning system has to adopt the concept of sustainable development, those goals should be comprehensive, and the appraisal has to evaluate the proposal against its own objectives. In this case, the appraisal is no longer an evaluation of unplanned impacts, but of planned ones. In other words, sustainability appraisal is then an evaluation of the plan in relation to its own objectives for sustainable development, in contrast to point (i) that does not necessarily mean that the appraisal evaluates a proposal against sustainable development objectives.

Thus, sustainability appraisal, as an iterative process undertaken during the preparation of a plan or strategy, requires "…to report on the extent to which the plan or strategy would achieve sustainable development" (Clive 2001, p. 96). This is consistent with a fairly common view that planning and policy-making should 'work towards sustainability'.

In a general methodological framework for sustainable development planning Magalhies (1998) involved two parallel and interconnected processes: *technical,* with the participation of experts and planners, and *participatory*, with involvement of stakeholders. In the initial process of participation a negotiation is necessary in order to create the constituency that will make the planning process feasible itself. During the negotiation process, the general framework methodology of planning is being developed that involves seven tasks (Box 5.3).

A common feature of the various sets of principles of *National Sustainable Development Strategies* (NSDS), which were used, e.g., by OECD (2001), is that they combine principles for sustainable development with principles for sound strategic planning and management. Cherp *et al.* (2004) proposed a methodology for assessing a country's progress in implementing effective strategic planning processes for sustainable

Box 5.3 Tasks of a general methodological framework for sustainable development planning

1. Assessment of the present state of sustainability in the region, including the economic, social, environmental, political and global dimensions. This requires the collection and organization of data, identification of key indicators of sustainability and their calculation.
2. Assessment of present vulnerability, with regard to the outcome of Task 1; identification of vulnerable social groups, activities, and ecosystems; assessment of environmental and social impacts, for instance, with regard to present climate variability.
3. Assessment of lessons from present and past development policies and their social and environmental impacts; what are the conditions for a policy to be effective and politically sustainable; analysis of replicability of the successful policies.
4. Assessment of future sustainability, based on trends and expert advice with regard to a business-as-usual scenario that should be designed for the time frame, at least, of one generation with some intermediate points.
5. Assessment of vulnerability for the future business-as-usual scenario. In order to assess this task in the conditions of climate change, two future scenarios must be designed: the first, assuming no global change; the second, assuming global environmental change and, particularly, climate change. The impact of future climate change must be assessed.
6. Construction of a desired scenario, based on a comprehensive process of stakeholder participation. The outcome of this exercise is a scenario of the future that is desired by the present society.
7. Design of a sustainable development strategy aiming at changing the path of the business-as-usual scenario towards the desired scenario through comparison between the present situation, the business-as-usual scenario and the desired scenario, plus the assessment of vulnerability in the present and in the future together with lessons from societal policies.

Source: Magalhies, 1998

development intended to be of particular assistance to developing and transition countries. These authors identified the core principles, which can be used for assessing NSDSs.

In particular, sustainable development emphasizes two key principles: (1) integration of economic, social, and environmental objectives; and (2) wide participation of stakeholders in the development process; the concept of strategic planning was summarized by Cherp and co-authors in three general principles:

- Country ownership and commitment implying that the planning processes and targets should be based on a country's own perception of what constitutes its national strategy for sustainable development;
- Comprehensive and coordinated policy process that means: (1) an effective strategy must be based on reliable information and drawn on valid analyses of the likely outcomes of chosen strategy options; (2) NSDSs should not be seen as separate planning processes, but rather represent the adaptation of existing processes, where this is necessary, to comply with sustainable development principles; (3) an effective strategic planning process should allocate specific means and responsibilities to the most appropriate bodies at the national, regional, or local levels;
- Targeting, resourcing, and monitoring that is concerned with the measurement and monitoring of development outcomes.

Cherp *et al.* (2004) also defined the purpose of the assessment methodology as to measure the degree to which a national process of strategic planning for sustainable development adheres to five afore-mentioned core principles. The proposed approach consists of the set of assessment criteria for each of the five principles that, taken together, provide the basis for the assessment of a particular principle. To serve this purpose, the criteria satisfy, as far as possible, the following requirements (Lee *et al.*, 1999)[14]:

(1) A limited number of criteria should be applied to each principle to provide a process that is workable, timely, and cost-effective.
(2) Each criterion should be well defined and framed in a way that allows a qualitative assessment of implementation to be made.
(3) Each criterion should deal with a distinct aspect of the principle, different from the aspects assessed by other criteria.
(4) Each criterion should be considered sufficiently important to merit influencing the overall assessment of the relevant principle.
(5) Each criterion should be useable by assessors who may not possess specialist expertise in strategic planning, but who are familiar with the current issues and policy debate on strategic planning for sustainable development in the national context.

Four key assessment criteria have been selected for each of these principles, based on a comprehensive analysis of the suite of information sources relating to strategic planning and sustainable development (Table 5.5).

The criteria in Table 5.5 provide the basis for the qualitative assessment of NSDSs. The outcome of criteria application should provide policymakers and other interested parties with a clear indication of the effectiveness of a planning process and allow identification of the areas where improvement is needed. Moreover, the cited authors proposed a qualitative scoring scheme for indicating the extent to which each criterion has been met:

A all of the criterion requirements are fully met;
B all the criterion requirements are satisfactorily met, although some further improvements are desirable;
C some criterion requirements have been satisfactorily or fully met, but others have not yet been satisfactorily met;
D few criterion requirements have, as yet, been satisfactorily met.

An example of applying the described methodology to the NSDS process and some results of the assessment of sustainability strategy in the Republic of Slovakia are presented in Box 5.4.

A second way to define sustainable development is in how it is measured or indicated. ***Sustainable development indicators,*** translating physical and social science knowledge into manageable units of information, facilitate the decision-making process as a whole and can help to measure and calibrate progress towards sustainable development goals by providing an early warning and sounding the alarm in time to prevent economic, social or environmental damage (UNDSD, 2001). The 1992 Earth Summit recognized the important role of indicators in helping countries to make informed decisions concerning sustainable

---

[14] Lee N., R. Colley, J. Bonde and J. Simpson, 1999: *Reviewing the quality of environmental statements and environmental appraisals*. OP 55, EIA Centre, Department of Planning and Landscape, University of Manchester, Manchester. *Source:* Cited by Sherp *et al.*, 2004

development. This recognition was articulated in Chapter 40 of Agenda 21 that specifically calls for the harmonization of efforts to develop sustainable development indicators at the national, regional and global levels, including the incorporation of their common, regularly updated and widely accessible reports and databases. In particular, the UN's Guidelines and methodologies on the indicators of sustainable development (UNDCD, 2001) includes climate change as a sub-theme of the Environment/Atmosphere chapter with a single indicator – *Emission of greenhouse gases*. Undoubtedly, it is not enough.

Table 5.5 Principles and criteria for assessing a country progress in implementing strategic planning processes for sustainable development

Criterion	Criterion's context
	A. Integration of economic, social, and environmental objectives
A1 – integration	Strategic planning in the country is based on a comprehensive and integrated analysis of economic, social, and environmental issues, which clarifies links between the three spheres, resolves conflicts between them where practicable, and negotiates appropriate trade-offs where conflicts remain.
A2 – social and poverty issues	Strategic planning in the country integrates poverty eradication, gender issues, and the short-term and long-term needs of disadvantaged and marginalized groups into economic policy.
A3 – environmental and resource issues	Strategic planning in the country integrates the maintenance of sustainable levels of resource use and the control of pollution to maintain a healthy environment into economic policy.
A4 – international commitments	Measures are in place to ensure compliance with international agreements which the country has entered into, on environmental and social issues.
	B. Participation and consensus
B1 – involvement of stakeholders	The country's processes of strategic planning, implementation, monitoring, and review include the participation of stakeholders, including government, decentralized authorities, elected bodies, nongovernmental and private sector institutions, and marginalized groups.
B2 – transparency and accountability	The management of the country's strategic planning processes is transparent, with accountability for decisions made.
B3 – communication and public awareness	Measures are taken to increase public awareness of sustainable development, to communicate relevant information, and to encourage the development of stakeholder involvement in the strategic planning process.
B4 – long-term vision and consensus	The country's strategic planning processes are based on a long-term vision for the country's development, which is consistent with the country's capabilities, allows for short-term and medium-term necessities, and has wide political and stakeholder support.
	C. Country ownership and commitment
C1 – high-level government commitment	The process of formulating and implementing the national strategy is led by government, with evidence of high-level commitment.
C2 – broad-based political support	The country's strategic planning process has broad-based political support.
C3 – responsibilities for implementation	Responsibility for implementing strategies is clearly assigned to bodies with the appropriate authority.
C4 – coordination with donors	The country's strategic planning process is coordinated with donor programmes.

Table 5.5 (continued)

Criterion	Criterion's context
	D. Comprehensive and coordinated policy process
D1 – build on existing processes	The national strategy for sustainable development is based on existing strategic planning processes in the country, with coordination between them and mechanisms to identify and resolve potential conflicts.
D2 – analysis and information	Strategic planning in the country is based on a comprehensive analysis of the present situation and of forecasted trends and risks, using reliable information on changing environmental, social, and economic conditions.
D3 – realistic goals	The national strategy is based on a realistic analysis of national resources and capacities in the economic, social, and environmental spheres, taking account of external pressures in the three spheres.
D4 – decentralization	The country's strategic planning processes embrace both national and decentralized levels, with two-way iteration between these levels.
	E. Targeting, resourcing, and monitoring
E1 – budgetary provision	The sustainable development strategy is integrated into the budget process, such that where plans have the financial resources to achieve their objectives.
E2 – capacity for implementation	The sustainable development strategy includes realistic mechanisms to develop the capacity required to implement it.
E3 – targets and indicators	Targets have been defined for key strategic economic, social, and environmental objectives, with indicators through which they can be monitored.
E4 – monitoring and feedback	Systems are in place for monitoring the implementation of strategies and the achievement of their defined objectives, for recording the results, and for reviewing their effectiveness as strategies for sustainable development, with effective mechanisms for feedback and revision within the planning process.

Source: Adapted from Cherp *et al.* (2004)

The general purpose of sustainability indicators is to simplify communication tools helping to guide political decision-making towards sustainable development. To provide a sound basis for decision making, sustainability indicators have to be (Spangenberg, 2002):

- *general*, i.e. not dependent on a specific situation, culture or society;
- *indicative*, i.e. truly representative of the phenomenon they are intended to characterize;
- *sensitive*, i.e. to react early and sensibly to changes in what they are surveying to permit monitoring of trends or the successes of policies, and
- *robust*, i.e. directionally safe with no significant changes in case of minor changes in the methodology or improvements in the data base.

Box 5.4 Assessing a country's progress in implementing strategic planning processes for sustainable development: The Slovak Republic case study

The Sustainable Development Strategy (SDS) of the Republic of Slovakia was developed through a ‘bottom-up’ process that involved more than 200 experts, coordinated by a 29-member Steering Committee, and was based on wide-reaching public consultations. The elaboration of the SDS included publishing the *Vision of the Sustainable Development for the Republic of Slovakia* in 1999. The analytical part of the strategy discussed outcomes of expert-group deliberations and workshops; they provided inputs for the strategy’s first draft. The findings of SEA of this draft as well as outcomes of several public hearings and the stakeholders’ comments were taken into account during the preparation of the second draft. Following consultations with various government agencies, the SDS was reviewed and endorsed by the government and parliament and became a legally binding document in 2001. The Government Committee for SD is in charge of the implementation and monitoring process.

The results of Slovakia’s SDS are summarized in the table below.

Assessment of the Slovak Sustainable Development Strategy principles

Principle	Criteria and score				Remarks
	1	*2*	*3*	*4*	
A. Integration and sustainability	C	C	C	B	Sectionalized planning with little integration. The environment is still treated as a ‘sector’ within the responsibility of the Ministry of the Environment (ME). The SDS was prepared mainly by the ‘environmentalists’ and hence failed to influence significantly economic planning in the country
B. Participation and consensus	B	C	C	C	Treated formally. Lack of publicity and awareness raising hinder effective public participation and stakeholder involvement. Difficulties with involving the higher ranking officials and experts
C. Ownership and commitment	B	C	C	B	There is significant government involvement and SDS process has a high level of authority. However, the process is still primarily ‘owned’ by the ME. Moreover, since the preparation of the SDS was supported by foreign aid, it was primarily accepted by technocratic elite and middle-level officials, while even Minister of Environment felt not so committed to it
D. Coordinated and comprehensive policy process	C	C	C	B	Goals of the strategy are realistic yet hardly challenging; the document suffers from vague and general formulations. Linkage with other strategic processes is very weak. The document failed to provide `added value' to other policy processes
E. Targeting, resourcing, and monitoring	D	D	C	C	Budgetary provisions are lacking. Limited progress in monitoring and evaluation of the strategy

A number of documents developed outside the scope of the SDS process, but clearly relevant to SD, included the *Vision of Slovakia Development* until 2020, which was prepared for the Economic Committee of the Slovak Government, and the draft version of the National Development Plan prepared to meet the requirements for acquisition of EU cohesion and structural funds. These documents indicated that SD principles in Slovakia were largely accepted by environmentalists and academics, which developed the NSDS, but are yet to make their way into mainstream economic planning. There is also a stronger consensus, including broader public and governmental support and commitment, around general issues and principles of SD than around specific details.

Source: Adapted from Cherp *et al.* (2004)

5.2 Transition and development

5.2.1 Process of transition and countries in transition

Transition is a dynamic historical process imposing changes in almost every element of society. In a broad sense, according to Havrylyshyn and Wolf (1999), this process implies:

- liberalizing economic activity, prices, and market operations, along with reallocating resources to their most efficient use;
- developing indirect, market-oriented instruments for macroeconomic stabilization;
- achieving effective enterprise management and economic efficiency, usually through privatization;
- imposing hard budget constraints, which provides incentives to improve efficiency; and
- establishing an institutional and legal framework to secure property rights, the rule of law, and transparent market-entry regulations.

Cherp and Vrbensky (2002) propose to use the term *transition* more broadly, namely, for the description of the transition processes from centrally planned to market economies and/or from authoritarian regimes to democracies, and/or from nations economically and otherwise dominated by large multinational states to societies integrated into diverse international associations. This definition does not imply, however, that the starting points, or the outcomes of transition, are the same in all countries: diverse geographies, cultures, political and economic histories resulted in different starting positions of each. The diversity of market economies and pluralistic democracies results also in the absence of a common end-point in the transition process. On the whole, the quoted authors generalized these processes into three broad dimensions:

- *International (geopolitical).* The end of the Cold War and the dissolution of multinational states, military and political blocs once dominated by the Soviet Union; the emergence and consolidation of new states; increased openness to foreign economic and other influences; integration into diverse international alliances, including the European Union.
- *Constitutional (political).* End of one-party regimes; consolidation of democratic institutions at all levels; decentralization; a continuing struggle over future political institutions in some countries.
- *Economic*. Abolition of centrally planned economies; economic liberalization and privatization; building institutions of free-market economies.

In due course, the World Bank (1996) identified 30 States as countries with economy in transition (EIT). Those are commonly understood to be the ex-socialist states of Europe and Central Asia that are in the process of economic restructuring and political reforms.

They comprise the countries of Central and Eastern Europe (CEE) and the Newly Independent States (NIS) of the former Soviet Union (FSU), each with significant differences in their levels of development and democratization – from EU accession to the Caucasian and Central Asian countries facing fundamental challenges in governance and democracy. At the same time, the UN Conference on trade and development (UNCTAD, 2004) included practically all CEE and FSU countries in the list of developing countries[15]. CEE and Commonwealth of Independent States (CIS) region also creates one of the UN's three main world classifications of countries (UNDP, 2007a).

Table 5.6 Country with economy in transition that are included in Annex I Parties

Belarus	*Lithuania*
Bulgaria	*Poland*
Croatia	*Romania*
Czech Republic	*Russian Federation*
Estonia	*Slovakia*
Hungary	*Slovenia*
Latvia	*Ukraine*

However, this study focuses mainly on FSU countries that are further divided politically and economically into two major subgroups: the Baltic States (Estonia, Latvia and Lithuania) and CIS[16]. Sometimes, as an example of countries that have undertaken certain actions, the CEE countries are also considered.

From the viewpoint of this work, the EITs' status with respect to principal climate regime documents is also important.

To date, the list of Annex I Parties[17] to UNFCCC includes 14 countries with economies in transition, mainly the more industrialized FSU and CEE countries (Table 5.6). This list was drawn up based on membership in political groups, in particular, the OECD, and more loosely the former Soviet bloc, rather than on any objective indicator. As result, Annex I includes two main sub-categories: on the one hand – the OECD members (as of 1992[18]) and on the other – EIT countries. The remaining transition countries, along with most developing countries, fall into the category of non-Annex I Parties. The division between the two categories has become rigid and increasingly fails to reflect the diversity of national circumstances. That is why the UNFCCC and its Kyoto Protocol typically make reference to "developing countries" rather than "non-Annex I Parties". However, in the Convention the term "developing country" was also not defined, similarly to the absence of an official definition in the UN system (UNCTAD, 2004). This lack of a clear definition leads to some uncertainty over a country's status and most countries of Central Asia and CEE do not consider themselves to be developing ones, rather as EITs (Depledge, 2002). However, this terminological aspect ('labeling' of the Parties) is not principal in our discourse because, in spite of great diversity, all these countries share enough common features in the transition processes.

---

15 In the cited document the designations '*developed'* and '*developing*' were intended for statistical convenience and do not necessarily express a judgment about the actual development stage reached by a particular country in the development process. Therefore, in this book the term 'developing countries' sometimes refers to EIT as well

16 In recent years these 12 countries are sometimes identified as Eastern Europe, Caucasus and Central Asia (EECCA) Region. Depending on the context and literary source, this term is also used in the book

17 See *International Emission trading association* at *http://www.ieta.org*

18 The Czech Republic, Hungary, Poland, and the Slovak Republic have joined the OECD since 1992, but they were already included in Annex I as EITs

Table 5.7 gives a general overview of the current situation in FSU counties expressed by their Human Development Index (HDI). This index measures average achievements of a country in three basic dimensions of human development: a long and healthy life; access to knowledge; and a decent standard of living. In particular, in the World Bank global classification (177 countries in all) only five FSU counties (three Baltic States, Belarus and Russia) are in the clusters of *high* human development (HDI of 0.800 or above); the rest – in the cluster of *medium* human development (HDI of 0.500–0.799). Undoubtedly, such a situation is caused, in many respects, by the costs of transition.

In the World Bank (2009) report the regional grouping of the Europe and Central Asia (ECA) countries covers the former Eastern Bloc (excluding East Germany) and Turkey. This report, based on these countries' current and projected climates as well as on their general economic and agricultural characteristics, made the following key messages:

- ✓ Contrary to popular perception, ECA faces a substantial threat from climate change, with a number of the most serious risks already evident.
- ✓ Vulnerability over the next ten to twenty years will be dominated by socio-economic factors and legacy issues—notably the dire environmental situation and the poor state of infrastructure—rather than by the changing climate itself.
- ✓ Even countries and sectors that stand to benefit from climate change are poorly

Table 5.7 Human Development Index (HDI) of FSU countries as of 2005

Country	HDI value, 2005	HDI range in the World	Level of human development	Life expectancy at birth, 2005	Adult literacy age 15 and above, %, 1995-2005	Combined gross enrolment ratio for education, %, 2005	GDP per capita (PPP US$) 2005	Life expectancy index	Education index	CDP index
Lithuania	0.862	*43*	*High*	72.5	99.6	91.4	14.494	0.792	0.965	0.831
Estonia	0.860	*44*		71.2	99.8	92.4	15.478	0.770	0.968	0.842
Latvia	0.855	*45*		72.0	99.7	90.2	13.646	0.784	0.961	0.821
Belarus	0.804	*64*		68.7	99.6	88.7	7.918	0.728	0.956	0.730
Russia	0.802	*67*		65.0	99.4	88.9	10.845	0.667	0.956	0.782
Kazakhstan	0.794	*73*	*Medium*	65.9	99.5	93.8	7.857	0.682	0.973	0.728
Ukraine	0.788	*76*		67.7	99.4	86.5	6.848	0.711	0.948	0.705
Armenia	0.755	*83*		71.7	99.4	70.8	4.945	0.779	0.896	0.651
Georgia	0.754	*96*		70.7	100.0	76.3	3.365	0.761	0.914	0.587
Azerbaijan	0.746	*98*		67.1	98.8	67.1	5.016	0.702	0.882	0.653
Turkmenistan	0.713	*109*		62.6	98.8	–	3.838	0.627	0.903	0.609
Moldova	0.708	*111*		68.4	99.1	–	2.100	0.724	0.892	0.508
Uzbekistan	0.702	*113*		66.8	–	73.8	2.063	0.696	0.906	0.505
Kyrgyzstan	0.696	*116*		65.6	98.7	77.7	1.927	0.676	0.917	0.494
Tajikistan	0.673	*122*		66.3	99.5	70.8	1.356	0.689	0.896	0.435

Note: HDI is a composite index that measures a country's average achievements in three basic dimensions of human development: a long and healthy life (Life expectancy index); access to knowledge (Education index); and a decent standard of living (GDP index). These dimensions are measured respectively by: life expectancy at birth; adult literacy and combined gross enrolment in primary, secondary and tertiary level education; gross domestic product (GDP) per capita in Purchasing Power Parity (PPP) – a rate of exchange in US$ that accounts for price differences across countries, allowing international comparisons of real output and incomes. *Source:* Adapted from UNDP (2007a)

positioned to do so. The low agricultural performance, with efficiency and productivity levels far below those of Western Europe, does not augur well for its capacity to seize new opportunities.
- ✓ The next decade offers a window for ECA countries to make their development more resilient to climate change while reaping numerous co-benefits. While some impacts of climate change are already being felt, they will likely remain manageable over the next decade, thereby offering the ECA region a short period of time to increase its resilience by focusing on actions that have numerous co-benefits.

The World Bank (2010) also estimates vulnerability to climate change in Eastern Europe and Central Asia as the result of a lingering Soviet legacy of environmental mismanagement and the poor state of much of the region's infrastructure.

5.2.2 Transition as development

There is much evidence of the relationship between sustainable development and transition, and the complex nature of the latter has significant implications for all three aspects of sustainable development. This relationship is complicated both by inherent conditions in the countries and by differences in the paths of transition they have chosen. The detail analysis of synergies, opportunities and threats – SOT analysis – of sustainability and transition has been carried out by Cherp and Vrbensky (2002). Further discussions in this book will follow their principal conclusions, using more recent data and facts for comments.

Undoubtedly, the transition process has brought public debate as well as new concepts and values linked to sustainable development. Here it is possible to distinguish two opposite aspects:

- The process of change itself provides new opportunities, and their effective exploitation promotes the achievement of sustainable development in transition countries;
- The process of transition carries significant threats to sustainability.

As for ***positive opportunities***, the governmental reforms and re-thinking of key policies have opened the doors for new approaches and priorities. The intensive and informal social debates introduced new values and concepts relating to sustainable development. Because transition and sustainable development seek to improve the quality of life through comprehensive reforms, they both have much in common, combining their efforts in a comprehensive set of reforms aimed at producing better conditions for present and future generations. In particular, the process of transition can act in synergy with sustainable development when it aims to reverse unsustainable social, economic and environmental trends associated with the former regimes. The economic transition seeks to restructure economic growth and provide an opportunity to reduce the share of environmentally damaging industries, e.g., to limit unsustainable subsidies for military and heavy industries. These goals are inherent in sustainable development as well. For example, the intention to curb the wasteful exploitation of natural resources and clean up environmental disasters inherited from centrally planned economies, which have been proclaimed by most transitional countries, are also a core task of sustainable development.

Constitutional transition, aiming to reform technocratic and over-centralized decision-making, provides opportunities for the establishment of environmentally responsible, decentralized and participatory decision-making institutions. The involvement of emerging civil society groups in sustainability efforts enhances the potential for local economic self-reliance and innovative activities. In the sphere of international relations, transition makes societies more open, thereby improving access to, and dissemination of, information on international experience in the area of sustainability.

Meanwhile, the process of transition carries significant ***threats to sustainability*** that, not being inevitably manifested, are inherent in transition. Despite the real synergies and opportunities, the transition process has not always been universally benign, with a much less positive value for sustainable development than was expected. First of all, the region's social fabric was greatly affected by political transition. Its today's social stability is threatened by the tensions and potential conflicts linked to the processes of building new nations (including the emergence of separatism tendencies), especially when minority ethnic or religious groups become the focus of intolerance from the 'dominant nationality'. Political liberalization created opportunities for the sharp manifestation of political interests of different social and ethnic groups and often results in heightened social tensions, leading to forced migration, violence or even to armed conflicts, all of which threaten stability.

Some *economic restructuring* in EITs has been quite negative from the sustainability perspective, especially with respect to their over-dependence on natural resources. Liberalized trade and privatization increase dependency upon volatile external markets and drive irrational, unsustainable exploitation of natural resources. Many transition economies have become heavily dependent on them, putting little effort into development of other economic spheres (Russia is the best example in this respect). Due to such a situation, a number of the EITs were forced to increase their dependence on exports of row produce and natural resources to external markets – a dependence that negatively affects their economic health and prospects. As a result, along with the destruction of many leading branches of national economies, an evident decline in the skills and quality of the labor force was observed. These 'costs of transition' are especially evident in the conditions of the global economic crisis.

Immediate socio-economic and political concerns can overwhelm decision-making agendas and favor quick solutions that may be detrimental to sustainability. More economic openness resulted in the increase of both foreign investment and external debt. Although to a greater or lesser extent from country to country, these factors have also affected the economic sustainability of transition countries. For example, in 2005 the net foreign direct investment inflows varied between 0.3% of GDP in Uzbekistan to 22.9% in Estonia, while total debt service as of GDP ranged from 23.1% in Kazakhstan to 1.9% in Azerbaijan (UNDP, 2007a). The experience of the developing world shows that heavy external debt without a concomitant rise in national income is a prelude to disaster.

Inequalities increased between different countries and also between social groups and genders within countries. For example, in 2005 the GDP per capita varied between $15,478 in Estonia to $1,356 in Tajikistan (UNDP, 2007a).

However, increases in economic inequalities comprise just one of the complex effects the transition process has on social sustainability. Radical changes have swept away such institutions as affordable education and health care, long-term planning, protection of environmental assets, quality of life, social safety nets and subsidies, which in the past ensured low levels of poverty and relatively high levels of equity. The human costs of transition and the quality-of-life threats to human security also include increased unemployment and poverty, declines in educational standards and diminished educational and health resources, decreased life expectancies, etc. In the past, these inequalities were partially offset by government cross-subsidies, largely abolished now.

The less apparent, but no less important, are the arising psycho-social pressures. Economic and political transition has left many social groups disenfranchised, marginalized and impoverished. Future-shocked, newly-impoverished older people, especially among the less-educated, are a disturbing feature for many EITs. Bewildered by rapid change and the disappearance of jobs and social safety, many of them are victims of forces, over which they have no control, and constitute a troubling waste of human potential.

Proceeding from the SOT analysis, Cherp and Vrbensky (2002) outlined some interactions between sustainable development and the transition process (Table 5.8). The next two tables present information on the development situation in FSU countries that, on the whole, confirms the identified threats.

Table 5.8 SOT analysis of interactions between the process of transition and sustainable development

Aspects of transition	*Synergies*	*Opportunities*	*Threats*
General	Reforming socio-economic institutions to ensure a better future	Mobilizing socio-economic resources for reform	Sweeping change in potentially destabilizing society and economy; shortening time horizons of decision-making
International	Alignment with international sustainability objectives	Opening up to international sustainable development experience and international co-operation	Globalization may threaten traditional ways of life and local economies; emerging nationalism may result in ethnic tensions and instability
Constitutional	Democracy and protection of minorities and other vulnerable groups	Decentralizing governance, making it more participatory and sensitive to environmental and social agendas	Potential political instability; disenfranchisement of certain social groups
Economic	Decentralization of resource-allocation decisions; revitalizing economic growth; phasing out environmentally and economically unsustainable industries	Developing local economies and encouraging independent economic initiative	Dependence on external markets; drive to over-exploit natural resources; potential for impoverishment

Source: Cherp and Vrbensky, 2002

In particular, transition processes caused a decrease in HDI in all FSU countries (Table 5.9). By 2000, the pre-transition level was exceeded in the Baltic States only. Even in 2005, HDI in most NIS countries was below the 1990 level; as to economic performance, its higher than in the pre-transition period level (expressed in GDP per capita) was only in six FSU countries (Table 5.10).

Table 5.9 Trend of the Human Development Index in FSU countries

Country	Year					
	1980	*1985*	*1990*	*1995*	*2000*	*2005*
Lithuania			0.827	0.791	0.831	0.862
Estonia	0.811	0.820	0.813	0.792	0.829	0.860
Latvia	0.797	0.810	0.804	0.771	0.817	0.855
Belarus			0.790	0.755	0.778	0.804
Kazakhstan			0.771	0.724	0.738	0.794
Ukraine			0.809	0.756	0.761	0.788
Armenia			0.737	0.701	0.738	0.775
Moldova	0.700	0.722	0.740	0.684	0.683	0.708
Uzbekistan			0.704	0.683	0.691	0.702
Tajikistan		0.705	0.703	0.638	0.640	0.673

Note: For the rest countries data for preceding years are absent. *Source:* Adapted from UNDP (2007a)

The effects of the transition process on ***environmental sustainability*** are clearer. Although in the early 1990s it was widely believed that transition reforms would promote more efficient technologies and energy use, thereby reducing environmental problems, the actual environmental impact of transition has proved to be some different and uneven throughout the region. While some areas have experienced lower levels of pollution mainly associated with abrupt declines in industrial output (rather than of increasing effectiveness of environmental protection), other environmental threats have grown. The environmental effects of transition in terms of 'decoupling' economic output and environmental pressures occurs as 'positive decoupling' only in a case when during recessions the environmental pressures decline faster than economic output, or when they increase slower than economic output in periods of growth. The environmental sustainability is affected not only by economic, but also by political transition. The latter occurs through the redistribution of political power among different groups with differing and sometimes conflicting environmental interests.

Table 5.10 Economic performance of FSU countries

Country	GDP		GDP per capita				PPP, US$		Average annual change in Consumer Price Index, US$ (%)	
	US$ billions 2005	*PPP US$ billions 2005*	*US$ (%) 2005*	*PPP US$ a 2005*	Annual growth rate (%)		*Highest value during 1975–2005*	*Year of highest value*		
					1975–2005	*1990–2005*			*1990–2005*	*2004–2005*
Lithuania	25.6	49.5	7,505	14,494	1.9	1.9	14,494	2005	14.6	2.7
Estonia	13.1	20.8	9,733	15,478	1.1	4.2	15,478	2005	12.0	4.1
Latvia	15.8	31.4	6,879	13,646	0.6	3.6	13,646	2005	15.5	6.8
Belarus	29.6	77.4	3,024	7,918	2.2	2.2	7,918	2005	144.6	10.3
Russia	763.7	1,552.0	5,336	10,845	-0.7	-0.1	11,947	1989	53.5	12.7
Kazakhstan	57.1	119.0	3,772	7,857	2.0	2.0	7,857	2005	29.7	7.6
Ukraine	82.9	322.4	1,761	6,848	-3.8	-2.4	10,587	1989	63.9	13.5
Armenia	4.9	14.9	1,625	4,945	4.4	4.4	4,945	2005	27.3	0.6
Georgia	6.4	15.1	1,429	3,365	-3.9	0.2	6,884	1985	12.8	8.2
Azerbaijan	12.6	42.1	1,498	5,016	–	–	5,310	1990	66.4	9.5
Turkmenistan	8.1	15.4	1,669	3,838	–	-6.8	6,752	1988	–	–
Moldova	2.9	8.8	694	2,100	-4.4	-3.5	4,168	1989	16.5	13.1
Uzbekistan	14.0	54.0	533	2,063	-0.4	0.3	2,080	1989	–	–
Kyrgyzstan	2.4	9.9	475	1,927	-2.3	-1.3	2,806	1990	13.2	4.4
Tajikistan	2.3	8.8	355	1,356	-6.3	-4.0	3,150	1988		

Notes: GDP – Gross Domestic Product; *PPP* – Purchasing Power Parity – a rate of exchange that accounts for price differences across countries, allowing international comparisons of real output and incomes; *Consumer Price Index* – the cost for the average consumer of acquiring a basket of goods and services. *Source:* Adapted from UNDP (2007a)

In short, *the transition process can equally facilitate or erode sustainable development.*

Thus, the key issues for EITs are how to maintain the long-term visions and goals of sustainable development, while protecting the population from the immediate and continuing threats of transition. Cherp and Vrbensky (2002) outlined four principal moments:

1. It is necessary to find a balance between the strategic priorities and today's pressing issues. Unless a country must deal with current issues, it is very difficult to mobilize support for long-term sustainable development.
2. Supporting the integration of social and environmental goals into development planning. The principles of sustainable development should be imbedded in planning agendas and decision-making to minimize the risk that direct short-term economic gains would be regarded as the only worthy decision-making criteria in a free-market economy.
3. Because transition involves threats to erode human and social capital, especially in areas where there has been significant political and economic turmoil, it is necessary to counter these threats by focusing on the most vulnerable individuals, communities and regions.
4. For some countries, the challenge is to maintain the momentum of sustainable development "beyond transition". Achieving truly sustainable development requires prolonged, unflagging attention and dedication.

There is a pressing need to redefine the vision of future sustainable development efforts in the EIT region. One of the most significant common challenges confronting these countries is how to ensure a consistent and responsive long-term development in the face of ceaseless, often turbulent changes in governments, social institutions, economies and attitudes. The entire process is complicated by the fact that rate and nature of change across the increasingly diverse countries are not uniform, with their individual needs for sustainable development.

Emrealp (2002) highlighted the progress made in EIT countries in creating legal, institutional and financial frameworks that can nurture ***local efforts*** of sustainable development. In his opinion, localizing sustainable development through Local Agenda 21 (LA21)[19] processes in the CEE region shows fundamental similarities to that found in other regions and, as elsewhere, requires:

- a people-centered approach
- encouraging long-term vision among stakeholders
- a comprehensive and integrated strategy
- ensuring effective participation
- linking national and local levels
- developing existing capacities.

---

[19] Local Agenda 21 is a local-government-led, community-wide, and participatory effort to establish a comprehensive action strategy for environmental protection, economic prosperity and community well-being in the local jurisdiction or area. See: *http://www.gdrc.org/uem/la21/la21.html*

Box 5.5 Two visions and strategies for localizing sustainable development in FSU countries

Estonia's vision of sustainable development rests on promoting local community planning and Local Agenda 21 development processes, and on raising environmental and sustainable development awareness so that the principles of sustainable human development will be commonly understood. Reaching this vision entails the development of an Estonian Agenda 21 as the national long-term sustainable human development strategy for the 21st century.

Moldova's vision focuses on fostering a participatory, multi-sectoral process to achieve the goals of Agenda 21 at the local level. It also seeks to contribute to the projection of the National Strategy for Sustainable Development at the local level through the elaboration and implementation of long-term, strategic action plans that address priority local sustainable development concerns. In order to implement related initiatives successfully, emphasis is placed on facilitating and developing strong links between local authorities, local business communities, NGOs, professional organizations, and the general public.

Source: Adapted from Emrealp (2002)

However, although the fundamental goals may be the same, the countries display sharply different institutional and organizational modalities for consultation, consensus building, vision and strategy for achieving local sustainable development. The specific programs of each country reflect local priorities and characteristics, even if they remain within the general framework popularly endorsed at the global level. Two examples of visions and strategies in FSU countries are shown in Box 5.5.

There is consensus across the CEE region regarding the crucial role of local authorities in moving towards sustainable development and promoting local participatory processes as well as a tendency to regard local authorities as a 'facilitating group' rather than an entity that plays a leading role in local participatory processes. Based on the analysis of various aspects of local response in the region, Emrealp (2002) emphasized that activities in this direction are important in generating a holistic and integrated approach to the development of the whole and to form explicit links with the Millennium Development Goals.

5.2.3 EU integration

Let us consider accession to the European Community (EC) as the final (or interim) goal of the transition for most CEE and some FSU countries. Undoubtedly, EC enlargement always had an impact on European and national environmental policies, both in the lead up to enlargement and in subsequent policy developments (Soveroski, 2004), because of the commitments that countries-candidates should meet under '*acquis communautaire*'[20]. These documents encompass the common rights and obligations that bind all the Member States together within the EU. Upon their accession the new Member States lag behind the current members in terms of the necessity to comply administrative capacity and infrastructure with the *environment chapte*r of the *acquis communautaire*. The EC candidates from CEE usually received a significant amount of pre-accession aid in support of meeting these environmental demands (Inglis, 2004; Soveroski, 2004).

[20] The *Acquis Communautaire* is the entire body of European laws (the treaties, regulations and directives passed by the European institutions as well as judgments laid down by the Court of Justice), each of which must be adopted, implemented and enforced (be 'closed' by the candidates) for the *acquis* to be allowed to join the EU

It should also be recognized that in spite of the fact that the EU accession is not generally a universally positive factor it presents a lot of opportunities (Cherp and Vrbensky, 2002). One such opportunity could be the generally improved openness in most transitional societies and their proliferating ties with industrialized countries. New links with Western Europe provide enlarged resources for carrying out development projects, and a number of international networks are becoming increasingly involved in sustainability efforts in EITs.

From an ***environmental perspective***, the most significant consequence of EC policy on enlargement is the transition of accession countries from aid recipients to aid donors and the necessary coordination of their development activities within the framework of the Development Cooperation Policy (DCP). In general, this will lead to incorporation by EITs of the sustainable development objectives and the full integration of environmental concerns into all aspects of EC development aid policies and activities. In accordance with this general framework, the specific elements of the development *acquis* strengthen the application of the principle of environmental integration into development policy. In this discourse, Morgera and Durán (2004) distinguish three general environmental implications linked with enlargement:

- ⇔ *An internal dimension*: new Member States are bound to adhere to the environmental integration approach of the DCP;
- ⇔ *An external dimension*: accession countries are encouraged to cooperate in the financial and technical support provided by the EC to third countries for the implementation of the major multilateral environmental agreements (MEAs);
- ⇔ *A global dimension*: through development cooperation, new and current Member States are expected to coordinate their policies with partner countries in international communities for the benefit of the environment, including in the UN and in WTO systems.

Soveroski (2004) stated a very different reason for *environmental protection* to be an important enlargement issue with respect to including the former Communist States. The low level of environmental protection practices and the heavily polluted state of many parts of the region led to concerns about how these countries could adjust to the requirements of the environmental *acquis*. Enlargement of the EU brings countries that customarily had weak environmental protection regimes into the EC. The fact that they all have gone through major changes in virtually all areas – legal, political, economic and social – adds to the challenge they face with their entry into the EU, including in the area of environmental protection. Examples that demonstrate this challenge are Poland, Slovakia and Romania.

Inglis (2004) ascertained the need for the new Members to search financing and investment for infrastructure projects that will be continuing for many years after enlargement. This undermines the true potential for implementation of the cornerstones of the existing *acquis* by the EITs. Efforts to improve administrative and judicial capacity will also continue to be a major challenge after enlargement. Decisions making among such a multiplicity of countries inevitably affect new legislation and policy initiatives and can be expected to exacerbate the implementation and enforcement deficit in the environment *acquis* of the enlarged Union.

Box 5.6 Results of surveying the opinions of Russian chief executive officers on the applicability of Western management methods in various areas of enterprise management (%)

The survey (see *Table*) included about 1,500 chief executive officers (CEOs) in Russian industrial companies. The 'reaching world standards' of quality is still viewed by the majority of the surveyed as a technical problem in the management and quality control areas of production rather than as a problem of job attitudes. The survey also showed that it is highly probable that human resource management innovations will continue to be initiated and implemented in an unsystematic mode and on a trial and error basis. It is unlikely that innovations in this sphere will seriously contribute to strengthening the competitiveness of Russian companies on local and overseas markets.

Area	*Group*	*Completely inapplicable*	*Low applicability*	*Medium applicability*	*High applicability*
Production technologies	Group 1	7.3	22.7	57.3	12.7
	Group 2	2.1	22.2	58.6	17.1
	Group 3	1.7	19.9	50.3	28.2
Quality management	Group 1	11.8	31.4	49.0	7.8
	Group 2	4.9	23.6	58.7	12.8
	Group 3	4.6	18.9	52.6	24.0
New product development	Group 1	12.1	30.3	50.5	7.1
	Group 2	4.0	33.0	54.5	8.5
	Group 3	2.2	29.1	53.8	14.8
Human resource management	Group 1	14.3	44.9	38.8	2.0
	Group 2	10.1	44.0	40.3	5.6
	Group 3	10.3	34.9	48.6	6.3
Financial management	Group 1	14.4	40.0	43.3	2.2
	Group 2	7.1	38.9	49.4	4.6
	Group 3	7.5	32.9	51.4	8.1

Note: Group 1 was formed from companies whose CEOs assessed the current situation as 'bad'; *Group 2* consisted of companies whose CEOs assessed the situation as satisfactory; *Group 3* comprised the companies whose CEOs assessed the situation as 'good' or 'excellent' and also the companies in a 'satisfactory situation' which showed a very positive performance trend. *Source:* Gurkov, 2002

Unfortunately, these presuppositions, which are right in principle, are rarely observed in practice. As an example of the 'sensitivity' of transition countries to an international experience, see Box 5.6.

Thus, there is widespread recognition within the EU that environmental protection must be integrated into sectoral policies because environmental policies alone cannot achieve the environment improvements needed as a part of sustainable development. *"If this were done successfully,* – Yamin (2005, p. 357) notices as an example, – *it is doubtful whether in the long term a separate climate policy would be needed at all"*. The important point, which he adds, is the fact that most discussions about *environmental integration*[21] within the EU development have focused on incorporation of GHG mitigation policies as reflected, for example, in the sectoral assessments included in the EC communication

[21] In Yamin's (2005, p. 357) interpretation, the term *integration* in the wide sense "is used in the EU to refer to incorporation of environmental and social considerations into all spheres of policy-making, particularly economic policy, in much the same way that the term 'mainstreaming' is used in a development context"

(European Commission, 2004). The incorporation of climate adaptation into these broader EU processes of environmental integration has yet to be examined in any real depth.

5.2.4 Institutional dimensions of transition to sustainability

5.2.4.1 The essence of institutional frameworks

The problems of environmental planning and policy concern mostly the negative environmental externalities of human activities. Briassoulis (2004) justifies the institutional complexity of addressing these problems by the multiplicity of human/environment interactions. As inherently complex societal issues they involve numerous actors to set goals, design future courses of actions and implement chosen solutions within uncertain contexts. To achieve sustainable socio-economic development, these solutions are needed in sound combinations of environmental and human resources, while their effective implementation depends critically on resource availability and social acceptance. The environmental resources "…are owned and used by individuals or groups belonging to various spatial/organizational levels and are subject to diverse, and not always mutually congruent, resource regimes. A stumbling block in the process of devising and, most importantly, implementing solutions is the variance between actual resource regimes and those that proposed plans and policies prescribe" (Briassoulis, 2004, p. 116). And further, "social actors….elaborate resource regimes that govern resource use with respect to activities in which they are interested and create organizations to administer them. Environmental or resource regimes are institutions that deal explicitly with matters involving human/environment relations" (p. 117). When the 'parameters' of a regime cease to match the characteristics of the resource being managed the 'problem of fit' arises with its significant implications for the management.

Environmental protection is dependent on an open dialogue and coordination across policy fields, requiring institutional and organizational reforms. To avoid the inefficient and wasteful use of resources and interventions of doubtful effectiveness, the institutional complexity should be addressed and managed through *institutional change* (Briassoulis, 2004; Lenschow, 2002).

Institutions remain a core subject in political science and sociology. On the path towards a common analytical framework, O'Riordan and Jordan (1999, p. 81) defined institutions as "…the multitude of means for holding society together, for giving it a sense of purpose, and for enabling it to adapt. Institutions apply both to structures of power and relationships as found in organizations with leaders, membership, resources and knowledge, and to socialized ways of looking at the world as shaped by communication, culturally ascribed values, and patterns of status and association". Later, discussed by Young (2005, p. 5), "institutions are systems of rules, decision-making procedures, and programs that give rise to social practices, assign roles to participants in these practices, and guide interactions among the occupants of the relevant roles. Unlike organizations, which are material entities that typically figure as actors in social practices, institutions may be thought of as the rules of the game that determine the character of these practices". Thus, *institutions* are not synonymous with *organizations*. They include organizations, but also norms and expectations within which individual organizations are embedded (Clark, 2003). The *institutional approach* to social and planning analysis places emphasis on actors (individuals and groups), the diverse relational webs or networks to which they belong, the stakes they have in local environments, and the practices they follow to pursue their interests (Briassoulis, 2004).

Summarizing a vast theoretical literature, O'Riordan and Jordan (1999, p. 82) have formulated a general agreement that:

- Institutions embody *rules* that encapsulate values, norms and views of the world, define roles and provide a social context for actions. These rules define the 'game' of politics, establishing for players both the objectives and the range of appropriate tactics or moves.
- Institutions take *time* to develop. They cannot be created instantaneously, but come about through recursive processes.
- Once developed, institutions have a degree of *permanence* and are relatively *stable*.
- Contrary to the image of 'fixity', institutions are *never completely static* being continually *re-negotiated* in the permanent interplay between conscious human agency (action) and the wider structures in society (e.g., laws, economy, common perceptions) over which individuals have relatively little control.

Thus, institutions, as a set of rules, are assigned to structure the relationship between individuals through determining the range of possible reactions to certain situations and designing the relationships between them in such a way that the predictable outcome is equilibrium, that is, they provide stability and meaning to social behavior. Institutions "…are created because they reduce the transaction costs of undertaking the same activity over and over; because they help stabilize expectations by transferring information; and because they promote compliance by building trust and creating enforcement mechanisms in circumstances where trust is weak or absent" (O'Riordan and Jordan 1999, p. 84). As a concept, the 'institution' is highly equivocal, referring to formal rules, behavioral standards, economic and political structures or framework conditions. Institutions are both the result of former actions and the framework within which their new activities take place; institutions can change over time and become increasingly differentiated (Varone *et al.*, 2002).

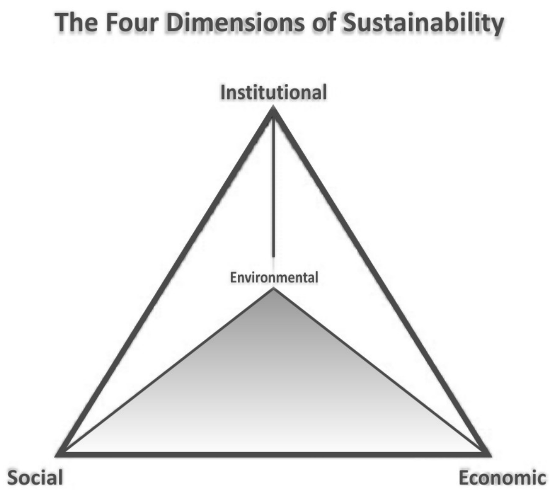


Fig. 5.9 The prism of sustainability with an institutional dimension. *Source:* Spangenberg, 2002

The ***institutional framework of a society*** consists of formal and informal rules, all of which determine incentives (stimuli) and transaction costs (Pejovich, 1997). *Formal rules* include constitutions, statutes, common laws, and other governmental regulations. Governmental authorities enforce these rules by means of sanctions such as fines, imprisonment, and execution. *Informal rules*, or the "old ethos," include traditions, customs, religious beliefs, and all other interpretations of the social world, which have passed the test of time. Informal rules are not a policy variable like formal rules. If formal rules are in harmony with informal rules, the incentives they create tend to reinforce each other. A new rule has to be integrated into the prevailing system of formal and informal institutions. Accordingly, public policy-makers must clarify rules and regulations. The number of such secondary (implementing) regulations depends on the relation of the prevailing informal rules to a new formal rule (Pejovich, 1997).

The problem of *institutions* arises in all areas of human endeavor, resulting in a wide spectrum of interpretations[22]. Where they arise to deal with matters involving human/environment relations, it is normal to speak of institutions as environmental or resource regimes (Young, 2005). Where they deal with sustainability, the institutional dimension and respective indicators can be introduced as the fourth pillar of sustainable development, resulting in a *prism of sustainability* (Fig. 5.9) – a structure of analysis that separates societies into four discrete subsystems where their permanent interactions constitute the linkages of the four dimensions (Spangenberg, 2002).

In the comprehensive discussion of the institutional dimensions of *global environmental change,* Young (2005) emphasized a set of defining characteristics that institutions share:

1. Institutions loom large as causes of large-scale environmental problems that in nature are both systemic (e.g., climate change) and cumulative (e.g., loss of biological diversity). The establishment of limits on GHG emissions is an example of their obvious relevance to global environmental change.
2. Institutions figure as determinants of the course of human/environment relations. Faulty institutional arrangements cause frequently large-scale environmental problems; conversely, right institutional arrangements often play a role in effectively solving environmental problems. In both cases, the fundamental premise is the same: the operation of institutions accounts for a sizable proportion of the variance in human behavior affecting biogeophysical systems. Summarizing this item with the previous, one can say that institutions figure both as sources of large-scale environmental problems and as elements in human responses to actual and anticipated environmental problems.
3. Institutions vary along a number of significant dimensions (types of members and size of membership, functional scope, geographical domain, mix of formal and informal elements, density of rules and programs, structure of administrative organizations, links to other institutions, and so on). Since institutions are not actors in their own right, to become effective they must influence the behavior of those subject to their rules, decision-making procedures, and programs.
4. Institutions are not stand-alone arrangements immune to other forces in societies. Rather, they operate within economic, political, and social settings that can and often do affect the outcomes they produce. Here, Young (2005) distinguishes direct and indirect institutional effects. Direct effects arise from the activities of environmental (resource) regimes, or the institutions explicitly created to deal with human/environment relations.

---

[22] As an example of a recent detail discourse on this issue, we recommend Greif, A., 2006: *Institutions and the Path to the Modern Economy: Lessons from Medieval Trade*. Chapter 1. Introduction. Cambridge University Press, p. 4-31

The impacts of these arrangements are direct in the sense that they involve institutions intentionally developed to regulate human interactions with biogeophysical systems. In the case of climate change, institutions such as the UNFCCC, Kyoto Protocol or IPCC can be considered. The indirect effects of institutions on human/environment relations are unintended and often unforeseen, for example, the side effects of institutional arrangements that were established to deal with problems arising in other areas of concerns. Indirect effects also arise from the operation of other types of institutions. Typically, environmental damages, as side effects of other, perfectly legitimate activities (for example, in the production and consumption of various goods or services), create a so called 'problem of interplay'. As a result, the effectiveness of specific institutions often depends not only on their own features but also on their interactions with other establishments.

5. Institutions differ in the dimensions of their resilience where Young distinguishes two types. The first is a capacity to cope with sharp and relatively short-term shocks (for example, hurricane or flooding); the second – to cope with slowly accumulating stresses (for example, desertification). All institutions are not alike in these terms: regimes that are good in coping with slowly accumulating stresses may collapse when hit by a sudden shock, and vice versa. Among the factors, which contribute to the resilience of institutional arrangements and which seem particularly relevant, there are, for example, a capacity to engage in the monitoring providing with early warning of impending changes in key biogeophysical systems, the existence of mechanisms that promote social learning, and the flexibility to introduce institutional adjustments to cope with these changes in proper time.

6. And, at last, the success of institutional innovations directed toward large-scale environmental problems depends on the extent to which they fit or match the major features of the biogeophysical systems to which they pertain.

Over the last few years, the international community identified a number of specific shortcomings in the present institutional systems and proposed some directions in which institutional reforms and innovation efforts are needed in order to harness better science and technology to the tasks of enabling and guiding a transition toward sustainability. Clark *et al.* (2005) identified the following issues as crucial:

- → mobilizing the right knowledge;
- → integrating the knowledge of practice with the formal knowledge of laboratory science to produce practical insights on solutions to particular sustainability problems;
- → balancing flexibility and stability to address the challenge of sustainable development that is simultaneously long-term and rapidly evolving;
- → the programs designed to promote sustainability need themselves to be sustained long enough to make a difference, but not at the cost of failing to learn from experience;
- → improving the situation with the world lacks of physical infrastructure and human capacity in harnessing science and technology to sustainability.

5.2.4.2 Nature of the institutional change in transition

Undoubtedly, the transition process has required institutional restructuring. The collapse of the soviet system in CEE and FSU countries created an institutional vacuum in the region and new States faced two critical issues: what new institutions to choose, and how fast to substitute the new institutions for the old ones, while they were ill prepared to quickly identify alternative institutional arrangements and evaluate their expected consequences (Ovin, 2001; Pejovich, 1997). The empirical evidence of transition has proved the importance of institutional change, as was claimed by advocates of this dimension of transition. Ovin (2001) has demonstrated that transition is not just an economic phenomenon, and, for example, the insufficient contribution of disposable resources even in CEE countries, the most progressive in transition, is a result of an inappropriate policy on institutional change.

In transition economies the importance of building new institutions is a paramount task since most of those inherited from the previous regime are simply inadequate for a market economy. In the institutional vacuum, caused by the disorderly dissolution of the command system, only a small part of the former institutions can be used, and new institutions must be introduced. There are various aspects of legal and institutional frameworks, which are vital to the functioning of a market economy, and which must have a significant place if an entry is to win in the sustainable competition. This is not only the economy, which must be reoriented in light of vastly and rapidly changing circumstances (both domestic and international), and naturally involving corresponding changes in policy, but also the State administrative system itself. In transforming economies, putting into practice an effective administrative system is even a more difficult and more important task (Jasináski and Ross, 1999).

The basic *neoclassical model* became a foundation for the development of transition strategies in most CEE. According to this model, the transition required macrostabilization, privatization, market prices, free international trade (including convertible currency), and a balanced government budget. However, the forcing, for example, of East Europeans to accept the institutions of capitalism (before they had become comfortable with the new system's culture) inevitably created a new conflict that in most countries replaced the existing between formal institutions and the region's ethos. This conflict between new formal rules and the old ethos has given rise to nationalism and ethnic disputes, inflation and unemployment (Pejovich, 1997).

The institutional change in a transition country must be distinguished from that in a stable market economy. Slovenian professor Rasto Ovin (2001), who studied this problem, saw two main reasons for this phenomenon. *The first reason* is the underdevelopment of actors, as a consequence of the former system, and their weak competence in this field. *The second reason* derives from the near inability of current institutions to efficiency exercise synergy effects on the emergence of new required institutions. In such situations the governments are restricted both by their own knowledge and the knowledge and loyalty of administrations. From a public choice perspective, the political risk, to which transition governments are exposed with institutional change, is high. R. Ovin agrees with the statement of Pejovich (1997, pp. 251–252) that *"...governments should try to provide—admittedly by fiat—a legal environment that would allow people to choose among alternative institutional arrangements, that is, to participate in a 'market for institutions'. This arrangement would predetermine neither a specific transition path…. nor the rate of institutional change. But… the market for institutions would give people a chance to learn about the institutions of capitalism, try them out and select those that perform well"*.

Transition made evident two opposite strategies that are well known in the stabilization debate: *Big Bang* versus *gradualism.* As applied to the institutional transition, this debate actually means the question whether measures of transition policy are to be considered as reforms or as simple transitionary changes. In a situation where no effective pre-existing rules exist, change of institutions is not only very extensive but also requires complex coordination and, in the opinion of Ovin (2001, p. 137), *"…cannot be described as reform, but rather has the character of a revolutionary change".* He considers the privatization issue as an example, although privatization processes and 'shock therapy' in most FSU countries are revealing examples of another kind.

In comparison with the well-known process of changes in the developed market economy, the conditions and processes of institutional change in transition countries must consider involving somewhat different factors that Ovin (2001) described as follows:

- The process of institutional change takes place in a "revolutionary environment" under which the pillars of the former system's legislation must be entirely abandoned and replaced with the new (system of election, property rights, market order, and so on).
- The former communist system did not emerge and develop an institution framework based on economically explainable rationality, path dependence or as the result of choice among alternative rules with different sets of outcomes. The former institutional framework was imposed mainly through political power.
- As a consequence of the former system, individual agents do not have a complete understanding of all existing strategies and pay-offs, which are valid in a market economy, and their actions could oppose their real economic interest.

As a result, the changes in so-called situative factors, as they are systemized by the economic theory of institutional change, – institutions, price relations, income, theories, ideologies and preferences – have only limited influence in transition countries; the complementary factors that additionally trigger institutional change here – *factors of transitionary change* – must be introduced. Ovin proposed a modified scheme of the economic theory of institutional change where these factors are included separately from changing situative factors. Because the validity of the factors of transitionary change is limited to a certain period, they are subjected to change in the course of transition realization and are losing their importance as it proceeds.

Evolving this viewpoint, Ovin systemized the factors of institutional transitionary change*,* which must be added to the situative ones, in two categories: internal and external. *Internal factors* determine the institutional vacuum that requires corresponding "filling" (institutional change and transition-driven change) by means of government activity. *External factors* refer to those, which exert their influence from abroad and are not incorporated in external effects of changes in situative factors. They refer to outside influences that become effective after transition has started. In particular, openness to international markets as well as the EU accession processes generate three types of external factors: (1) a technologically and environmentally driven institutional change (standards), or the direct *import of institutions*; (2) an adjustment to *relative prices* that triggers not only changes in institutional arrangements but also in the institutional environment; and (3) the direct influence on the institutional change through accepting the *Acquis communautaire* during the process of *association* to the EU. The European integration processes serve here as an anchor helping domestic governments in introducing market economy institutions.

The scheme of the drivers of possible institutional change modified in conformity with the specifics of transition countries is presented in Fig. 5.10.

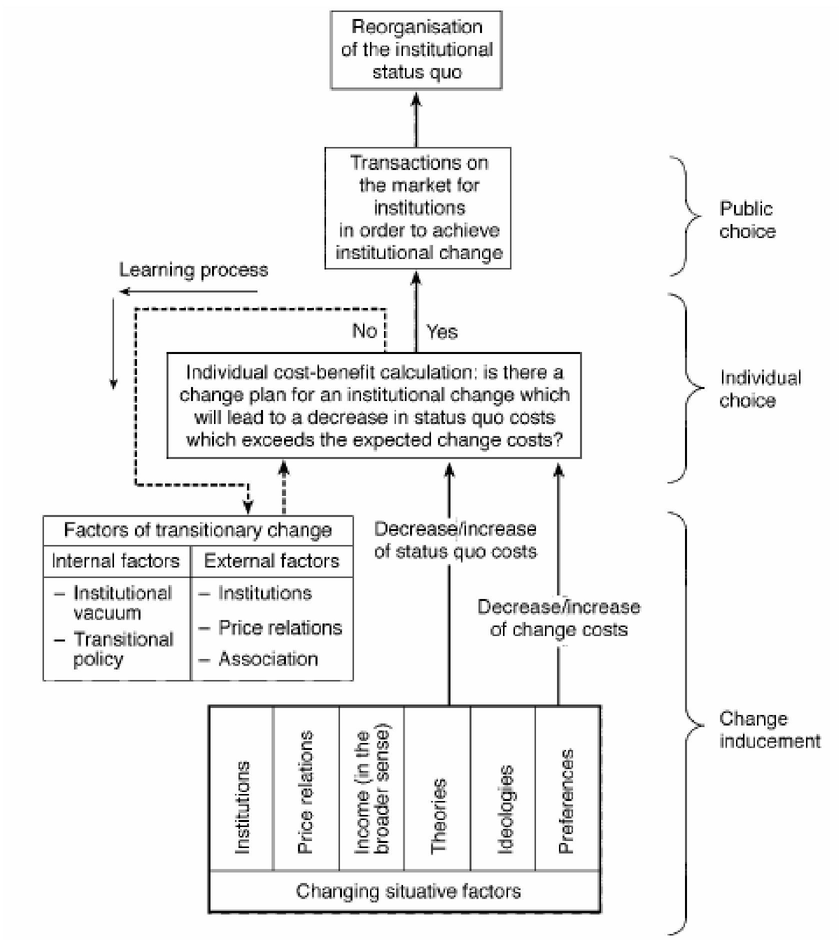


Fig. 5.10 Summary of the basic explanations of institutional change in transition countries. *Source:* Ovin, 2001

5.2.4.3 Institutional capital in governing sustainability[23]

[23] This subchapter is mainly based on the paper of Evans *et al.* (2006) that summarizes the finding of the DISCUS *(Developing Institutional and Social Capital for Urban Sustainability)* research project. This project, co-funded by the European Commission, was undertaken during 2001–2004 and involved an in-depth study of 40 European towns and cities in order to understand the institutional and social factors and conditions that might contribute to policy 'achievement' or 'failure' in local sustainable development policy and practice

Evans *et al.* (2006) regard the governance process as a key mechanism to involve and incorporate citizens and organizations into the decision-making process, thereby increasing political engagement and levels of acceptance of what are often difficult decisions. This commitment to 'good governance' has been a central feature of the local sustainability discourse since the 1992 Rio declaration (UNCED 1992). One of its Chapter 28 key statements was to consider the process of 'good governance' as a precondition for achieving sustainability at the local level.

However, Evans and colleagues call to be precise in the use of related terms – *governance, government* and *governing*. They explain this need by the fact that within the discourse of sustainable development there has been a tendency to suggest that while *governance* is somehow unarguably a 'good thing', and that more of it should be encouraged, the *government* is somehow less desirable. Hence, "…the changes in the processes of local politics and administration can usefully be conceptualized as a continuum moving from government to governance with a clear assumption that any movement along this continuum towards governance is both progressive and supportive of sustainability" (Evans *et al.,* 2006, p. 850). There is also a tendency within the discourse to conflate government and governance, sometimes using the terms interchangeably, although these two processes have distinct identities. Fig. 5.11 illustrates these different interpretations.

If we follow the cited authors, they "have chosen to regard the sphere of local authority activity, the internal organization of local government, and the legal, financial and political processes therein as *government*" (*ibid,* italic added*)*. *Governance* (although there is no generally agreed definition) is the sphere of public debate, partnership, interaction, dialogue and indeed conflict and dispute entered into by local citizens and organizations and by local government. Thus, the cited authors clearly differentiate governance from government, taking as the starting point "…that good governance is a necessary precondition for achieving sustainable development" (p. 851). The term *governing* is used to describe the interaction between these two processes.

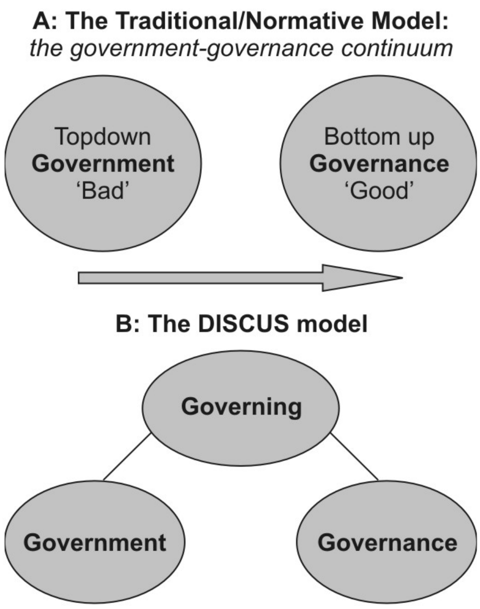


Fig. 5.11 Two contrasting interpretations of governance. *Source:* Evans *et al.*, 2006

Evans and co-authors also proposed the definition of *institutional capacity (capital*), considering it as "the internal patterns of behavior and ways of working, as well as the collective values, knowledge and relationships that exist within any organized group in society" (*Ibid,* p. 853). Institutions with high levels of such capital might reasonably be expected to act effectively and efficiently, and to demonstrate institutional initiative and responsibility. It might be expected also that in the context of sustainable development such institutions would be proactive in their undertaking of sustainability initiatives. Institutional capital is evaluated in the interplay with *social capacity (capital)* that encompasses "the complex ways in which sectors of civil society build and maintain capacity…for action to promote the needs of different groups" (*Ibid).* A high level of social capital could be a basis for a high level of sustainable development capacity because it promotes involving different sectors of civil society and stakeholder groups in decision-making processes.

Lowndes and Wilson (2001)[24] proposed four interacting dimensions of what they term ***'institutional design'*** within local governance. This term signifies the creation and mobilization of social capital, namely:

- *Relationships with the voluntary sector*: the ways in which local government supports and recognizes voluntary associations;
- *Opportunities for citizen participation:* the institutional design of local governance may influence prospects for the formation of new groups and new stocks of social capital. Local authorities may, in practice, rank service improvement as the main purpose of participation, ahead of citizen development and building social capital;
- *Responsiveness of decision-making:* even where there are institutional arrangements to involve citizens and groups in policy formulation, social capital can only have an impact on democratic processes where policy-makers actually take account of citizen preferences;
- *Democratic leadership and social inclusion*: the relationship between social capital and democracy is shaped by the capacity of government institutions to listen to, and channel citizen demands.

Table 5.11 The relationship between social and institutional capacity, capacity-building measures and sustainable development (SD) policy outcomes

Social capacity for SD	Institutional capacity for SD	
	High	*Low*
High	*Dynamic governing* Active sustainability capacity-building High possibility for sustainability policy achievement	*Voluntary governing* Voluntary SD capacity-building Low possibility for sustainability policy outcomes
Low	*Active government* Medium SD capacity-building Medium or fairly high possibility for sustainability policy outcomes	*Passive government* Low/no SD capacity-building Sustainability policy failure

Source: Adapted from Evans *et al.* (2006)

The interplay between local government and local community which Evans *et al.* (2006) have named the ***process of governance*** is likely to result in tangible benefits both for participants and policy outcomes. Table 5.11 sets out different categories or 'ideal types' of governing arrangements for sustainability policy achievement, where:

[24] Lowndes, V. and D. Wilson, 2001: Social capital and local governance: exploring the institutional design variable. *Political Studies*: **49**: 629–647 (Quoted by Evans *et al.*, 2006)

1. *Dynamic Governing* for sustainable development describes a situation where the higher the levels of both social and institutional capital, the greater the likelihood of sustainable development policy success.
2. *Active Government* assume that better results can be achieved if the local government institutional structures have clearly included the goals of sustainability within their activities. This kind of active government can, from a theoretical point of view, be viewed as (eco-) efficient in that it is making attempts to implement some sustainable development policies – perhaps those that are less sensitive to the need for public participation.
3. *Passive Government* would, in practice, result in the failure for sustainable development policies. Although in this case a local government would retain some routine tasks within the national setting, the actions would be restricted. This situation is likely to remain unchanged as there seems to be low both a pressure from civil society for change and the social capacity for sustainable development.
4. *Voluntary Governing* means a situation where civil society is expected to act alone in order to make progress with sustainability while the functions of local government are only meant for routine tasks. Nevertheless, there could still be (fairly low) positive outcomes for sustainability although capacity building for sustainable development would, in practice, be somewhat limited and only distributed by and through civil society actors. To rely just on a high social capacity presents limited possibilities to secure policy achievement.

Fig. 5.12 illustrates how the various elements of governance and government interact to produce four 'ideal types' of governing.

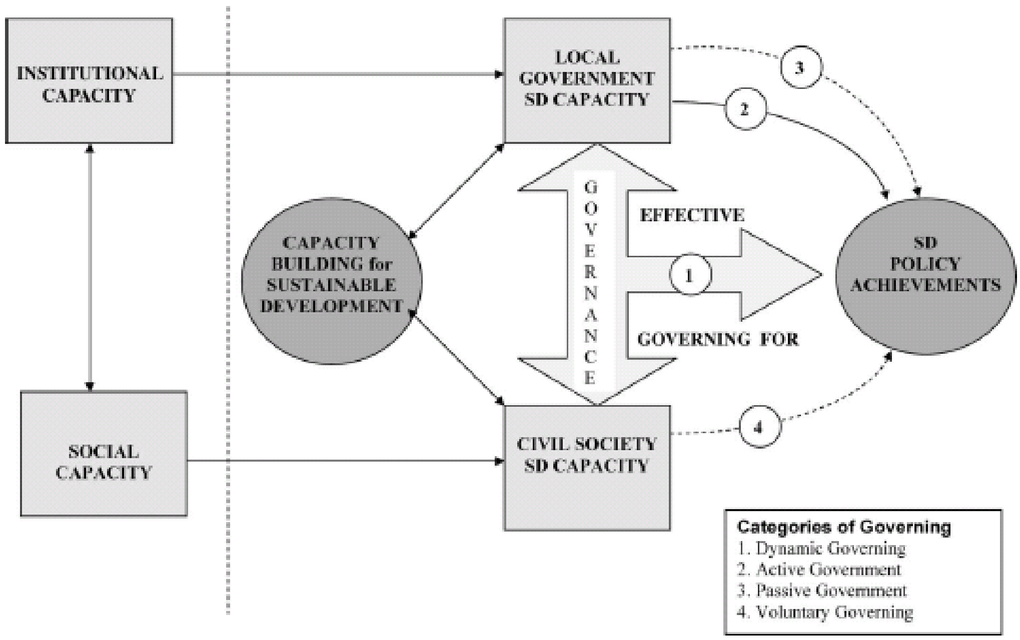


Fig. 5.12 Dynamic institutional capacity and sustainable development policy achievement. *Source:* Evans *et al.*, 2006

On the whole, the referenced research shows that *dynamic governing* patterns are clearly most efficient in achieving positive policy achievements for sustainable development. The authorities with clear tangible policy achievements also exhibit high levels of institutional capacity and evidence of capacity building. The lower extent results can also be achieved if local government is active in terms of developing its own capacity for delivering sustainable development, but not fully taking a civil society into account. *Passive governments* that only carry out routine tasks are clearly lagging behind in terms of policy outcomes. Active civil society can, to some extent, help this process, but progress is still marginal.

The civil society respondents appear more critical than local government with regard to the policy outcomes. Effective or dynamic governing for sustainability is most likely to occur when governments work closely with civil society agents in the *process of governance* where *governance* and *government* are two intertwined but distinct elements of the process. Moreover, *governance* alone cannot adequately convey the substance of the governing process which to be effective involves both the active involvement of local civil society and the leadership, and commitment of local government. In the accepted terminology, *governance* alone is unlikely because it needs *government* to stimulate and support it. In its turn, *government* without *governance* cannot generate the local resources, support and energy needed to deliver outcomes in the current complex policy environment. The DISCUS research has indicated that only the two elements together can create a process of governing which can promote and sustain real policy progress (Evans *et al.,* 2006). This research also supported the notion that governmental action, or the application of institutional capital, can support the creation of social capital. But the reverse is also true – the activity and action within civil society can support the building of institutional capacity. Thus, in the case of sustainable development policy, the intensity of tangible policy achievement is almost always linked to a high level of dialogue between local government and civil society.

The cited authors see the two-fold logic behind this statement. First, it is based upon the belief that the changes required to achieve sustainable development are of such a magnitude that they cannot be secured by governments acting alone. They are needed in mobilizing the energies and initiative of citizens, interest organizations and stakeholders – *local communities* – if changes in attitudes, values and behavior are to be secured. Second, the governance process is regarded as a key mechanism to involve and incorporate local communities into the decision-making process, thereby increasing political engagement and levels of acceptance of what are often difficult decisions.

In achieving a better government, Mackay (2007) has focused on government systems for ***monitoring and evaluation***. He proceeds from "…a general understanding that for a government to improve its own performance it needs to devote substantial effort to measuring its performance" (p. 11). Such systems for monitoring and evaluation (M&E) are used to measure the quantity, quality, and targeting of the goods and services – the outputs – that the state provides, and to measure the outcomes and impacts resulting from these outputs. These systems also facilitate understanding of the causes of good and poor performance, providing information about the performance of the government, individual ministries and agencies, as well as of managers and their staff. Civil society can play a role in M&E in different ways, both as a user and producer of M&E information on government performance. This idea is close to that of Evans *et al.* (2006) who see civic engagement equally on the demand side (the civil society expecting better government) and on the supply side (the performance of representative government, facilitated by the social infrastructure of civic communities and of officials and citizens). The interrelationship between the 'demand' and 'supply' sides is directly affected by the nature and levels of social capital, and also by the ways in which governments of all levels support and encourage its development.

However, it is clear that there can be no "…standardized, 'cookie-cutter' approach to developing a government M&E system" (Mackay, 2007, p. 80). Building a government M&E system needs to be tailored closely to each country's individual circumstances and to the government's particular vision of such a system.

Finally, the ***institutional sociology framework*** emphasizes the importance of regulatory, normative and cognitive factors that affect decisions to adopt a specific organizational practice, above and beyond the practice's technical efficiency. Delmas and Toffel (2004) showed that the institutional perspective does not only address the fundamental issue of a business strategy: why do organizations subjected to the same level of institutional pressure pursue different strategies? They argue that organizations adopt heterogeneous sets of environmental management practices because they interpret these pressures differently due, for example, to specific company characteristics. Although different managers are subject to the same level of institutional pressures, they are expected to perceive these pressures differently due to disparities in their organizations' structure, strategic position, financial and environmental performance. This difference between 'objective' and 'perceived' pressures leads to different responses, and the adoption of environmental management practices varies therefore not only due to different levels of institutional pressures but also because of the organizational process that transforms objective pressures into perceived ones.

5.2.4.4 Institutional dimensions of climate change policy

Institutions define anthropogenic climate change both as a problem and a context through which such socialized devices as creating and interpreting scientific knowledge and selecting politically tolerable adaptation strategies are achieved (O'Riordan and Jordan, 1999). On the other hand, in many respects climate change is attributable to the prevalence of rules and decision-making procedures, such as systems of land tenure that allow owners to cut trees for wood products or to clear land for agricultural purposes without regard to the release of carbon into the atmosphere associated with these activities. It is apparent that institutional innovations must address behavior at a number of distinct levels to succeed in solving these problems (Young, 2005). GHG emissions, for example, are sensitive to the actions of national governments that may or may not take steps to discourage uses of fossil fuels or to encourage the development of alternative fuels. But emissions are also sensitive to the investment decisions of corporations and even to the choices of individual consumers (e.g., the power of used automobiles). The release of carbon associated with the destruction of trees (e.g., the Russian taiga) is influenced in most cases by the actions of foreign consumers who have little or no concern for the environmental or climate consequences of these actions.

Since the structure of any effective governance system must be tailored to the specific problem at hand, Biermann (2005, p. 274) expressed a premise that in climate policy the *institution-building* has to convincingly deal with five characteristics:

1. Persistent uncertainties regarding causes, impacts, interlinkages, and nonlinearity;
2. Long, potentially irreversible cause-and-effect relationships and hence planning horizons that surpass the tenure, and even the lifetime, of most present decision-makers and stakeholders;
3. Complex interlinkages between different policy areas within and beyond climate policy;
4. Global interdependence and mutual substitutability of response options (for every global policy target there is an unlimited number of possible combinations of local responses across nations and time frames with equal degrees of effectiveness);
5. Possibly devastating climate change impacts that current governance systems might not be fully prepared for.

5.3 Climate change and development: potential damages and opportunities

5.3.1 Putting climate change in the context of sustainable development

It is common knowledge that climate change is closely intertwined with economic development, since its adverse consequences affect all countries, especially those whose economies or related economic sectors are based predominantly on natural resources. Climate change is also a useful reminder of why environmental issues as a whole need to be taken into account in development activities (Lamin, 2004). Research on the relationship between climate change policies and those of sustainable development is an emerging and, at the same time, obligatory international scientific issue, apparent from the UNFCCC. Article 3.4 of the Convention specifies: "the parties have a right to, and should promote sustainable development. Policies and measures to protect the climate system….should be integrated with national development programmes, taking into account that economic development is essential for adopting measures to address climate change". This so called "policy mandate to deal with climate change within the context of sustainable development" (Najam *et al.,* 2003, S10) was then re-affirmed in the Kyoto Protocol. The linkage between climate change and the priorities of wider sustainable development, providing with new opportunities, is a necessity to make progress in both areas, nationally and internationally (Swart *et al*., 2003).

Thus, the question is not just how to make development more resilient to climate change; it is how to pursue growth and prosperity without causing 'dangerous' climate change. In other words, climate change policy is not, for example, a simple choice between a high-growth, high-carbon world and a low-growth, low-carbon world, but between whether to grow or to preserve the planet (World Bank, 2010). "Development that does not take climate change into account is unsustainable" (Kok *et al.,* 2008).

The integration of climate change and sustainable development, although from a theoretical stand-point is not very challenging, is difficult in reality. It is necessary to answer two basic questions: could climate change affect the outcomes of future development paths and, vice versa, could development choices affect future GHG emissions and vulnerabilities to climate? Unfortunately, in many cases there is not a pure win–win situation. The trade-offs often have to be made between certain aspects of development and addressing climate change. In fact, the intention to make development more sustainable by bringing it in the climate dimension might be at odds with other dimensions of sustainability. Promoting large-scale bioenergy production is a prime example of a policy where higher costs of clean energy systems have to be weighed against social and economic benefits (Kok *et al.*, 2008).

The challenge is to explore how synergies can be established between development objectives, while also confronting climate change where wide participation in international climate policy cooperation is facilitated. In many countries, policies that are sensible from a climate-change perspective can emerge as side-benefits of sound development programs, but they do not arrive automatically. National policies, especially in developing and transition countries, often include goals for eradicating extreme poverty, ensuring primary education for all, encouraging female empowerment, enhancing life expectancy, access to energy for all, environmental sustainability, and so on. In their article, Halsnæs *et al.* (2008) demonstrate the relationship between these goals and climate change based on the lessons from a whole number of international country studies.

It is a known fact that climate change is only one of many sources of stress on human and natural systems; its pressures play out on the stage of broader global and regional processes of change, such as economic globalization, technological or institutional change (Wilbanks, 2003). As such, climate change adds to the list of stressors that challenge our ability to achieve the ecological, economic and social objectives defining sustainable development. However, the subject of climate change in sustainable development goes far from a trivial factor and far beyond issues of mere academic or scientific interest (Wilbanks, 2003; Yohe *at al.*, 2007). Although entire history of humankind has been a struggle to establish dominance over nature, it is still evident that climate continues to be important for human well-being, affecting the living conditions and costs as well as providing inputs for a normal human life through sustainable functioning of natural and social systems. The complexity of the problem can be partly ascribed to the fact that climate change is interlinked in both cause and effect with most areas of human activity and is inherently linked with the development goals of countries: an effective climate policy is tantamount to an effective sustainable development policy (Asselt *et al.*, 2005).

However, although there is a wealth of policy-relevant research on climate change, the examination on substantive, multiple and varied linkages between climate and sustainable development concerns is in its early days (Yamin, 2004). As Newell stated (2004, p. 120), "the fact that climate change has been so neglected as an issue by the mainstream development community should not come as a surprise, however. Not only because, despite the rhetoric, most environmental issues have yet to be effectively mainstreamed within development policy and practice, but because climate change raises a series of uncomfortable challenges for the theory and practice of development". Even the term *sustainable development* itself is understood with wide differences in the development and climate communities (Markandya *et al.*, 2002), and for a long time climate change and sustainable development have been pursued as largely separate discourses. This has led to difficulties in establishing strong working linkages between the research and policy communities at both the international level and within individual nations (Cohen *et al.*, 1998).

In particular, following the 1992 Earth Summit, the agenda of international sustainable development was taken up by the UN Commission on Sustainable Development (UNCSD), while the climate change agenda was carried forward by the UNFCCC. The cultures of these institutions are remarkably different. The former mostly deals in broad principles, seeking to address tensions among the major domains of the sustainable development discourse (e.g., economic, environmental and social sustainability). Climate change analysis and policy have been dominated by economic thinking, narrowly focused on cost-effective responses to global warming with the debate mainly confined to the economic and environmental realms of sustainable development; the social sustainability agenda was largely sidelined. Over the long term the social context under which GHG are produced has been largely ignored, except as technical questions about rates and physical processes, and climate science was mainly predicated on the idea that the objective of GHG properties can and should be distinguished from their human meanings or any social objectives in managing them. The vast majority of research funds have been devoted to reducing scientific uncertainties about the physical processes, rather than exploring the social context in which they will be understood and experienced. At the same time, sustainable development and climate change approaches are complementary and important (Cohen *et al.*, 1998; Michaelis, 2003; Munasinghe, 2003); both are seen as two evident and interlinked challenges facing humankind in the 21st century and merit careful joint analysis.

In detail, the history of 'the search of dialog' between climate change and sustainable development was traced in the first of afore-mentioned works. In the opinion of Cohen and colleagues such a situation was objective, reflecting great complexities, conceptual and methodological disagreements in the relationship among the various fields and disciplines within the global change arena. For example, while a *natural science approach* defines environmental problems in terms of physical flows of matter and energy, *a social science approach* tends to define them in terms of human behavior. As a result, initially, the sustainable development research community did not even consider how a changing climate might affect efforts to develop more sustainable societies, and the concept (as well as the methodological and substantive arguments associated with it) were practically absent from the climate change literature. The reason for this, as has been mentioned above, was rooted in the different approaches to science, politics and practice associated with the separate discourses and research cultures of the two global problems. That time opinions were summarized by Cohen *et al.* (1998, p. 342) as the follows:

> *"While the reductionism of the dominant natura1 science approach to climate change has constructed it as an environmental problem amenable to scientific analysis, this formulation has not been especially helpful in figuring out how to respond politically because it ignores the human dimensions of the problem and the difficult and locally differentiated politics of responding to it. As a result of this political detachment, the questions posed by the science of climate change have not proven terribly relevant for policy making, despite the ambitions of making science policy-relevant. By contrast,*

the human-centered sustainable development approach to environmental problems is more politically and geographically sensitive, but it is analytically vague. This makes it difficult to define or implement in practice. The solution is not to subsume one approach to the other, but to reformulate them both, recognizing their complementary strengths in addressing environmental problems".

The science-driven nature of the climate change debate and the problem-driven nature of the sustainable development field explained partly the differences in the way these two concepts have played out both as research questions and as policy issues. The logic of initial climate change research was to construct the problem as a simple physics matter and, excluding from the analysis the underlying social factors causing the problem, to facilitate its mathematical modeling. It was a reasonable step before to communicate the new scientific knowledge to widespread public attention. However, because of the overwhelmingly instrumental character of the climate change discourse, the national and international politics of global warming have been not only driven by the claims of science, but founded upon them (Cohen *et al.*, 1998).

The main negative consequences of the separation of climate change and sustainable development were: (1) weak social aspects in the first families of GHG emission scenarios and the absence of alternative patterns of development, which later can be found in SRES scenarios; and (2) separation of mitigation and adaptation in confronting climate change. Nevertheless, the discourses of climate change and sustainable development were not completely unconnected, and there were intensive attempts to combine them in research and policy initiatives. The Earth Summit in 2002 confirmed the perception of climate as of an integral part of the natural resource base, whose protection and management was recognized as an essential element of economic and social development. This perception triggered a discussion on key ethical and political issues surrounding climate change, and sustainable development became a meta-goal for international organizations linked to UNFCCC (Linnér, 2006). And although after Rio the international climate change and sustainable development programs followed their separate paths, there has been progressively greater inclusion of sustainability concerns in each subsequent IPCC assessment (Najam *et al.*, 2003).

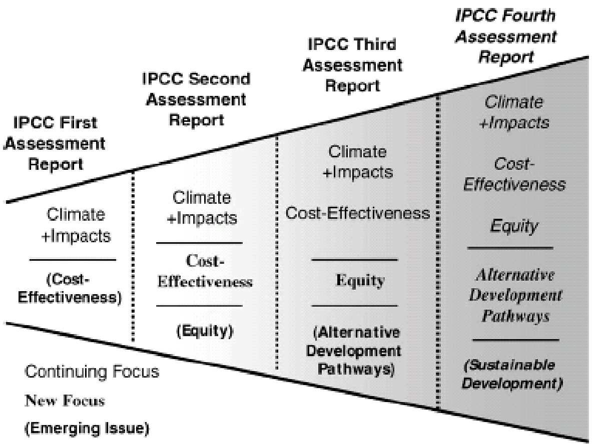


Fig. 5.13 Evolution of the IPCC assessment process as to sustainable development issues. Source: Najam *et al.*, 2003

Fig. 5.13 highlights how the range and scope of the policy analysis tools used by the IPCC have expanded over its assessment reports and how each expansion has brought it closer to a relatively deeper treatment of sustainable development.

Thus, in spite of long-time debates and rather separate paths, *the linkages* between climate change and sustainable development are multiple and profound, and with amply demonstrated evidence of their complementary and even synergistic relationship. As Tschakert and Olsson (2005, p. 330) stated, *"…sustainable development has ceased being a simple 'add-on' to climate change policies or an 'in-the-bag' side-benefit to mitigation or adaptation activities. Rather, sustainable development should be seen as the driving force in the framing of the international climate debate"*.

The complex relationship between development and climate change necessitates a two-way approach (Metz and Kok, 2008), embracing (1) the influence of climate change and climate change policy/strategy/action on development, and (2) the influence of development policies/strategies/decisions on climate change. This applies to development strategies that reduce vulnerability to climate change ('climate-safe' development or 'climate-proofing' development) and to 'climate-friendly' or 'low-carbon' development strategies. Both perspectives are important in order to effectively engage with the projected change in the climate. However, dealing with these aspects independently is not enough. Given the interconnectedness of development and climate change, only an integrated approach could work. Such an integrated (or *mainstreaming*) approach moves towards sustainable development.

The 'development first' approach, which starts from development priorities and integrates climate change adaptation and mitigation considerations, provided a framework for reconciling development and climate concerns in numerous works (Agrawala and van Aalst, 2008; Beg *et al.*, 2002; Halsnæs and Shukla, 2008; Halsnæs *et al.*, 2008; Kok *et al.,* 2008; O'Brien *et al.*, 2008; Srinivasan, 2006; and other). "The resulting climate-inclusive policies aim at development with low vulnerability to climate change and development with low emissions. They look for synergies and for a rational consideration of possible trade-offs between the different dimensions of sustainability", – Kok *et al.* (2008, p. 104) stated. One algorithm of the implementation of climate-resilient development is shown in Box 5.7.

However, on a practical note, both nationally and internationally, there is an enormous 'disconnect' between the general support of sustainable development and the practical implementation of moving in that direction by integrating climate change into development decisions. At the same

Box 5.7 Steps to implementing a comprehensive strategy for climate-resilient development

The US Economic for Adaptation (ECA) team proposes the following steps to implementing a comprehensive climate-resilient development strategy at the national or local levels:

- Start with a comprehensive approach that ideally would be an official process led by a senior government decision-maker, with significant engagement from the private sector, NGOs and academics;
- Prioritize hazards and their locations;
- Recognize the uncertainty about future climate, but do not be frozen by it;
- Define current and targeted level of penetration as well as expected growth of cost-effective priority measures;
- Focus on addressing traditional development implementation bottlenecks, such as policy frameworks, institutional capability, and organization;
- Encourage sufficient funding from the international community, e.g., technical skills, knowledge dissemination, institutional capacity-building, policy and planning;
- Recognize, facilitate and mobilize different roles for each stakeholder, including governments, private and informal sectors, communities, NGOs and individuals.

Source: ECA, 2009, p. 64

time, the latest IPCC (2007) report states that there are many opportunities for synergies between pursuing development and dealing with climate change, and much better insight has been created for understanding the trade-offs that in some cases have to be made. These trade-offs relate to aspects of sustainable development where compromises may have to be made when giving attention to climate change.

5.3.2 Nexus of climate change and sustainable development policies

In fact, climate change is linked to general development issues in a much stronger way than many other international environmental problems, and climate policies have significant synergies and trade-offs with other policy areas. Climate is a resource in itself and mediates the productivity of other critical resources (e.g., food, forests, waters, etc.), although sometimes acting as a hazard. Similarly, human development choices and policies have large and demonstrable side-impacts on the state of the climate system, resulting not only in GHG emissions. Performance of development determines the societies' ability to adapt to potential impacts. Given the precedence of economic development goals in the political agenda of nations, the many development and climate linkages imply that climate change needs to be addressed as part of a broader policy agenda (Halsnæs and Shukla, 2007). In addition to the *supply push* from climate change to the development community, there are early signs of a *demand pull* from the opposite direction. Donor agencies as well as sectoral planners are increasingly coming to terms with the issue of how to incorporate projected climate change impacts within their core development activity (Agrawala, 2004).

Najam *et al.* (2003) proposed their own version of the well-known triangle of sustainable development, putting its three elements together and additionally highlighting how each element manifests itself within climate change debates (Fig. 5.14). According to this presentation, the environmental (ecological) dimension is best reflected in the debate focusing on climate change/variability impacts; the economic dimension is encapsulated most potently in discussions related to cost-effectiveness; and the social dimension is best captured through a focus on equity.

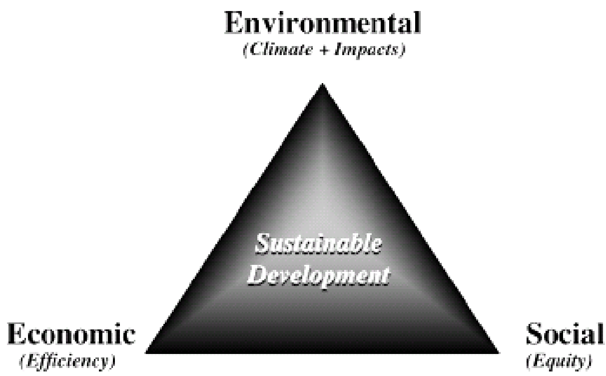


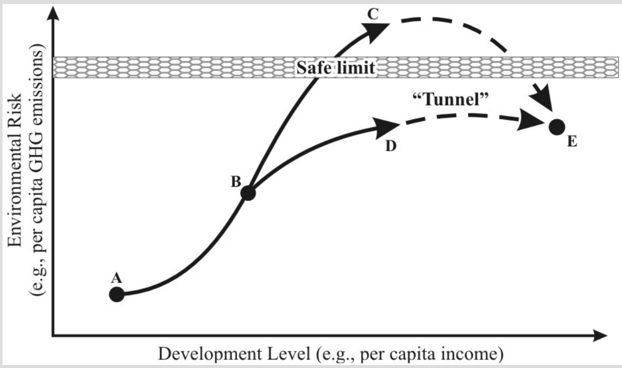
Fig. 5.14 The elements of sustainable development in the context of global climate change policy. *Source:* Najam *et al.*, 2003

No doubt, as with any other global and hard to predict environmental problem, the adverse impacts of climate change can seriously undermine the prospects for sustainable development. The driving forces for GHG emissions – population, economic growth, land use and the choice of technology – are intricately linked to development and have caused most of the current change in the climate. It is also clear that combating climate change should not hinder sustainable development, especially in developing and transition countries due their equal right to development. On the other hand, the adverse impacts of global warning should not hinder development needs. The challenge is to combine development objectives with mitigation and adaptation activities. As a possible alternative to a politically acceptable way towards an equitable, although difficult in achieving, global climate change regime, Metz *et al.* (2002) proposed to frame the debate not as an environmental problem – the industrialized countries' vision – but as a development problem. They suggest that "it certainly would appeal to developing countries and would acknowledge that the quest for a more sustainable development pattern and the implementation of climate change mitigation and adaptation strategies can mutually reinforce each other" (Metz *et al.*, 2002, p. 222). To explore these questions, they have analyzed changes in energy efficiency and the de-carbonization of energy systems, required by the IPCC SRES B1 scenario. It was shown that in a world with a strong orientation towards sustainable development to limit climate change would be generally easier. However, this type of development requires the social and institutional change supported by interventions in a much broader area of policy making than of environment/climate only. This idea is well demonstrated by Munasinghe (Box 5.8).

Box 5.8 Tunneling to restructure growth more sustainably

Economic growth continues to be a widely pursued objective of most governments, and therefore the sustainability of long term growth is a key issue. Given that the majority of the world population lives in conditions of absolute poverty, a climate change strategy that unduly constrains growth prospects in those areas would be more unattractive. A sustainomics based approach seeks to identify measures that modify the structure of development and growth rather than restricting it, so that GHG emissions are mitigated and adaptation options enhanced. Such an approach is illustrated in the figure below, which shows how a country's GHG emissions might vary with its level of development. One would expect CO_2 emissions to rise more rapidly during the early stages of development (along AB), and begin to level off only when *per capita* incomes are higher (along BC). A typical developing country would be at a point B of the curve, and an industrialized nation might be at C. If developing countries follow the growth path of the industrialized world, then concentrations of GHGs in the atmosphere would rise to dangerous levels. The risk of exceeding the safe limit could be avoided by adopting SD strategies that would permit developing countries to progress along a path such as BD (and eventually DE), while also reducing emissions in industrialized countries along CE.

Some cross-country econometrical estimations of the relationship between GHG emissions and per capita income reported dependencies like the curve ABCE, which in turn is similar to the environmental *Kuznet's curve* (EKC). In this case, the path BDE could be viewed as *a sustainable development 'tunnel' through the EKC*.



Environmental risk versus development level

Source: Munasinghe, 2003

Beg *et al*. (2002) also noted that despite some uncertainties the *economic assessment* approach has the advantage of being well known, widely accepted and frequently used to support policy and investment decisions. Though economic optimization goals still tend to dominate policy decisions, the policy-makers increasingly acknowledge that in the climate area the durability goals may call for the establishment of thresholds or critical levels that respect ecological limits, such as the rates of temperature change in a given time frame[25]. Establishing such long-term *'ecological thresholds'*, or '*safe limits'* for climate change, would be based on a review of relevant impacts and a determination of what is and is not "socially" acceptable, although in practice the uncertainties about climate impacts associated with alternative threshold levels are likely to thwart political consensus on such thresholds. The durability-based approach may also be extended to encompass broader and multiple goals aimed at maintaining "quality of life" that might come at the cost of "optimal" economic growth. Focusing decision-making on the *structure of economic development* rather than simply on the *magnitude of economic growth* assists in the systematic evaluation of trade-offs and synergies among climate and development policy alternatives.

A stronger focus on ***synergies*** between sustainable development and climate change policy efforts has been initially proposed as a way to further commitments to the large-scale reduction of GHG emissions by developing countries, with the primary goal of the synergies to enhance capacity building at the national and local levels. However, later climate change was also linked to sustainable development by a strong focus on adaptation measures, such as improved health care, infrastructure development, housing, food, and water and resource security, particularly in the most vulnerable countries. Depending on how the connection between climate change and sustainable development is framed, the linkage may involve different potential synergies, including conflicts and consequently trade-offs for agents depending on their respective goals. *'Capturing synergy'* is primarily framed in terms of avoiding overlaps, thus promoting cost efficiency by reducing potential conflicts, rather than in terms of the definition used in natural science, which includes potential conflicts among the synergetic effects (Linnér, 2006).

There are wide-ranging potential impacts of climate change on prospects for sustainable development, but, in turn, the alternative development paths will certainly affect future climate change. From the development viewpoint, climate change vulnerability, impacts and adaptation are the main elements of concerns. From the climate perspective, socio-economic development pathways first of all determine emission levels, but they also have implications on mitigation and adaptation strategies (or social responses to climate change impacts). Munasinghe (2003) provided the integrated view of the full cause-effect cycle dynamics between climate change and sustainable development across

---

[25] This discussion can be enlarged by the earlier Tolerable Windows Approach (TWA) that is widely-used in analyzing global change mitigation policy, attempting to define the boundaries of "tolerability" as guardrails against catastrophic impacts. Yohe (1999), basing TWA application in climate change mitigation policies, consider it as the intersection of windows of tolerable change drawn from a multitude of climate-sensitive systems whose diversity results in a 'virtually endless' set of criteria. So, for the economic systems a tolerable change can be defined in terms of monetized damages below some threshold; demographers and sociologists might propose boundaries based on limiting climate-induced migration or social stress; ecologists – on limiting ecosystem migration or ecosystem stress; political scientists – on preserving certain institutional structures or initiatives boundaries, and so on

all sectors (see Fig. 5.15). This figure is a more detailed elaboration of well-known Fig. SPM-1 from the IPCC TAR Synthesis Report (IPCC, 2001a).

Summarizing the author's comments to Fig. 5.15, one can say that climate and sustainable development domains interact in a dynamic cycle, characterized by significant time delays. Both impacts and emissions, for example, are linked in complex ways to underlying socio-economic and technological development paths. Adaptation reduces the impact of climate stresses on human and natural systems, while mitigation lowers potential GHG emissions. Development paths strongly affect both the adaptation and mitigation capacities. In this way, adaptation and mitigation strategies are dynamically connected with changes in the climate system and with prospects for ecosystem adaptation, food production, and long-term economic development. As such, climate change impacts are part of the larger issue on how complex social, economic, and environmental sub-systems interact and shape prospects for sustainable development, creating multiple links.

Swart *et al.* (2003) also emphacized the *linkages*, rather than *differences* between climate change and sustainable development, and the opportunities they provide for policy. If the linkages are well understood, policy synergies provide opportunities, and trade-offs can be minimized. Thereby, sustainable development measures and climate-change policies, including adaptation, can reinforce each other. The authors provided a framework for exploring these linkages and portrayed some of the texture of the interaction they envisioned (Fig. 5.16). The policy linkages are directly related to the ones between the underlying natural and socioeconomic processes.

Climate change, its driving forces and impacts have linkages with all three dimensions of sustainable development. Among those related to the environment, Swart *et al.* (2003) mentioned stratospheric ozone depletion; urban and regional air pollution; desertification,

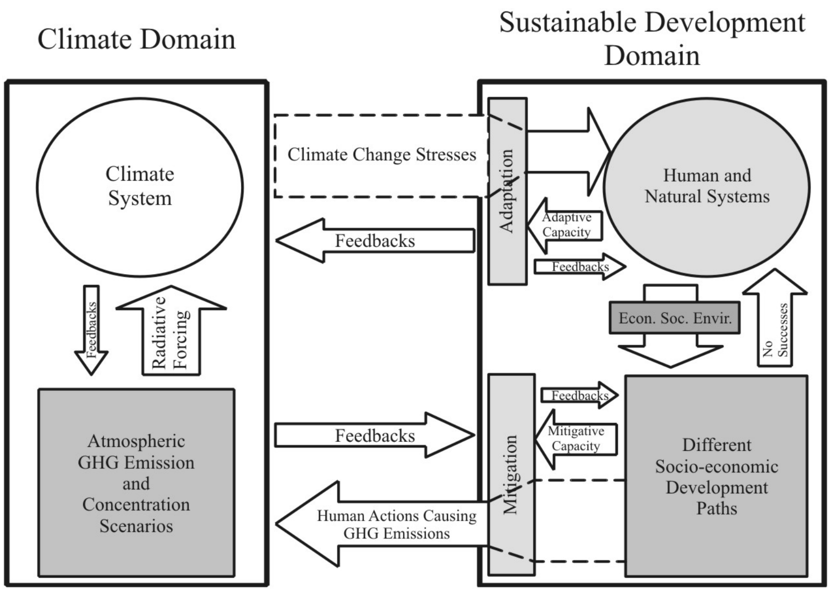


Fig. 5.15 Integrated Assessment Modeling Framework for analyzing climate change and sustainable development linkages. *Source:* Munasinghe, 2003

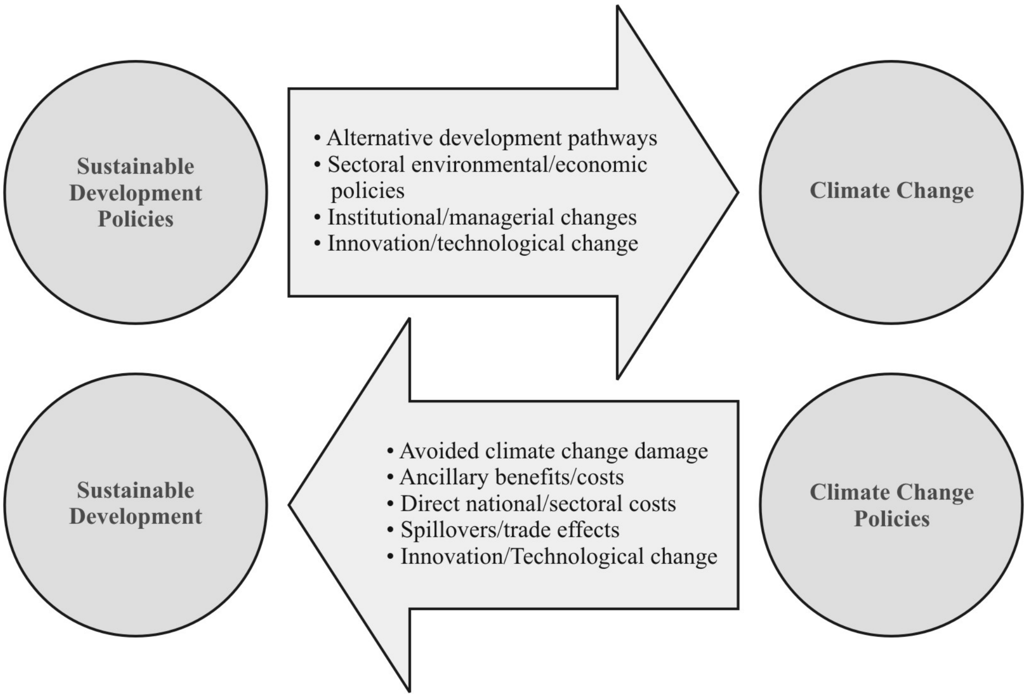


Fig. 5.16 Linkages between sustainable development, climate change and policies in these areas. *Source:* Swart *et al.*, 2003

land degradation and food production; land-use, land-cover change and biodiversity; forestry; quantity and quality of water resources. Examples of linkages between climate change and socio-economic problems include poverty; economic growth and development; human health; security and access to environmentally sound technologies.

The impacts of climate change on sustainable development – *Climate Change => Sustainable Development* (in the symbolism and interpretation of Srivastava and Heller (2003)) – are conventionally assessed in terms of their consequences for human and natural systems. The consequences would, in turn, relate to sustainability through their implications on the opportunities for economic development and its planning, on access to resources, on the different distributional equity, and so on. Positive implications for sustainable development can also result from the properly designed measures and investments enhancing the adaptive capacity of communities/systems to climate change.

Swart *et al.* (2003) divided the impact of *climate policies* on sustainable development objectives into:

(i) *Reducing climate change damages* not only through reducing GHG emissions or enhancing their sinks (mitigation), but also by reducing vulnerability and adapting to climate change. In this way, sustainable development aspirations are less frustrated by negative climatic impacts.
(ii) *Providing ancillary benefits,* for example, through abatement of local air pollution, conserving biological diversity, or enhancing employment.

(iii) *Imposing direct costs associated with measures to confront climate change,* whose magnitude and direction (whether they are positive or negative) are dependent on the strictness of the measures and their implementation.
(iv) *Causing—positive or negative—"spill-over" effects,* that is, measures in one country can have an economic effect on other countries; also, trade-effects may result from changes in competitiveness.
(v) *Inducing and spreading technological innovation (technologies and practices)*, induced by climate policies, would be also more environmentally sound in a more general sense and would spread across regions.

Climate policies, in turn, will have to be 'development-led', if they are to have any chance of achieving the political support necessary for implementation (Yamin, 2004). Wider development policies can affect climate change and the response measures *(Sustainable Development => Climate Change)* through (Swart *et al.*, 2003):

(i) *Pursuing alternative development pathways,* that means that mitigation or adaptations efforts may depend as much on underlying socio-economic and technological development paths as on specific climate policies. This follows directly from the UNFCCC stating that "The Parties should co-operate to promote a supportive and open international economic system that would lead to sustainable economic growth and development in all Parties, particularly developing country Parties, thus, enabling them better to address the problems of climate change" (UNFCCC, Article 3.5). For example, avoiding building in flood-prone and other high risk areas would also reduce vulnerability to future climate change impacts.
(ii) *Specific sectoral environmental, social or economic policies, which have climate side effects.* For example, nature conservation programs to protect forests would protect carbon storage as a side effect.
(iii) *Pursuing institutional changes.* For example, the capability to adapt to climate change can also be ameliorated by building or improving institutions to address current socio-economic and environmental problems and by enhancing social capital.
(iv) *Stimulating technological innovation and change.* For example, development of drought-resistant crop varieties to reduce vulnerability to current climate variability will also reduce vulnerability to future climate change.

Srivastava and Heller (2003), considering the ability to adapt as a function of the state of development and access to resources, list some sustainable development measures that can enhance capacities to deal with climate change and reduce vulnerabilities to impacts:

- ⇨ Reducing poverty and hunger, women's empowerment, improved access to health services, potable water, education, better infrastructure, etc.
- ⇨ Enhancing industrial productivity and competitiveness.
- ⇨ Developing programs for mitigating the effects of extreme events and natural hazards.
- ⇨ Developing an integrated, multi-hazard, inclusive approach to address vulnerability, risk assessment and disaster management.

In addition to direct influences in specific areas, it is important also to recognize a more integrated set of concerns related to *human well-being*, *consumption and social organization* (Swart *et al.*, 2003). This suggests a need to go beyond thinking of unidirectional effects of climate change on sustainable development, or vice versa, and beginning to see the both as part of a complex system of interactions, ranging from concrete issues to questions of institutional design and management, and to more abstract questions related to, e.g., identity, agency, control and power. It is difficult, for example, to simply change the technological or behavioral aspects of energy use, since these are both part of larger embedded socio-psychological and institutional practices. Thereby, we tie the climate change and sustainable development issues into the broader agendas and findings of the social sciences and humanities.

In particular, Munasinghe (2003) emphasized that *integrated* sustainable development and climate change policies must take into account the powerful *economy-wide* reforms that are commonly in use, including sectoral and macroeconomic adjustment policies, which have widespread effects throughout the economy. The highest priority needs to be given to finding 'win-win policies', which promote all three elements of sustainable development. With other policies, trade-offs among different objectives need to be analyzed. Economy-wide policies that successfully induce growth could also lead to environmental and social harm, unless the macro-reforms are complemented by additional environmental and social measures. For example, Beg *et al.* (2002), as another cross-cutting sustainability issue, consider maintaining the *eco-system "health",* which may be threatened in a number of important ways, including accelerating irreversible changes such as loss of biological species or their habitat. These concerns lead decision-makers to focus on "durability" as opposed to optimizing the "economic use" of natural resources, using principles and ideas from *environmental economics*[26] (Munasinghe, 2003).

In the context of climate change, the *social dimension* of sustainability raises a number of important "fairness" issues. Studying this question, Beg *et al*. (2002) divided them with respect to outcomes and process. On the outcome side, relevant issues include the distribution of impacts of climate change as well as of responsibilities (and economic impacts) for mitigation and adaptation actions both from inter- and intra-generational points of view. Fairness in the process of climate policy-making includes participation and access to decision-making, which will inevitably determine the perceived fairness of any policy and ultimately its effectiveness. The social dimension also encompasses institutional capacity, which determines the ability to participate in climate change decision-making.

[26] In the consideration of climate change response options, Munasinghe (2003, p. 90) included the following principles and ideas of *environmental economics*: the polluter pays principle, economic valuation, internalization of externalities, and property rights. From the *social equity* viewpoint, the polluter pays principle is based not only on economic efficiency, but also on fairness. An extension of this idea is the principle of *recompensing victims* – ideally by using the revenues collected from polluters. There is also *the moral/equity* issue concerning the extent of the polluter's obligation to compensate for past emissions (i.e., a form of environmental debt). Some concepts from contemporary environmental and social analysis are also relevant for developing climate change response options: the concepts of durability, optimality, safe limits, carrying capacity, irreversibility, non-linear responses, and the precautionary principle

5.3.3 Regionalization and globalization discourses

Climate change is not a constant factor in protecting, assuring and enabling sustainable development. Its role is highly variable geographically, and its stresses on strategies for sustainable development must be considered in a ***place-based context*** where an integrated view of complex interrelationships is more tractable and strategies for action can be made more tangible (Wilbanks, 2003). In more recent work, Wilbanks (2007) consider geographical scales as a factor in interactions between climate change and sustainable development because of varying spatial dynamics of key processes and because of varying scales at which decision-making is focused. In his metaphorical words (p. 278), "interactions between climate change and sustainable development are expressions of an ever changing dance that happens at a variety of geographical scales, and appreciating this dance is one of the keys in assuring that sustainability can be realized".

Sustainability may be viewed differently at different scales, and relevant information may not be the same (Wilbanks and Kates, 1999). Regarding, for example, vulnerability to extreme events due to climate change, Wilbanks (2007) argues that smaller scales have a lower probability of threat but less resilience if that threat were to occur, while larger scales have a higher probability of threats somewhere within them but more resilience in coping with the threat, because in principle they have access to a wider range of resources for damage response and cost-sharing.

In many cases, it appears that responses to sustainability challenges that effectively integrate understandings of both natural and human systems, such as the potential for adapting to climate change, depend heavily on location specific contexts, options, and avenues for action (Burch and Robinson, 2007). It is evident, the role of climate change in multi-stress environment, when it accentuates or ameliorates other stresses, will be different in different locales. Although *"the significance of climate change for sustainable development, compared with other driving forces, is in fact uncertain, almost certain to vary considerably with location and level of development, and likely to emerge in many areas as part of a multi-stress context for development, the intellectual—and practical—challenge is to keep it in perspective"*, – Wilbanks (2003, p. 153) noted.

Using climate change as a 'lens' for focusing on key sustainable development issues, a salient example of scale issues for sustainability is climate change adaptation, which is deeply entangled in initiatives that cross scales. The central challenge is that most effective adaptation responses are determined at a local scale. At the same time, many effective adaptation responses depend on structures and resources at global and national scales. Moreover, sustainability issues may appear different according to whether they are examined top-down or bottom-up. For instance, top-down analyses are strongly shaped by input assumptions that may not be appropriate for every locality, while bottom-up analyses can be so case-specific that extracting general lessons is difficult. Wilbanks (2007) believes that too often the top-down and bottom-up initiatives work at cross purposes. Actions at larger scales can overshadow, discourage and suppress local initiatives, by reflecting larger-scale agendas in standardized bureaucratic structures that complicate access to resources. On the other hand, actions at local scales can undermine larger-scale initiatives through political opposition or downright obstruction, by passive resistance and/or by local redirections. *"Where voluntary local initiatives are not sufficient to meet needs for sustainable climate-change-related actions, the challenge is to find ways to combine the strengths of both scales rather than having them work against each other"*, – Wilbanks (p. 284) proposes.

		External Factors: Enabling Structures Offering Resources For Adaptation	
		H	L
Internal Factors: Local Agency Offering Current Assets for Adaptation	H	Access to resources	Enhancement of external linkages
	L	Attention to local constraints	Longer term capacity-building

Fig. 5.17 Considering the differences in local concerns in top-down strategies to encourage and support adaptation. *Source:* Wilbanks, 2007

This author also argues that top-down strategies to encourage and support local adaptation should be tailored for differences in local contexts (Fig. 5.17). For instance, a locality blessed with both substantial external enabling structures and substantial internal assets for action can adapt if it has access to resources. A locality with limited external enabling structures but substantial internal assets needs attention to external linkages and structures, such as access to information about adaptation options. A locality with substantial external enabling structures but limited internal assets needs attention to internal constraints, such as a lack of local leadership. A locality with neither type of assets is not a promising prospect for adaptation without longer-term capacity-building. In any case, the aim should be to move a locality up and to the left in its capacities for adaptation, where access to resources is the only significant limitation to appropriate adaptive behavior.

Viewed through the lens of transition theory, adaptation problems with livelihoods at risk from climate change will be understood as part of a complex system with multiple chains of causality. Here, Jerneck and Olsson (2008) propose to use a multi-level representation (such as niches, regimes and landscapes) of technological and social change, rather than an ontological description. In particular:

- The *niche level* refers to individual actors (or groups of actors), technologies or practices. On this level, the symptoms of the problem are identified; in this case – the risk of damage from climate change impacts on the livelihood.
- The *regime level* refers to the web of institutions governing the predominant practices at the niche level; in this case it could represent regional markets, local credit systems and government services.
- The *landscape level* refers to slowly changing social, physical and natural structures, such as physical infrastructure, international political institutions, macro-economic conditions, and the natural environment; in this case it represents transportation constraints, agricultural trade policies and subsidies, structural adjustment programs, and global climate change.

Adaptation can occur at any level, from plant, field or farm to national or international policy and is therefore a multifaceted decision-making process. In the context of transition, this would mean interdependent multiple levels, from niche to regime and landscape. A good example would be a change from crop production to livestock involving a change in agricultural practices at the niche level, but also regime-level changes in markets and infrastructure, as well as changes in international trade at the landscape level.

Schouw (2005) demonstrates the concept of *Climate Landscapes* that has been developed and put into practice to bind the focus in local and regional policy making for sustainability in the Netherlands' energy efficiency (Fig. 5.18). In his interpretation Climate Landscapes are areas of municipalities, urban or rural, in which Energy Efficiency (EE), Renewable Energy Sources (RES) and Rational Use of Energy (RUE) culminate into sustainable energy systems (SES) that can be integrated into spatial planning and socio-economic development. It is supposed that a community that adopts this holistic approach is an effective Sustainable Energy Community (SEC). The Climate-Landscapes approach integrates RUE, EE and RES with the conservation of nature, the creation of recreational areas and new employment, with economic development and spatial planning. Thus, Climate Landscapes are a mechanism for the integration of SES in local/regional social policies (labor, economic development, etc.). Establishing the links that transcend policy areas, Climate Landscape ensures that apparently competing political claims and possibilities can be reconciled within three themes of sustainability, or the so-called three *P* of sustainable development: *profit, people* and *planet*. This triple *P* should be enriched with the forth *P* of *planning*. Spatial planning is the instrument where renewable energy techniques face other regional questions and can be integrated. Thus, within Climate Landscapes the people, planet, profit and planning form building blocks of an integrated solution.

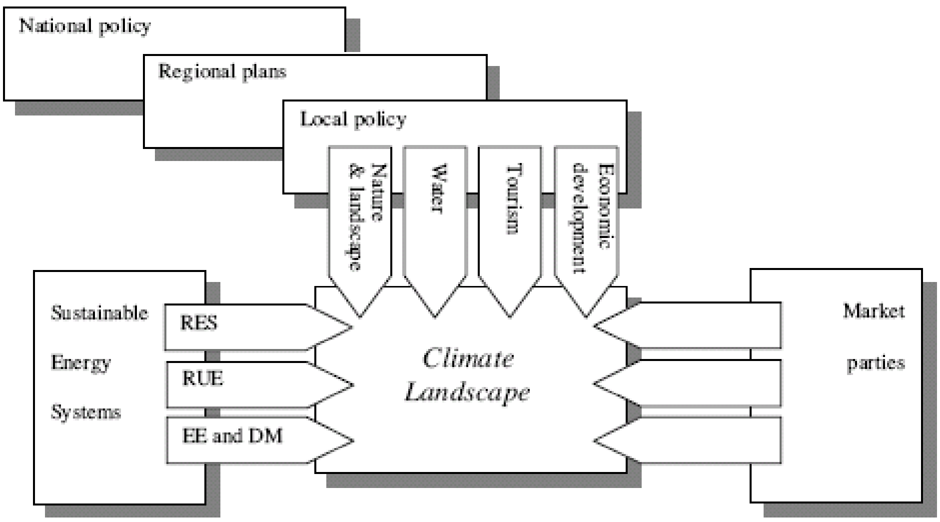


Fig. 5.18 Application of *Climate Landscape* concept for the vision of a sustainable energy system in the community (abbreviations according to the text). *Source:* Schouw, 2005

The aim of this concept is to implement a variety of SESs according to the scale and possibilities the communities afford. Climate Landscapes is a metaphor for making SES visible in communities (Fig. 5.18). It facilitates the integration and intelligent management of RES, EE and RUE by combining the knowledge of techniques, the ambitions of the politicians in selected areas and the interest of investors concerning the SES areas and technologies.

On the other hand, any discourse upon regional aspects of the links between climate change and sustainable development cannot be completed without answering new challenges caused by ***globalization processes***, which in the IPCC (2007d, p. 875) interpretation mean "the growing integration and interdependence of countries worldwide through the increasing volume and variety of cross-border transactions in goods and services, free international capital flows, and the more rapid and widespread diffusion of technology, information and culture".

Globalization processes create objective conditions for shifting of production and consumption activities from the local or national level to a global scale, and modifying or exacerbating existing vulnerabilities to climate change. The common effect of climate change and economic globalization can lead to so-called *"double effects"* or *"double exposure"* which refers to a fact when a region, sector or social group is exposed both to the impacts of climate change and to the consequences of globalization (O'Brien and Leichenko, 2002). The essence of the concept and the principal arguments of the authors can be expressed as the follows.

To estimate possible consequences of overlapping the two processes, O'Brien and Leichenko use a second concept – *'winners'* and *'losers'*. In terms of climate change, a 'win' is referred to any net benefit from changes in climatic conditions, a 'loss' – to any adverse effect. In some cases, the consequences of globalization may offset the impacts of climate change or vice versa, but the superimposing of two impacts can result in a 'double win' or in a 'double loss'. Both the 'win' and the 'loss' can be identified and measured with concrete indicators: increased (decreased) productivity of agriculture or natural ecosystems, changes in water resources or in the distribution of infection disease vectors, etc., although objective and reliable criteria still need elaboration. Climate change and economic globalization are ongoing processes with uneven impacts, and both include implicit winners and losers. Therefore, any discussions on this issue should take into account the simultaneity of the two processes and the resulting "*double exposure"*. The overlays between them must be viewed from a regional or sectoral perspective, with an emphasis on specific social groups or systems. The 'winners' and 'losers', under concurrent impacts of climate change and globalization, can form their new or modified set (configuration). It is clear, 'winners' will be those that are likely to benefit from the ongoing processes of climate change and globalization, while 'losers' – those that are likely to experience cumulative negative consequences.

"Double exposure" has important policy implications, especially for the losers. At the same time, because its consequences depend on the perspective of the study – regional, sectoral, social or another – a winner from one perspective is not necessarily a winner from the other. For example, the need for better conditions for agriculture in the northern regions of Russia can be nullified by free access of cheaper products from other countries to its market. And vice versa, new climatic conditions may frustrate the efforts to reorient economic activities for adjusting to the global economy. From a policy standpoint and to better understand the future, the joint globalization & climate change impacts should be examined, with an emphasis on how these processes may exacerbate or offset each other. The regions, sectors, or environmentally sensitive systems, which are 'double losers', should be of particular concern.

Thus, on this evidence, statements of some previous publications, for example, of Yin *et al.* (2000, p. 22), – "whilst the concept of sustainable development has been discussed world-wide, it seems to have made little progress towards linking climate change impact assessment and regional sustainability evaluation", – have significantly changed today. A challenging issue in evaluating regional sustainability under climate change conditions, namely, to design the effective options or policies that can reduce potential damages or take advantage of opportunities associated with global warming, is answered not only in the IPCC AR4 where perspectives on climate change and sustainability are discussed as an individual issue (IPCC, 2007d). For example, in 2003 the European Commission triggered a process towards coordinated actions on climate change and development by adopting the special Communication[27]. In turn, Tschakert and Olsson (2005) emphasized three most urgent areas of EU policy: (1) to promote adaptation for vulnerable groups and areas, (2) to underline clear and equitable connections between poverty eradication and climate policies, and (3) to counteract unsustainable patterns of consumption and production by promoting clean technology transfer to rapidly growing regions. In their opinion, this could promote not only full incorporation of sustainable development into the EU policy on climate change, but also assign it a leading role in this process.

5.3.4 Sustainable development and adaptation

5.3.4.1 Mainstreaming adaptation and adaptive capacity in sustainable development

Despite the fact that humans have always adapted, more or less successfully, to the climate of their environment, including its stress and shocks, adaptation is now receiving increasing emphasis in climate change and development discourses, aiming to be 'folded into' existing plans for 'improving' development. There has also been a considerable evolution in the dialog between climate and development communities on the issue of adaptation to climate change. First of all, there are problems about what this actually means (see Chapter 3).

Adaptation measures embedded within climate-change policies should, by design, try to reduce climate change vulnerabilities and risks by enhancing the adaptive capacity of communities and economies, and thus being consistent with sustainability goals. Yamin (2004) sees a cause of difficulties to resolve the problem in two different interpretations of the term *vulnerability*. We would remind that these interpretations, confounding the issue, had been initially named by O'Brien *et al.* (2004) as an '*end point'* and *'a starting point',* and later were conceptualized as '*contextual vulnerability'* and '*outcome vulnerability'* (O'Brien *et al.*, 2007). Seeing climate change impacts in an 'end point' focuses attention

[27] European Commision (EC), nd: *Communication from the Commission to the Council and the European Parliament: Climate change in the context of development cooperation.* Available at: *http://europa.eu/scadplus/leg/en/lvb/r12542.htm*

on adaptive capacity as the main determinant of the ability to cope. Development approaches, on the other hand, more commonly see vulnerability as a "starting point", whereby vulnerability determines future adaptive capacity. This viewpoint stresses the necessity in adaptation now. The 'end point' approach tends to result in climate change being regarded as an anthropologically incremental add-on to natural climate variability. However, this is logical until such an approach seems also to go hand-in-hand with relegating climate change to the level of incidental background noise, with tiny streams of funding then being justified to cope only with "increment" (Yamin, 2004).

Despite the flurry of interest in climate change adaptation from certain parts of the development community, there is also a fair degree of skepticism from others. Agrawala (2004) distinguished three principal questions here:

- How does a global concern like climate change, aspects of which might manifest itself decades to centuries in the future, compare with more immediate local/regional priorities for development, such as poverty or food security?
- How can we access the exposure of development portfolios to potential risks of climate change?
- Given that coping with the impacts of weather extremes is already an integral part of ongoing development activities ranging from famine early warning and flood plain management, would climate change really require anything different in operational terms?

Nevertheless, recent research and policy initiatives have moved adaptation from being the "handmaiden to impacts research in the mitigation context" (Burton *et al.*, 2002) to an activity that is considered crucial within the broader context of sustainable development. The link between adaptation and development is particularly relevant when seeking to enhance the capacity of people and communities to adapt to climate change. Research on economic development supports the fundamental observation that the factors determining a country's ability to promote sustainable development coincide usually with the factors influencing an adaptive capacity relative to climate change/variability impacts. Here, as before, when the links between climate change and sustainable development were discussed, we can see a two-way causality, but this time between sustainable development and *adaptive capacity* to climate change; the pace and character of development influences the adaptive capacity and, in turn, the latter influences the pace and character of the former. Development paths and the choices defining them will affect the severity of climate change consequences not only through the features of system exposure and sensitivity, but also through its capacities to adapt to new conditions (Yohe *et al.*, 2007). In particular, Yohe and colleagues (p. 816) emphasized that "…the list of determinants of adaptive capacity: *access to resources, entitlements* (property rights), *institutions and governance, human resources* and *technology*…conform well to the "5 capital" model articulated by Porritt (2005)[28] in terms of human, manufactured, social, natural and financial capital".

In the early 2010s, Halsnaes (2002), in his review of the literature on climate change and sustainable development, emphasized two things: (1) the potentially wide range of climate change mitigation policies has significant co-benefits on the local environment and

[28] Porritt J., 2005: *Capitalism as if the World Matters,* Earthscan, London, 304 pp.

development; (2) the impacts of mitigation projects on sustainability are very site and context specific; therefore, their actual effects from case to case should be assessed in relation to national development priorities. Sure, these conclusions are true for adaptation actions as well, but keeping in mind the principal difference between mitigation and adaptation: the former attempts to prevent the climate change problem from occurring at all (or getting worse), whilst adaptation aims to cope with the problem of climate impacts when they occur or are expected to occur (Hug and Reid, 2004).

Past adaptation and development experience displays mixed results. For example, Klein *et al.* (2005) suggest that adaptation has not been seen as a viable option, both because many observers see market forces creating the necessary conditions for adaptation even in the absence of explicit policies, and because understanding of how future adaptation could differ from historical experience is limited. However, IPCC AR4 (Yohe *et al.*, 2007) accepts that the challenge of mainstreaming adaptation into development planning will be a critical moment in understanding what policies will work, where and when. It also states that future links between sustainable development and climate change will evolve from current development frameworks, recognizing the exposure of places and peoples to multiple stresses.

The need to mainstream adaptation to climate change into development planning and ongoing sectoral decision-making is increasingly recognized (Agrawala and van Aalst, 2008; Klein *et al*., 2007; Kok *et al.,* 2008; Metz and Kok, 2008, and other). In many cases the risks posed by climate change can affect the efficiency, with which development resources are invested, and the eventual achievement of many development objectives, causing a need to integrate adaptation to climate change within a range of development activities. Mainstreaming involves the integration of policies and measures that address climate change into development planning and ongoing sectoral decision-making, so as to ensure the long-term sustainability of investments as well as to reduce the sensitivity of development activities to both today's and tomorrow's climate. In particular, Klein *et al*. (2007) distinguish two things that can be achieved by mainstreaming. First, it can contribute to the climate proofing of existing projects ensuring that their modification makes them no longer at risk from climate change, or no longer likely to contribute to the vulnerability of their recipients. The second type of mainstreaming has implications for the formation of development priorities and projects themselves. It can ensure that future projects and strategies are consciously aimed at reducing vulnerability by including priorities that are critical to successful adaptation, e.g., ensuring water rights to groups exposed to water scarcity during droughts.

Adaptation to climate change is fundamentally linked to development both for the developed and developing countries, and thus mainstreaming adaptation is not only an issue for the developing world, but a subject, which merits further universal analysis (Agrawala, 2004). It is also clear that many of the activities, which need to be undertaken to reduce vulnerability, relate closely to the ongoing mainstreaming development activities at different levels, and several findings have emerged from the body of work that relates to this challenge within development planning. General rankings of economic development performance and general reflections of different levels' goals and aspirations can play critical role in choosing the different development alternatives. Here, Hug and Reid (2004) distinguished the following levels:

1. *Local level,* where the most severely impacted communities will be those living in geographical regions most exposed to climatic impacts (e.g., flood- or drought-prone areas).
2. *Sectoral level,* where in a sectoral planning the policy-makers, planners and managers need to anticipate the future impacts in the most adversely impacted sectors.
3. *National level*, where policy makers need to take into account potentially adverse impacts in different sectors and take policy decisions across different sectors.
4. *Regional level*, where common regional actions (e.g., for transboundary river basins management) should be undertaken. At present, the regional level is also the smallest scale at which potential climate change impacts under different scenarios can be effectively modeled.
5. *Global level,* where any implementation of adaptation actions requires the global community or nations to act together.

Effective integration of climate change adaptation into mainstream development activities remains the essence and the greatest challenge if current efforts are to prove be successful and sustainable in the long term (Lamin, 2004). It is evident that consideration of climatic risks might often be central to development investments and projects. However, the issue of *"mainstreaming adaptation"* has caused some friction between stakeholders in the climate change discussion. This is because this term sometimes is used in the distinct senses. For example, Hug and Reid (2004) differentiate:

1. *Mainstreaming adaptation into development* that requires that main actors engaged in development work (governments, funding agencies, NGOs, local communities, etc.) should increase their awareness of the potentially adverse impacts of climate change and then to 'mainstream' relating issues into their regular activities.
2. *Mainstreaming adaptation funding* that refers broadly to utilization of existing Official Development Assistants (ODA) resources to fund climate change related adaptation.

In other words, mainstreaming adaptation in development is not the same as mainstreaming adaptation funding. The absolute magnitude of official flows in sectors potentially affected by climatic risks is considerably higher than funding amounts committed to *financing adaptation* as part of the climate change regime. Therefore, over the long term, there appears to be far greater potential for mainstreaming adaptation within core development activity, compared to the financing of action on adaptation initiated from within the climate regime.

Drawing upon illustrative case studies in six developing countries, Agrawala and van Aalst (2008) examined the synergies and trade-offs involved in integrating adaptation to climate change in development cooperation activities. They identified main barriers and methods to more effectively mainstream adaptation, the three of them are the follows:

- Barriers within governments and donor agencies
- Insufficient relevance of available climate information to development-related decisions
- Trade-offs with other priorities.

On the other hand, in their opinion, adaptation can be better integrated in development through:

- Making climate information more accessible, relevant and usable
- Developing and applying climate risk screening tools
- Using appropriate 'entry points' for climate information
- Shifting emphasis to implementation rather than developing new plans
- Encouraging meaningful coordination and the sharing of good practices
- Involving non-governmental partners
- Transboundary and regional coordination.

Kok *et al.* (2008) studied the influence of international frameworks and agreements on the mainstreaming of climate change into development policy. Usually, these institutions are not designed to promote integration between different policy areas, and institutional structures often complicate such integration. Some opportunities to better use existing policy frameworks, in the hope of achieving sustainable development and climate benefits at a national level, are shown in Box 5.9.

Box 5.9 Effective ways of mainstreaming climate change into different policy areas at a national (sub-national) level

Experience shows that integration of development and climate policies can be most effectively achieved if:

- Take the evolving political and economic conditions in the country as the point of departure, and concentrate on the main policies and programs that form the core of development planning.
- Acknowledge the importance of the sub-national level for implementation of measures to reduce vulnerability; local level solutions are key. Without the involvement of decentralized institutions, local development planning, and use of participatory approaches, policy implementation is not likely to be successful.
- Develop shared strategies between relevant ministries and governmental bodies and allocate responsibilities in a coordinated manner. National development strategies, sector and environmental strategies, strategy poverty reduction papers, the planning and budgeting process offer opportunities to mobilize coordinated efforts. It is not primarily a matter for the Ministry of Environment; action also has to come from other Ministries (Economy, Finance, Agriculture, Energy etc.) where the core decisions on development are taken.
- Promote a risk-management approach in public and private decision making, so that stakeholders will take into account uncertainties on climate change and its impacts. An important contribution can be made by the scientific community in communicating these climate change risks to all stakeholders in the development process.
- Consider climate change as a cross-cutting issue in development assistance. This implies moving away from a situation in which the topic is dealt with by climate experts in a special field and integrating climate change with other development policy areas.
- Focus on facilitating national governments in their process to mainstream development and climate. Capacity building and capacity utilization will be key factors.
- Show realism in dealing with synergies and trade-offs; the former are not always possible, especially when markets are imperfect.

Source: Adapted from Kok *et al.* (2008)

5.3.4.2 A conceptual framework of synergistic adaptive capacity

The whole point of the work on adaptation processes is to know risks (and opportunities) associated with practical addressing the climate change challenges in policy and decision making. One of the fundamental findings is that it is extremely unlikely for any type of adaptive action to be taken in light of climate change alone: practical climate change adaptation initiatives are invariably integrated with other sustainable development programs (Smit and Wandel, 2006). Tschakert and Olsson (2005), arguing the need for explicit focusing on adaptation and sustainable development in future climate change programs, consider adaptation as a key synergistic element between climate change and sustainable development. In their opinion, although a number of substantial funds and mechanisms related to climate change and sustainable development policy regimes are now available, there are serious bottlenecks for creative actions that restrain adequate policy responses in practice. What is lacking most of all is a clear notion of synergies between climate change and sustainable development which ought to be based on the 'livelihood empowerment' mode and be linked to reduced social vulnerability. Making a difference between spontaneous, planned and forced adaptations, they refer the latter to cases where an inadequate response results in losses of life and property, and a few 'lucky survivors' force upon a large mass of 'losers'. In their opinion, such type of adaptation[29] is ethically unacceptable. Through a sustainable development lens, any adaptation to climatic stressors must include not only the clear understanding of social and economic processes that facilitate or constrain it, but also whether or not the outcomes are equitably distributed. In other words, processes of adaptation are intrinsically linked to the wider political thinking about uneven development resulting in winners and losers. Thus, it is proposed (Adger *et al.*, 2007; Tschakert and Olsson, 2005) to discuss adaptation not only within the context of biophysical stressors, impacts, and prevention but also, or even primarily, to refer to the *'social vulnerability',* and any conflicts over decision-making, participation and the distribution of benefits should be addressed from the very beginning and include an efficient approach to rigorously assess trade-offs between the social, economic and environmental criteria.

Sustainable development appears most feasible if undertaken through the lens of a *social vulnerability* framework that focuses explicitly on enhanced adaptive capacity and risk management. In particular, such a social vulnerability approach can be highly useful when addressing the inherent dilemma between basic survival strategies and more complex development options. The former often aim to simply reduce poverty and risk aversion in the short run, but deteriorate them into dead-end solutions in the long run ('missionary hand mill' mode). In contrast, the complex development options imply more flexible and diverse opportunities to cope with risks and develop adaptive responses at a larger scale ('livelihood empowerment' mode). The evolution of the emerging synergies and its current shortcomings are summarized in Box 5.10.

To make these synergies more apparent, Tschakert and Olsson (2005) proposed a conceptual framework entitled *synergistic adaptive capacity (SAC)* that substitutes poverty

---

[29] Policies and practices that are unrelated to climate but which still increase a system's vulnerability to climate change are termed ***'maladaptation'*** (Burton, 1996, 1997).

eradication, as put forward in the general development policy regime, with increased adaptive capacity/ reduced social vulnerability. An enhanced adaptive capacity constitutes not only an important response to climate change but is also a key to sustainable and equitable global environmental management. Thus, in the proposed framework the *adaptive capacity* is in its centre, but along with *equity* that should be taken into account. Fig. 5.19 depicts this synergistic role: the equity filter ensures a more equitable distribution of roles and responsibilities in four directions: short-term adaptation, long-term mitigation, production and consumption, and environmental sustainability. In the opinion of its authors, the framework should be embedded in political economy thinking and can be used by the EU to better align its policy architecture for the post-2012 climate negotiations.

Box 5.10 Emerging synergies between climate change and sustainable development based on a 'pro-poor' focus on vulnerability and adaptation

- Socio-economic development patterns determine the vulnerability to climate change and the human capacity for mitigation and adaptation;
- Present livelihood and risk management strategies are an efficient entry point for assessing and enhancing adaptive capacity and measures relating to climatic and non-climatic stressors;
- Social capital and strong institutions that address socio-economic and environmental problems often improve also people's capability to mitigate climate change or adapt to it;
- There is an apparent shift to social actors and their capacity to simultaneously contribute to mitigation and adaptation (mitigative and adaptive capacity);
- The adoption of an 'ecosystem approach' (integrated management of land, water, and living resources) provides a more holistic understanding of ecosystems and their social actors.

Current shortcomings

- Synergies between mitigation options, adaptation benefits, and sustainable development are assessed mostly qualitatively, based on best guesses (low-high, positive-negative);
- Strong bias towards technical solutions rather than institutional strategies focusing on human agency;
- Focus on ‘produced’ adaptation, as an indirect contribution from integrated ecosystem management, rather than an explicit policy priority that is oriented towards the enhancement of adaptive capacity;
- Some alarming parallels to sustainable development, unrealistically perceived as a by-product of CDM projects without a clear emphasis on equity.

Source: Klein *et al.*, 2003; Swart *et a1.*, 2003; Tschakert and Olsson, 2005

The SAC framework considers adaptation and adaptive capacity as a key to resilient livelihoods, reduced social vulnerability and strengthened risk management. At the same time, an improved adaptive capacity to a variety of stressors is likely to contribute to better adaptation to climatic stressors, to more efficient mitigation strategies and more effective integrating the excluded poor into market, to more sustainable environmental management (Tschakert and Olsson, 2005).

A crucial element for promoting the synergistic adaptation paradigm, at the level of both policies and Official Development Assistance (ODA), is to adopt a livelihood diversification approach and focus specifically on differential access to natural, human, productive, social, and institutional capital. A 'pro-poor' approach means deliberately working with those who have the least adaptive potential to promote strategies that could reverse negative trends, at least in the short run, even if overall economic or ecological gains are not maximized.

It is necessary to understand clearly that whereas adaptation is a matter of need, it is also a matter of equity, since its impacts fall disproportionately on those least able to bear

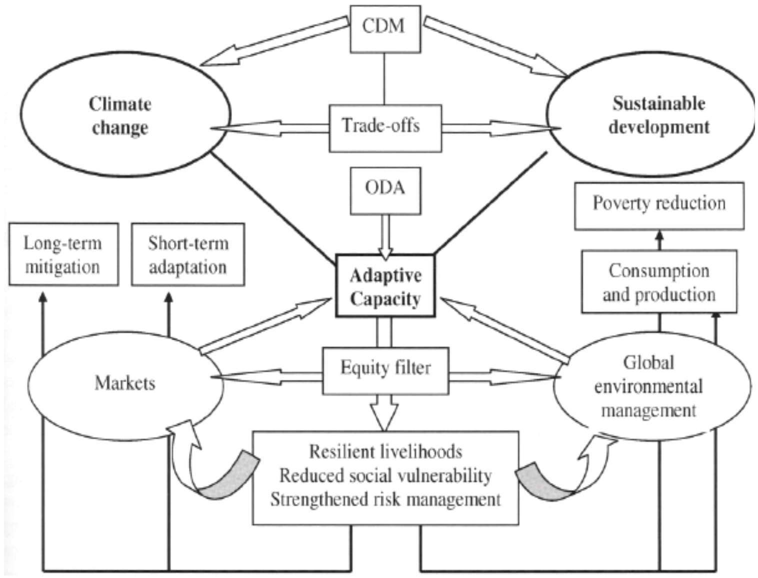


Fig. 5.19 A conceptual illustration of the *synergistic adaptive capacity (SAC)* framework. *Source:* Tschakert and Olsson, 2005

them. Moreover, those most vulnerable to climate change are the ones least responsible for it. Adaptation to climate change is not a future scenario for the world; it is already happening, at least in rich countries. However, the contrasts are striking. If, for example, in the Netherlands or London people are being protected against the risks associated with rising sea levels through public investment in infrastructure, in the poorest countries adaptation is largely a matter of self-help (UNDP, 2007a). Inequalities in capacity to adapt are becoming increasingly apparent.

The question is also how to turn the identification and understanding of the links between climate change and sustainable development into actions needed to respond to the former and to make development more sustainable at the same time. Swart *et al.* (2003) discuss two approaches to address this question. The first includes the concept of *alternative development pathways* that recognize that "the world's development is influenced by myriads of decisions made by individual human beings", or "thinking through the characteristics and consequences of alternative development pathways". The second approach includes policies, which integrate climate change and broader development concerns to address them simultaneously, or "evaluation of specific adaptation and mitigation policies integrated into general development policies". They argue that similar climatic futures can have very different socio-economic impacts due to the different levels of vulnerability/resilience of communities or economic sectors, and different climatic futures can have very similar socio-economic impacts because of similar, limited vulnerability. That is why the nature of the development path may be at least as important for adaptation and vulnerability reduction as policies specifically targeting these aims. IPCC AR4 (Yohe *et al.*, 2007), summing the efforts to promote adaptive capacity and alternative development pathways that are more sustainable, named some factors that are critical in a broader development context and extend the context beyond a particular climate change stress. Those, for example, incorporate different aspects of broader social dimensions including societal engagement and rights, education, health and governance, as well as local-scale disaster risk reduction and resource management.

A qualitative assessment, carried out by Swart *et al.* (2003), illustrates how a development path could affect the projected adaptive capacity and vulnerability of societal systems (Table 5.12). The development paths addressing local and regional sustainability issues (such as modeled by SRES B1 scenario), with an emphasis on the development of human and social capital, and appropriate technology in order to reduce vulnerability to current climate variability, would also better prepare communities to adapt to future climatic changes. In a scenario with slow and inequitable economic development, with less rapid technological change and high population growth (e.g., SRES A2), the vulnerability would be high; vulnerability also is increased by larger climate impacts and decreased by higher levels of development. By this assessment, its authors demonstrate that development paths should be assessed on their adaptation/vulnerability aspects. Policies specifically aimed at reducing vulnerability can also be more effective if other development objectives are included. Taking climate change into account implies a difference in weighing different criteria and hence is likely to influence the priority ranking and implementation characteristics of policies.

Thus, sustainable development, as a very broad conceptual framework that includes a wide range of short- and long-term policy goals, is highly relevant to climate change policy analysis and may be introduced as a general approach for assessing climate change adaptation studies. So, Yin *et al.* (2000) consider the understanding of relationships between climate change impacts and sustainable development as a prerequisite for better decision-making: once an understanding of climate related threats to such development is established, consideration of adaptation options can then follow. This approach has thrown up a number of theoretical and practical complexities relating to the very broad policy agenda that sustainable development, by definition, is trying to address (Halsnaes, 2002). Comprehensiveness is an important requirement in the study of sustainable development and climate change links. The scope of analysis needs to extend from the global to local scale, to cover time spans extending as long as centuries or more, and to deal with problems of uncertainty, irreversibility and non-linearity. The approach, integrating the economic, social and environmental dimensions of sustainable development, must provide their balanced treatment along with the traditional emphasis on the development *vs.* sustainability discourse.

Table 5.12 SRES scenarios and proposed rating of vulnerability

SRES scenario	*Projected climate impacts*[a]	*Projected adaptive capacity*[b]	*Future vulnerability as to present*
A1F1	+++	++	More vulnerable
A1B	++	++	About the same
A1T	++	++	About the same
A2	+++	+	Much more vulnerable
B1	+	+++	Less vulnerable
B2	++	++	About the same

Note: [a] *adverse climate impacts*: +++ high, ++ intermediate, + low; [b] *adaptive capacity*: +++ large, ++ moderate, + low. *Source:* Swart *et al.*, 2003

Winne *et al.* (2005), discussing a long-term European strategy on climate change policy, noted that although a post-2012 climate policy regime could be created without addressing sustainable development explicitly, for developing and transition countries this linkage might be crucial; the reverse (i.e. addressing sustainable development without addressing climate change) is not possible. They argue (p. 248): *"climate change is certainly a sustainable development issue and there are important policy linkages, but diluting climate change in the broader sustainable development context might slow progress on climate change. On the other hand, singling out climate change might not attract sufficient policy attention"*.

5.3.4.3 Integration of adaptation and mitigation in sustainable development policies

The links among adaptation *(A)* and mitigation *(M)* in the context of sustainable development *(SD)*, usually referred to as *AMSD* (Bizikova *et al*., 2007; Swart and Raes, 2007; Wilson and McDaniels, 2007), are necessitated by the requirements of complex decisions in responding to climate change. The two last authors see the underlying reasons for AMSD as the following:

- Many dimensions of the values that serve as the motivation for these decisions are, in broad terms, common to all three decision contexts. Values can be understood here simply to mean what is ultimately important to decision-makers;
- The impacts from any one of these three decision contexts may have important consequences for the other contexts;
- The choice among alternatives in one context is therefore a potential means to achieving the underlying values important in other contexts.

Moreover, the quoted authors summarized certain characteristics that should be addressed by AMSD structured decision processes[30]:

- AMSD decisions often involve multiple scales of impact (across both time and space), and multiple scales of governance;
- A related point is that AMSD decisions involve complex relationships between *ends* and *means:* ends (or fundamental objectives) in one context (adaptation or mitigation) may be means in another, broader context (sustainable development);
- A major commonality includes uncertainties and path dependence within AMSD decision contexts, which suggests that approaches are needed to foster learning over time about these repeated decisions;
- AMSD decisions would typically be made within pluralistic decision processes, often involving civil society.

Discussion of these four commonalities of AMSD decisions through the detailed discussion of their concepts, methods, tools, and stepwise application can be found in the cited work (Wilson and McDaniels, 2007).

Bizikova *et al.* (2007) also emphasize that linkages between adaptation and mitigation are highly context-specific and place-based, depending on the priorities guiding development. In this way, AMSD demonstrates that climate change adaptation and

---

[30] "*Structured decision-making* is a 'participant-friendly' term referring to the practice of decision analysis in public policy contexts" (Wilson and McDaniels, 2007, p. 355).

mitigation are a part of the wider development goals in transition towards sustainability. Moreover, the effectiveness of their own measures is limited, especially those that aim for behavioral changes without challenging the underlying development pathway.

The special issue of *Climate Policy* journal (No 7, 2007) identified a number of methodological challenges to advance AMSD. These measures, generalized by Bizikova and co-authors (2007) include actions to:

- ✓ Enhance multidisciplinary assessments in developing complex policies.
- ✓ Expand participatory integrated assessment to built models that should facilitate the involvement of stakeholders in defining the course of development pathways and create a context for adaptation-mitigation linkages by linking impacts and vulnerability with effectiveness of mitigation efforts.
- ✓ Elaborate the linkages between adaptation and mitigation capacities and actions. This entails analyzing the diversity of their dimensions, including social, economic, institutional, technological and cultural characteristics, and facilitates identifying shared areas, connections, and potential reinforcements between their strategies.
- ✓ Develop methodologies to assess trade-offs between adaptation and mitigation in respect of uncertainties. In this context, diversity of values and development priorities create support for actions and policies.
- ✓ Promote two-way communication in defining projects and disseminating results.

Swart and Raes (2007) provide some examples of approaches, which link adaptation and mitigation at different scales, and three dimensions of sustainable development (Table 5.13).

5.3.5 Building capacities to confront climate change

5.3.5.1 Capacity for sustainable development

There is no 'one size fits all' formula for either capacity or capacity building. UNDP (2002) proceeds from the belief that a society's ability to move towards sustainable development is determined by the capacities of its people and institutions, as well as the ability of public, civic and private sectors to perform their functions, to solve problems, to set and achieve objectives. "The capacity of each society corresponds to the functions and objectives it sets for itself" (*ibid,* p. 151). Undoubtedly, such capacity must be developed.

Heugens (2006), discussing management of the environment, places *capability,* as one synonym of capacity, into the hierarchy of three related concepts, namely *skills, capabilities* and *competencies,* with the following meaning:

- *Skills* are a specific ability or proficiency deriving from practice or experience that allows organizations to perform certain tasks. Skills are embedded in organizational routines: repetitive and predictable behaviors developed by organizations using certain resources and tend to be useful only in specialized situations. Many learning opportunities are determined by the present stock of available skills, and learning usually focuses on the improvement of existing skills rather than on the acquisition of radically new ones, thereby creating natural trajectories or path dependencies of skill development.

Table 5.13 Examples of adaptation–mitigation linkages for different scales and dimensions of sustainable development

Dimension	Scale		
	Global	*Regional/national*	*Local*
Economic/ development dimension	Analyse theoretically optimal shares through cost–benefit analysis	Mainstream climate into development/sector policies, identify most efficient way	Avoid economic trade-offs, research most efficient solution taking into account co-benefits
Examples	*Analyse theoretically optimal shares of mitigation and adaptation action to support international negotiations*	*Include climate change mitigation and adaptation concerns in energy and water policy, spatial planning, development aid*	*Evaluate mitigation potential of renewable energy taking into account possibly increased vulnerability to climate change*
Institutional/ social dimension	Negotiate balance adaptation and mitigation actions in UNFCCC context	Link local with global through national/regional SD policies (link different actors)	Enhance adaptive and mitigative capacity, involve stakeholders
Examples	*Account for justice, compensation, common but differentiated responsibility*	*Translate commitments from international agreements into framework for local actors (e.g., EU emissions trading system)*	*Inform local stakeholders (farmers, companies, citizens) about climate change risks and mitigation opportunities*
Environmental/ precautionary dimension	Determine acceptable level of climate change limits to adaptation (UNFCCC Article 2)	Determine environmentally most effective national policies	Protect ecosystems, health, search synergies
Examples	*Evaluate the EU's 2°C climate goal, taking into account adaptation as well as critical vulnerable ecosystems of global importance*	*Develop ecosystem and water basin management strategies taking into account adaptation and mitigation concerns*	*Manage protected areas taking into account climate change impacts, carbon sink function, and biodiversity*

Source: Adapted from Swart and Raes (2007)

- *Capabilities* can also be identified as repeatable, rule-guided patterns of actions; however, they occupy a higher position in the hierarchy because represent more complex and often interactive combinations of various lower-level organizational skills. Capabilities adapt, integrate and reconfigure internal and external organizational skills to match the requirements of a changing environment.
- *Competence* is an organizational ability to sustain the coordinated deployment of assets in a way that helps to achieve the goals. Competencies are at the top of the hierarchy of organizational abilities, not only combining several lower-order skills (like capabilities), but also integrating them to bring coherence to organizational actions and problem-solving routines.

The Brundtland Commission's definition of sustainable development is conceptually appealing, but for most people it only becomes real in specific actions or results related to energy, water, environmental health, biodiversity, etc. That is why, Dobie (2002, p. 8) is of opinion that capacity-building is a product of the process, and if a strategy is written by experts, no new capacities are built. But if "…people are trusted with the task of managing the process, they become knowledgeable, skilled and empowered. New skills need to be taught, and these are best identified through the implementation of a process, rather than being established in advance as the tools to drive the processes”. Namely this logic forms the notion *‘Learning through doing’*. *“Making changes that lead to sustainable development,* – Dobie continues (p. 9), – *requires the people to know what they want to achieve. They must work out what is good and what is bad about their current situation, agree on what changes are needed and then make the changes”*. He expressed this idea as:

Vision ⟷ ***Analysis*** ⟷ ***Action***

Following the Earth Summit 1992, the UNDP launched the Capacity 21 program to help developing and transition countries to integrate the principles of Agenda 21 into their national and local development initiatives. The key principles that lie at the heart of any Agenda 21 process have also served as the main building blocks for Capacity 21 (UNDP 2002, p. vii):

- *Participation* of all stakeholders in programs development, implementation, monitoring and learning;
- *Integration* of economic, social and environmental priorities within national and local policies, plans and programs;
- *Information* sharing among sustainable development actors to help people make better decisions.

UNDP (2002) also outlined recent changes in thinking about capacity. The traditional view – *capacity building* – stemmed from the ‘engineering’ approach that was characterized by top-down flow, based on blueprints, and was implemented hierarchically. A new emerging view – *capacity development* – substitutes these characteristics, growing out of a holistic, organic approach that emphasizes bottom-up development with a non-predetermined blueprint and a non-hierarchical network model to resolve problems. Capacity development is multi-stakeholder in nature, drawing civil society and private sector organizations into the planning, design, and implementation of programs; however, it would also encompass the public sector. The principal differences between these two concepts are shown in Table 5.14.

Table 5.14 Differences between *capacity building* and *capacity development*

Issue	*Capacity building*	*Capacity development*
Focus	• institution-building • “getting the pieces right” • transfer of information	• ownership • “getting the approach right” • acquisition of knowledge
Concentration of efforts	Government and public sector	A society as the whole
Flow of expertise and knowledge	North–to–South	Global networking (North-South, South-North and South-South interchange)
Basing on	Short-term projects with little attention to either longer-term retention or loss of developed capacities	Medium- and long-term projects accented on the maintenance and expansion of knowledge and nurturing the capacities developed

Source: UNDP, 2002

A second principal moment is: *What is capacity development for sustainable development?* According to UNDP (2002, p. 147) this means "…the sum of the efforts needed to create, nurture, enhance and grow the skills of people and their institutions and to set in motion those long-term processes that will make peoples' lives and livelihoods more sustainable". Capacity for sustainable development is also "…the sum of both human and social capital interacting with physical capital – the resource base – and financial capital".

Cherp and Vrbensky (2002) carried out the SOT analysis of the Capacity 21 support of sustainable development in transition countries. The analysis was mainly structured around two themes: (1) promoting a different kind of planning and (2) capacity building for sustainable development. Since in the past the government planning agencies in these countries sought to direct nearly all economic, social and environmental activities, one of transition goals was to redirect the 'driving' of many of these activities to market forces. An inherent threat in this process was the danger that short-term economic priorities might displace critical long-term priorities, especially in the social and environmental domains. Moreover, the emerging ecological restructuring of capitalism cannot guarantee its ecological sustainability; it gives rise to new problems and contradictions rendering ecological sustainability of capitalism uncertain (Vlachou, 2004). Partially due to this factor, national Capacity 21 programs sometimes supported the creation of new institutions with explicit mandates for cross-sectoral coordination and promotion of sustainable development. Here, as O'Riordan and Jordan (1999) argue, institutions define, for example, anthropogenic climate change both as a problem and a context through such socialized devices as creating and interpreting scientific knowledge and selecting politically tolerable adaptation strategies.

To explain the inevitable differences between national policy outputs in environment protection, Jost and Jacob (2004) used the theory of *environmental policy capacity*. As a highly differentiated policy field, the environmental policy encompasses many different issues, notably with reference to differences in the selection of actors, policy strategies, policy style, along with problem structure and the like. A huge number of policy actors are involved in the formulation and implementation of policies in such a field as climate change, which affects almost every economy sector, private households, a wide range of government agencies, different scientific disciplines and almost every environmental organization.

5.3.5.2 Capacity 2015 platform

A new UNDP platform (UNDP, nd) for capacity development – *Capacity 2015* – is the successor of Capacity 21. It was intended as a global mechanism administered by UNDP, funded by a range of donor organizations and supporting several key areas of capacity development for sustainable development with the overall task to develop capacities needed by developing countries and countries in transition to meet their sustainable development objectives under Agenda 21 and the MDGs (Box 5.11). The latter not only defined specific targets and timetables for reducing poverty by half by 2015, but called also for launching the implementation of national development strategies and for the reversal of local and global environmental resources deterioration by the target date. Both documents also highlighted the ways in which environmental objectives can and should be pursued in the broader context of SD.

The key weaknesses of national Capacity 21 programs determined the design proposed for the Capacity 2015 platform (UNDP, 2002, p. 139):

- Future support to capacity development in most countries must include more effective support for the economic dimension of sustainable development.
- Sound environmental management and social policies are necessary but not sufficient; they cannot survive without effective long-term economic support.
- Sustainable development needs to be clearly recognized as the only valid form of development that any country should pursue, but not as a subset of a broader development agenda (for example, not simply as a euphemism for sound environmental management).
- Innovative local sustainable development initiatives are critical, but these must be effectively linked with the national level. This link is critical for ensuring that local actors are able to influence the evolution of national policies and programs that will give them the long-term support they need.

Box 5.11 UN Millennium Development Goals

MDGs, adopted by world leaders in 2000 and set to be achieved by 2015, provide concrete, numerical benchmarks for tackling extreme poverty in its many dimensions.

The goals are to:

1. *Eradicate extreme poverty and hunger*
2. *Achieve universal primary education*
3. *Promote gender equality and empower women*
4. *Reduce child mortality*
5. *Improve maternal health*
6. *Combat HIV/AIDS and other diseases*
7. *Ensure environmental sustainability*
8. *Develop a global partnership for development.*

These MDGs are broken down into *21 quantifiable targets* that are measured by *60 indicators***.**

Source: *http://www.undp.org/mdg/basics.shtml*

As such, the capacities need to be developed at three levels – individual, institutional and societal, where UNDP distinguishes (*Ibid,* p. 147):

- Development of *individual capacities* that helps individuals to embark on continuous learning processes–building on existing knowledge and skills and extending these in new directions as fresh opportunities arise.
- Development of *institutional capacities* that also involves building on existing capacities; but rather than trying to build new institutions, the existing ones are needed in support to improve their performance. For example, Cherp and Vrbensky (2002) showed that strengthening of institutional capacities for sustainable development in transition countries has occurred through supporting the organizations and mechanisms involved in the planning processes.
- Development of *societal capacities* that involves transforming society as a whole and creating opportunities, which enable people and institutions to use and expand their skills.

These three layers of capacity are interdependent, and comprehensive capacity development is a function of all three. However, a strong local or national capacity is not the sum of individual or institutional capacities; it is a more complex phenomenon weaving individual and institutional strengths into the strong and resilient fabric of relationships. For example, Evans *et al.* (2006) found a strong relationship between *institutional capacity* and *social capacity,* and showed that in the cases that exhibited sustainable development achievements, there was also greater levels of civil society activity and knowledge regarding sustainability issues, and high levels of institutional capacity.

Capacity 15 should ensure a truly global partnership where donor and recipient countries, and important new players – global foundations, non-government and private sector organizations – will co-operate, taking advantage of new technologies and new approaches. In particular, *co-operation in development* provides innovative types of support to developing and transition countries. Basing the new approaches to capacity development, the resumptive paper in the Special Issue of Development Policy Journal (UNDP 2002, p.149) states that the idea of *development* as a whole, which prevailed through much of the 20th century, suggested that poor countries lacked important skills and had only to emulate richer ones and follow their paths to a similar destination. It was thought that poorer countries should be able to do this rapidly because they could take advantage of the richer' experience, approaches, technologies, aid, and so on. However, elsewhere, especially in recent years, the uneven record of most other countries in achieving socio-economic transformation has left many questions on how *development co-operation* can be made more effective.

The first area of activity to be supported by the Capacity 2015 platform, which is based on the principle *"Scan globally, reinvent locally",* will be a program of direct, practical support to develop local capacities for sustainable development in general. This approach encompasses the recent rise of formal and informal networks in almost all areas of life that allow countless organizations and millions of individuals to share ideas, information and knowledge (UNDP, nd). Evans *et al.* (2006), discussing sustainable development capacity-building efforts within local governments, define them as measures that strengthen the governmental structures to meet the demands of sustainable development, as well as measures that create these capacities in cooperation with civil society. Local governments play a key role in influencing the creation of both institutional and social capacity by affecting the mobilization of local-level agents within the sphere of sustainability policies.

The Capacity 2015 platform supports developing and transition countries to ensure their effective participation in implementing key multilateral environment agreements on biological diversity, climate change and desertification. A comprehensive approach to develop the national capacities needed to sustainably address these global environmental issues involves three steps: the assessment of capacity development needs, the development of strategies to address these needs, and the definition of action plans to implement the strategies (UNDP, 2002).

5.3.5.3 Capacity building in confronting climate change

In the context of climate change, "…capacity building is developing the technical skills and institutional capabilities in developing countries and economies in transition to enable their participation in all aspects of *adaptation* to, *mitigation* of, and research on *climate change*, in the implementation of the Kyoto Mechanisms, etc." (IPCC 2007d*,* p. 871).

Such a need for capacity building to assist the Parties to respond to climate change has long been recognized by the UNFCCC[31]. Under the Convention (Article 9), this assistance provides advice on "…ways and means of supporting endogenous capacity building…", while the Kyoto Protocol (Article 10e) commits Parties to cooperating in and promoting "…the strengthening of national capacity-building…". Capacity-building cuts across many of the issues under consideration in the climate change process, and has featured in several decisions of the Conferences of the Parties.

As a separate item, the issue of capacity-building in confronting climate change was first considered at COP 5 in 1999. Through its two decisions (10/CP.5 and 11/CP.5), COP 5 launched a process to address capacity building in an integrated manner, resulting in the *Capacity Building Frameworks* for developing countries and countries with economies in transition; the Frameworks were agreed upon at COP 7 in Marrakech in 2001[32]. The Marrakech Accords, along with additional guidance to the Global Environmental Fund (GEF) and other decisions including capacity-building components, were intended to serve as a guide for climate change capacity-building activities around the world.

As to EIT Parties (UNFCCC**,** 2002: Decision 3/CP.7), the *purpose* of the Frameworks was "…to set out the scope and basis for action for capacity-building activities … under the Convention and for the preparation of EIT Parties for their participation in the Kyoto Protocol…" The *objective* and *scope* were defined respectfully as "to build the capacity of EIT countries to enable them to effectively implement the objective of the Convention and to prepare for their participation in the Kyoto Protocol…" To ensure that capacity-building efforts are country-driven, "…each EIT Party should, within the scope of capacity building, determine its specific objectives, needs, priorities, and options to implement the Convention …consistent with its national sustainable development strategy, taking into account existing capacities and past, and current activities undertaken by the country itself and in partnership with bilateral and multilateral institutions, and the private sector".

The Frameworks' primary guiding principles and approaches for climate change capacity building in transition countries are shown in Box 5.12.

As general *priority areas* for capacity-building related to the implementation of the Convention in the scope of this book, the national actions should include (UN FCCC, 2002, p. 19):

- Impact assessment and adaptation
- Research and systematic observation
- Education, training and public awareness
- Transfer of environmentally sound technologies
- Policies and measures, and the estimation of their effects
- National communications and national climate action plans
- Reporting obligations.

The Marrakech Accords has also formulated the responsibilities of EIT Parties in the implementation of the framework for capacity building, namely (*ibid,* p. 20):

---

[31] Available at: *http://unfccc.int/cooperation_and_support/capacity_building/items/1033.php*
[32] Available at: *http://unfccc.int/cooperation_and_support/capacity_building/items/3664.php*

(a) To provide an enabling environment to promote the sustainability and effectiveness of capacity-building activities relating to the implementation of the ultimate objective of the Convention;
(b) To identify their specific needs, priorities and options for capacity building on a country-driven basis, taking into account existing capacities and past and current activities;
(c) To identify and provide information on their own capacity-building activities;

Box 5.12 Extract from 'Frameworks for capacity building in countries with economies in transition'

B. Guiding principles and approaches

3. As Parties included in Annex I, EIT Parties have quantified emission limitation and reduction commitments that impose challenges to their existing capacities to implement the Convention. As Parties undergoing the process of transition to a market economy, they need to enhance their ability to address climate change issues. Capacity building is therefore critical to the effective implementation by EIT Parties of their commitments under the Convention and the preparation for their participation in the Kyoto Protocol.

4. Capacity building for EIT Parties must be country-driven, be consistent with their national sustainable development strategies, reflect their national initiatives and priorities, respond to needs determined and prioritized by EIT Parties themselves, and be primarily undertaken by and in partnership with other Parties and relevant organizations, in accordance with the provisions of the Convention.

5. Capacity building should contribute to the effective implementation of the Convention by EIT Parties and their preparation for participation in the Kyoto Protocol.

6. Capacity-building efforts are more effective when they take place within an enabling environment conducive to the development of human, institutional and technical capacity.

7. Capacity building should be results-oriented and implemented in an integrated and programmatic manner to facilitate its monitoring and evaluation, cost-effectiveness and efficiency.

8. Capacity building is a continuous process aimed at strengthening or establishing, as appropriate, relevant institutions, organizational structures, and human resources in order to strengthen expertise relevant to paragraph 3 of this framework.

9. Capacities should be developed and strengthened in a manner and under conditions that will work towards sustainability and support the short- and long-term objectives and priorities of EIT Parties under the Convention.

10. Capacity building involves "learning by doing". Capacity-building activities should be designed and implemented in a flexible manner.

11. Capacity building should improve the coordination and effectiveness of existing efforts and promote the participation of, and dialogue between, a wide range of actors and constituencies, including governments at all levels, international organizations, civil society and the private sector.

12. Wherever possible, capacity-building should utilize existing institutions and bodies and build on existing processes and endogenous capacities.

13. National focal points and other institutions, such as research centers, universities and other relevant organizations, should play an important role in providing capacity-building services and facilitating the flow of knowledge, best practices and information.

14. Capacity-building should be designed so that it results in the development, strengthening and enhancement of institutional capacities, human resources, knowledge and information, methodologies and practices, and the participation and networking of EIT Parties to promote sustainable development.

15. Capacity building in support of achieving the objectives of the Convention should maximize synergies between the Convention and other global environmental agreements, as appropriate.

16. Capacity building is more effective when it is coordinated at all levels (national, regional and international) through dialogue between and among Annex I Parties, and when past and existing efforts are taken into account.

Source: UNFCCC, 2002

(d) To promote cooperation among EIT Parties as well as to report to the Conference of the Parties on these activities in their national communications;
(e) To ensure the mobilization and sustainability of national capacities, including the institutional leadership necessary for national coordination and the effectiveness of capacity building activities;
(f) To promote the participation in and access to capacity-building activities of all stakeholders, including governments, civil society and the private sector, as appropriate.

Annex II Parties, for their part, should provide additional financial and technical assistance for implementing capacity-building activities through the GEF and other channels, while all Parties should improve the coordination and effectiveness of existing activities. The mutual responsibilities of EIT and Annex II Parties for *implementing* the activities undertaken within the framework for capacity-building include improving the coordination and effectiveness of existing efforts, and providing with information to enable the Conference of the Parties to monitor progress in the framework implementation.

5.3.5.4 Practice of capacity-building in countries with economies in transition

The first comprehensive review of the Frameworks of capacity building in EIT countries, conducted at COP 10[33] (Buenos Aires_2004, decision 3/CP.10), identified key factors that should be taken into account to increase their capacity-building effectiveness. While acknowledging some progress in a range of priority areas identified in the Frameworks, COP 10 noted that significant gaps still remained to be filled, and access to financial resources remained an issue to be addressed. The Conference re-affirmed the relevance of the Frameworks and identified key factors that could assist in further implementing decision 3/CP7[34]:

(a) Enhancement of enabling environments to promote the sustainability and effectiveness of capacity-building activities relating to the implementation of the Convention;
(b) Improvement of information sharing through, for example, databases and other means of sharing experiences and best practices;
(c) Enhancement of training, education and public awareness relating to climate change;
(d) Cooperation and coordination relating to capacity-building among the Parties with economies in transition;
(e) Enhancement of the national capacities and expertise in the governments of Parties with economies in transition, including improving institutional arrangements and national coordination;
(f) Improvement of the abilities of Parties with economies in transition to participate effectively in international negotiations in the climate change process, including the Convention and its Kyoto Protocol;

---

[33] Tenth Session of the Conference of Parties (COP 10). Available at: *http://unfccc.int/meetings/cop_10/items/2944.php*

[34] UNFCCC, 2004: Decision -/CP.10 Capacity-building for countries with economies in transition. Available at: *http://unfccc.int/files/meetings/cop_10/adopted_decisions/application/pdf/04_sbi_l_22_add_1.pdf*

(g) Participation in, and access to, capacity-building activities by all stakeholders, including governments, civil society and the private sector.

Simultaneously, COP 10 *encouraged* EIT Parties:

- to use the outcomes and results of national capacity self assessments in prioritizing their capacity-building activities at the country level, and to improve the capacity of experts and institutions to implement the action plans derived from their national capacity self assessment projects;
- to exchange information with Annex II Parties on human and institutional capacities relating to general priority areas identified in decision 3/CP.7;
- to strengthen national institutions to build capacity through training, public education and awareness programs for addressing the various issues relating to the implementation of the Convention and its Kyoto Protocol.

A second comprehensive review took place in 2007 (UNFCCC, 2007a). It has shown that, according to available information, since the first comprehensive review in 2004 the EIT countries have achieved significant progress in the development of institutions and mechanisms necessary to implement the Convention and its Kyoto Protocol. The National Communications (Table 5.15) and the Parties' submissions (e.g., UNFCCC, 2007b) showed a high intensity of this activity, carried out by the EIT countries independently or in cooperation with Annex II Parties and international organizations.

Table 5.15 Preparation of National Communications to UNFCCC by the FSU countries (year)

Country	National Communication			
	First	*Second*	*Third*	*Fourth*
Armenia	1988	2010		
Azerbaijan	2000			
Belarus	2003	2007	2007	2007
Estonia	1995	1998	2001	2005
Georgia	1999	2009		
Kazakhstan	1998	2009		
Kyrgyzstan	2003	2009		
Latvia	1995	1998	2001	2006
Lithuania	1995	2003	2005	2005
Moldova	2000	2010		
Russia	1995	1998	2003	2006
Tajikistan	2002	2008		
Turkmenistan	2000	2010		
Ukraine	1998	2006	2009	2009
Uzbekistan	1999	2008		

Major achievements in capacity building in EIT countries include the following:

- Strengthening of national climate-related units and offices;
- Strengthening of national legislative systems;
- Establishment of new or strengthening of existing national institutions necessary for the implementation of the Convention and its Kyoto Protocol;

- Strengthening of national expertise in the areas of preparation of GHG inventory, its projections and registry maintenance;
- Wide involvement of stakeholders in the process of GHG abatement in a cost-effective manner;
- Increased public awareness of climate change and the related policies.

Major efforts in capacity-building activities were directed at the creation of national expertise, knowledge and know-how in order to institutionalize each EIT Party's capacity and facilitate it to become self-reliant. Efforts were also made towards ensuring the sustainability of created capacities. The activities took various forms, including assessment of capacities' needs in different areas, financial aid, legal and technical expertise, transfer of technology and know-how, sharing information on best practices and failures, training and workshop organization, preparation of tool kits, guide books and manuals, information campaigns, etc.

The made progress and remaining needs and gaps by priority areas, related mainly to capacity building in general climate change and adaptation policies, are generalized in Table 5.16.

Table 5.16 Progress and remaining gaps in implementation of frameworks on building capacities to confront climate change in the countries with economies in transition

Area	*Progress*	*Remaining needs and gaps*
Policies and measures, and the estimation of their effects	Capacity-building took place to address many priority areas, with less intensity in some areas and countries, and with science-intensive areas receiving limited support.	• Lack of inclusion of climate change issues in the development of sectoral strategies, action plans, policies and measures; • Incomplete information on these policies and measures in environment ministries; • Lack of methodologies for estimating the effects of policies and measures.
Impact assessment and adaptation	A number of EIT countries have carried out activities in impact and vulnerability assessment, mainly through international grants. Models used were acquired through various capacity-building activities.	• Lack of regional and country specific modeling to assess the impact of climate change, especially on water resources, forests and coastal zones; • Lack of regional and country specific models to assess the socio-economic consequences of climate change; • Lack of awareness of climate change in general and, as a consequence, lack of a proactive approach to adaptation; • Lack of legal and institutional capacity to prepare proposals for adaptation plans in different economic sectors and at the national level; • Lack of human, scientific and technical capacity to carry out the necessary studies and assessments.

Table 5.16 (continued)

Area	*Progress*	*Remaining needs and gaps*
Research and systematic observation	Though capacity-building activities that were conducted at meteorological institutes through various international and EU supports did not always focus directly on climate change issues, they nevertheless contributed significantly to capacity building.	• Lack of widespread involvement of national academia in international scientific forums; • Lack of modern equipment and technical capacity for research and observation in the meteorological research centers of some countries (Belarus, Moldova, Ukraine).
Education, training and public awareness	The need for sustained efforts to raise awareness and provide information on climate change was recognized by most countries, however available information points to very few activities in this area.	• Low awareness of climate change issues among stakeholders, including governmental officials in non-environmental government bodies; • A need to raise awareness among the business community and provide training in relation to applicable legislation, the audit scheme of the EU and other technical areas; • A need for training of journalists in the area of climate change; • Lack of legal and institutional support, limited dedicated financial resources; • Lack of reliable or accessible information as well as information on climate change in national languages.
Transfer of environmentally sound technologies (ESTs)	ESTs occurred mainly through Joint Implementation (JI) projects. The design of Green Investment Schemes (GIS) promoted 'learning by doing'. All EITs have developed either climate change or GHG reduction action plans.	Lack of the proper design of GIS that would promote the transfer of ESTs.
National communications and national climate action plan	The legal and institutional framework for the preparation of national communications is well established.	• Lack of funding is a major constraint in conducting the necessary assessments for some countries; • A need to harmonize national statistics to improve reporting.

Source: Adapted from UNFCCC, 2007a

The following capacity-building needs and gaps were identified as common to almost all the priority areas and all EIT countries (UNFCCC, 2007a):

(a) Lack of prominence of climate change on the political agenda in most participating EIT governments in spite of the pressing needs related to the approaching deadlines to meet Kyoto Protocol requirements;
(b) There is a need for awareness-raising, education and training for decision makers, the general public, experts, the media, and pupils and students at all levels of the educational system;

(c) Although there is an increase in the number of employees in the climate change units of the environment ministries and other institutions involved in climate change, human capacity remains insufficient;
(d) Sustainability and diffusion of knowledge have not been fully achieved. There is a need to improve the transfer of skills and knowledge from the national climate change office to other institutions within a country and to promote integration of climate change issues into all sectors and planning processes;
(e) For the new EU member States, the completion of obligations under the Convention and its Kyoto Protocol as well as the EC is a considerable challenge, owing to limited capacity. A single body to coordinate reporting activities under the Convention and its Kyoto Protocol and EU reporting activities is a common need.

The assessment of the implementation of the framework for capacity-building in EITs countries (UNFCCC, 2007a) also concluded that many of the ***lessons highlighted*** in national communications and submissions from these Parties are similar to the lessons learned in capacity-building in other regions and in other contexts, and include the following:

(a) Capacity-building is most effective when carried out in conjunction with the design and implementation of real systems, such as registry systems;
(b) Continuous training is necessary to maintain a steady supply of human capacity to counteract brain drain and staff movements;
(c) When a national climate change centre or office is in place and has adequate capacity,

Box 5.13 Illustrative Examples of the US capacity-building activities in EIT countries: *Ukraine case study*

1. *Tariff reform and communal services enterprise restructuring in Ukraine (http://www.mdi.org.ua/eng)*

The goal of this five-year US sponsored activity was to improve delivery of communal services (water, wastewater and district heating) by improving the policy and regulatory framework, building the management and technical capacity of communal service enterprises (CSEs), and increasing public sector participation in services delivery.

Phase I focused on regulatory reform at the national level and application of new approaches at the local level in two pilot cities. At the national level, the US assisted in preparing the National Strategy for Communal Services Reform and the Law on housing and communal services. At the local level, guidelines for setting cost-recovery tariffs and an accounting handbook were prepared.

In *Phase II*, successful approaches tested in the pilot cities were rolled out to 31 CSEs in 16 Ukrainian cities. Formal classroom training was combined with technical assistance in the field. The US assisted in establishing and providing institutional strengthening of the Municipal Development Institute and new local NGOs committed to advancing the cause of communal services reform in the future.

2. *Impact assessment and adaptation: Ukraine Land Titling Initiative*

The US helped to develop survey procedures and a surveyor training program to ensure that agricultural lands subject to privatization exclude environmentally sensitive land (wetlands, lands with a slope in excess of 3%, a 100 m exclusion zone around agricultural chemical storage sites, a 10 m exclusion zone on watercourses, and lands that have been erosion degraded). Support was provided to conduct training for surveyors and to conduct quality control of survey works to ensure that environmentally sensitive land had been excluded from privatization in six oblasts.

Source: Adapted from UNFCCC (2007b)

ability of a Party to address all climate change issues is greatly enhanced;

(d) The capacity-building framework for EIT countries that is annexed to decision 3/CP.7 has served as a useful tool for bringing country-driven priorities to the attention of those bilateral, multilateral and international organizations in a position to respond;

(e) Building capacity in the new EU member States has led to the simultaneous capacity-building for implementation of the Convention and its Kyoto Protocol.

The Annex I Parties have provided significant support to the EIT countries to enable them to implement UNFCCC and helped them to meet the Kyoto Protocol commitment. This support took the form of training and awareness-raising at the individual and institutional level, learning-by-doing and pilot activities, and technical assistance. Some examples of the support provided or received are presented in Boxes 5.13 and 5.14.

The overall conclusion of the subsidiary Body for Implementation of the Convention (UNFCCC, 2007b) was that capacity-building in EIT countries has been focused and quite successful. As a result, a legal and institutional framework for the implementation of the Convention and the Kyoto Protocol has been created. A remaining need is the improvement in existing capacity, to insure its continuity and increased effectiveness.

Box 5.14 Capacity building in the new EU countries: *Lithuania case study*

The EU considers building capacity as essential for countries both to be able to implement their commitments in the climate change area, and more broadly – to assist them in achieving sustainable development. As with capacity building efforts elsewhere, capacity building for climate change policy in economies in transition has also been guided by the principle of country-drivenness and the internal assessment of needs done by recipient countries, being consistent with their sustainable development strategies, reflecting their national initiatives and priorities.

Lithuania had many obligations arising from the UNFCCC, the Kyoto Protocol and necessity to comply with the new EU requirements. In 2004 the National Committee for implementation of these requirements was established. After several meetings it decided upon more active integration of climate policy into different fields of research, economy, enhancing capacity building, strengthening institutional arrangements and raising public awareness.

The major part of Lithuanian science and development capacity is concentrated in three types of universities and research institutes, whose mission is stated in relevant legal acts, namely:

1. University research institutes established to carry out research of high international quality. They focus mainly on basic research and provide research basis for university education, doctoral studies and improvement of scientific qualification of university personnel;

2. State research institutes established to carry out long-term research of international quality important for the national economy, culture and international cooperation. Research activities involve groups of specialized scientists and require data collection and specialized experimental instruments. State research institutes together with higher education institutions help to train specialists;

3. State research establishments aiming at carrying out R&D activities important for the national economy and culture, for the development of industry, state government and other institutions.

NGOs play an important role through seeking to use all available national scientific potential and lobby state officials to attain common purposes. The greatest part of research related to the implementation of Conventions in Lithuania was carried out according to international projects, which proves that the state care for the performance of international commitments is not sufficient enough.

Source: Adapted from UNFCCC (2007b)

5.3.6 Evaluation of climate change and sustainable development relationships

The efforts in the available assessments of sustainability only to a small extent accompany a much more extensive set of evidently serious attempts to define sustainability objectives, identify appropriate indicators and apply sustainability considerations in scenario building, multi-criteria evaluations, and a host of other tools assisting decision-making in complex circumstances (Gibson, 2006a). This conclusion is also true for the assessment of climate change–sustainable development relationships. *"Whilst the concept of sustainable development has been discussed world-wide, it seems to have made little progress towards linking climate change impact assessment and regional sustainability evaluation"*, – Yin *et al.* (2000, p. 22) remarked in the late 90s. Nevertheless, the standard analysis of sustainable development and climate change relationships should follow the clear logic running from their reciprocal impacts that were discussed in previous sections. As an answer to this challenge, Yin and co-authors presented a paper focused on methodological aspects in research on the study of climate change impacts and regional sustainable development (RSD), and described the so-called Integrated Land Assessment Framework (ILAF) methodology that was designed to identify implications of climate change for RSD through integration of major physical, biological, and socioeconomic components in the identification of the regional economic–environmental climate change risks.

We decided to use the paper of Yin and co-authors as a good illustration for this section's discourse on the subject. These authors proceed from the initial premise that any approach attempting to identify how the potential climate change impacts may affect regional sustainability ideally would: (a) involve multiple stakeholders, (b) be systematic and holistic, (c) account for multiple objectives and sectors, (d) be able to easily identify trade-offs, and (e) be able to link climate change and R&D. Fig. 5.20 represents a research scheme which consists of six principal components described as individual blocs below.

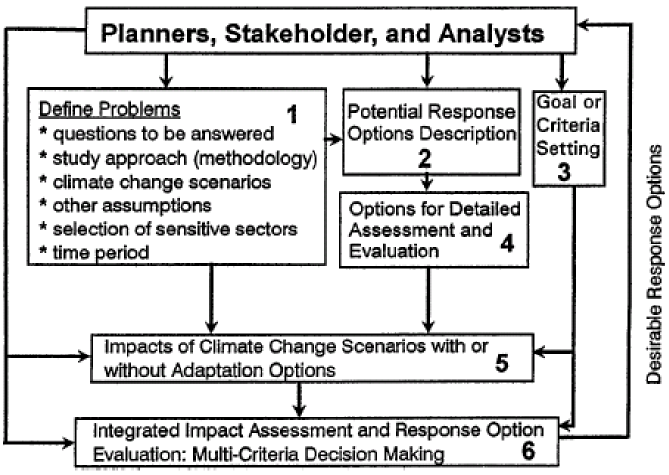


Fig. 5.20 The scheme of the integrated land assessment framework for linking climate change impact assessment and regional sustainability evaluation. *Source:* Yin *et al.*, 2000

1. *Definition of problems.* Two questions that need to be addressed here are: (1) What are the impacts of climate change scenarios on various sustainability goals/indicators? (2) What are the effects of various response options available to reduce the adverse consequences of climate change and to improve sustainability? Answers to these questions can be approached in different ways by applying various methods and is, in essence, the main goal of our book.
2. *Description of potential response options,* including their inventory, categorization by types and other relevant information.
3. *Setting of sustainability goals and indicators.* These parameters reflect generally the preferences and desires of decision-makers and indicate some specific target levels to be achieved through development options or policies. In a regional climate change study the goals/indicators act as decision criteria or standards by which the impacts of climate change and the efficiency of alternative response options can be measured[35].
4. *Initial screening of options.* Since the potential response options to alleviate negative consequences associated with climate change and to safeguard regional sustainability are numerous, the initial screening process can be conducted to reduce their number before further detailed evaluation.
5. *Climate change impact assessment* conducted with different climate change scenarios coupled with or without certain adaptation options.
6. *Integrated impact assessment and regional sustainability evaluation* that is the core of a study.

Thus, to link climate change impact assessment and sustainability evaluation, first of all, the regional sustainable development goals and indicators must be set, and the policies performance must be measured in a manner that integrates social, environmental, and economic parameters that may influence or be influenced by climate change.

Srivastava and Heller (2003) propose to begin standard approaches to address this task with some (more or less defined) constraint on the GHG emissions, which then lines up a wide variety of technical options, usually by sector (e.g., energy, buildings, transportation, waste) or policy instruments (taxes, permits) that might be useful in meeting this constraint. The options are evaluated in two dimensions. The first dimension is whether the options should be selected by policy-makers as superior to the current choices favored in that sector or policy field. A second dimension considers the impact of climate change on sustainable development values such as poverty relief, equity, democracy, or specific MDGs beyond environmental costs.

For example, in the before-demonstrated study (Yin *et al*., 2000), to assess climate change implications for the regional sustainable development of the Mackenzie River Basin four goals were specified: *economic growth, resource sustainability, environmental quality, and social stability.* To measure regional sustainability under different climate change scenarios, these goals were further divided into ten indicators (Table 5.17).

---

[35] Another way to define sustainable development goals is in what it specifically seeks to achieve. Kates *et al.* (2005) illustrate three sets of goals that use different time-horizons: the *short-term* (2015) goals of the UN Millennium Declaration; the *two-generation goals* (2050) of the sustainability Transition of the Board on SD; and the *long-term* (beyond 2050) goals of the Great Transition of the Global Scenario Group. Still another mode of defining sustainable development is through the values that represent or support sustainable development

Table 5.17 Regional sustainability indicators used in the Integrated Land Assessment Framework

Goals	*Indicator*
Economic growth	Economic return, energy development, transportation
Sustainable resource use	Sustainable resource production, water balance, and forest cover enhancement
Environmental quality	Wildlife habitat protection, soil erosion control, GHG emission reduction
Social stability	Community stability

Source: Yin et al., 2000

Since the identification of any goal/indicator is a difficult and complex process, the *analytic hierarchy process (AHP*), as a multi-criteria decision making technique, was employed in the ILAF to assist goal setting. AHP provided a means by which the identified alternative goals were compared and evaluated in an orderly and systematic manner, expressing the stakeholders' preferences by goal ranking, for example, as 'most important' (first priority), 'next most important' (second priority), and so on.

Integrated assessment through a goal programming (GP) model was applied to identify the possible impacts of climate change scenarios on regional sustainable development. For integration, the linkages between climate change impact assessment and regional sustainability need to be incorporated in the structure of the model by a clear articulation and reconciliation of objective functions and decision variables. The basic structure of the GP model adopted in the ILAF included goals and constraints; its specific equations were grouped into four types: resource and other restrictions, supply–demand balances, goal constraints, and the objective function.

Although the primary purposes of the GP model application were the integrated impact assessment, scenario analysis and, more specifically, the identification of various climate change scenario implications for regional sustainability, this model could also be used for ***policy analysis***. The identification of possible response options to deal with climate change impacts is an essential step in scenario evaluation. The options possess different characteristics and their implementing would have various impacts on different locations and on achieving different goals. According to the Tinbergen principle, to achieve a desirable outcome it is necessary to design as many options or policies as there are objectives. Consequently, in our case, the number of response option scenarios required for a study depends on how many adaptation alternatives or options need to be investigated. The estimation of the likely consequence of a potential response policy or a policy scenario on the achievement of regional sustainability goals provides a basis for planners or decision-makers to determine the adequacy and effectiveness of the policy before its implementation.

Then the policy scenario can be represented in the model by adjusting its parameters or structure with the aim of reducing the negative impacts or to take advantage of potential benefit of possible climate change, and thus to improve regional sustainability. The procedure of the policy analysis is to translate response policy scenarios into specific analytical questions that can be addressed by the model. Response policies influence each factor relating to regional sustainability. In the analytical process, different policy scenarios are represented in the structure of the GP model by modifying its parameters.

Of course, this short narration of the Yin *et al.* (2002) paper is not so much to provide sufficient information or solutions for improving regional sustainability under climate change conditions; it is proposed only to give an example of one possible approach to deal with this problem.

So, Munasinghe (2003) describes a *mapping model* that facilitates the implementation of sustainable development assessment by incorporating the environmental and social assessments into the conventional economic decision-making process. Economic valuation of environmental and social impacts serves here as a bridge to a cost-benefit analysis. Multi-criteria analysis aids in making trade-offs among diverse objectives, especially when economic valuation is difficult. He has also proposed the Action Impact Matrix approach as a tool that would analyze economic-environmental-social interactions and integrate climate change policies with overall sustainable development strategy. The matrix helps to explicitly identify key linkages, focus attention on methods of tracing and analyzing important impacts, coherently articulate the links among a range of development actions and suggest action priorities and remedies, including climate response measures.

Comprehensive, multi-sector models based on an expanded set of national accounts help to integrate economic, social and environmental issues at the macroeconomic decision-making level. The highest priority, Munasinghe (2003) emphasized, needs to be given to finding 'win-win policies', which promote all three elements of sustainable development. Economy-wide policies that induce growth could also lead to environmental and social harm, unless the macro-reforms are complemented by environmental and social safeguards.

Finally, the significance of climate change relative to other contextual factors that confront development will need to be evaluated on a case by case basis, because there are a growing number of cases where climate change might be an immediate concern to development activity. In other cases, its impacts might only warrant attention over the medium- to long-term and might not end up becoming immediate priorities for development. Agrawala (2004) also emphasizes a need for further work both at the donor and at the national level to develop appropriate tools to screen development projects for exposure to climatic risks. In turn, Rotmans (2006, p. 53), who proposed a strategy for Integrated Sustainability Assessment tool development, in the conclusion of his extremely comprehensive study said that this strategy "…follows a learning-by-doing and doing-by-learning approach, which is a risky but highly challenging strategy". *Let us consider this thesis as a 'guide to action'.*

Chapter 6
Public Awareness and Scientific Research

6.1 Public awareness and participation

6.1.1 Participatory processes in environmental management

Public opinion is “a force for change” (UNDP, 2007a). At the same time, as Toth and Hizsnyik (2008, p. 83) remark, *“participatory techniques are often argued for but less often used in environmental assessments”*.

Public participation refers to the partnership of ordinary citizens in debates on controversial issues such as climate change. It is focused on allowing all interests to voice their concerns and how citizen juries can be used to support policy making in relation to new global and regional challenges. Symbolically, Enserink (2000) sees public participation in three roles: as a legal right of affected social groups; as a means for empowering social groups; and as a means for improving the quality and effectiveness of decision-making. The ***participatory approach***, sometimes labeled *participatory integrated assessment (PIA)* (e.g., Metz *et al.*, 2003; Rotmans, 2006; Schlumpf *et al.*, 2001), starts from the idea that designing policies and strategies, and assessing their contribution to reaching ultimate goals are improved if these activities and processes are not restricted to a small circle of scientists and policymakers, but also involve interest groups and civil society. A broader involvement of different actors would add meaningful information, new insight and a less narrow and less technocratic view on causes and solutions. More specifically, Metz *et al.* (2003) summarized the arguments of different authors in favor of a more participatory approach as follows:

- It helps to bridge the gap between a scientifically-defined environmental problem and the experiences, values and practices of actors who are at the root of both cause and solution of such problems;
- Participation helps in clarifying different, often opposite, vies and interests regarding a problem, making problem definitions more adequate and broadly supported;
- Participation has an important social learning component for the participants;
- Participation in the scientific assessment may improve the quality of decision making, not by taking over the role of scientific expertise but by adding to it and supplementing it with other dimensions. As such it increases feasibility and democratic content, prevents implementation problems, establishes commitment among stakeholders, and so on.

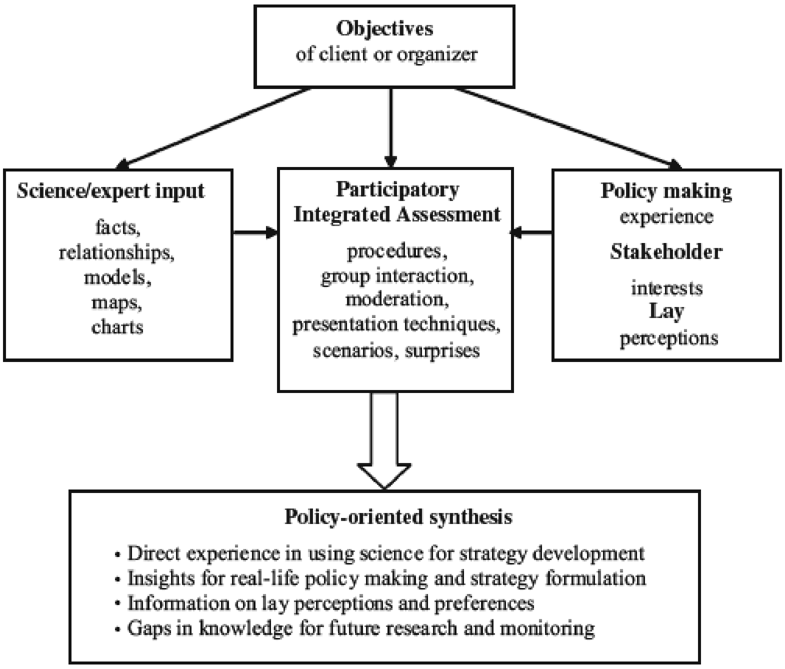


Fig. 6.1 The general structure of participatory integrated assessment. *Source:* Toth and Hizsnyik, 2008

A simple sketch of the key components of PIAs and their linkages is presented in Fig. 6.1. The process is driven by the objectives of an organizer or client who commissions the project. This determines the nature and the amount of scientific and expert knowledge as well as the policy, stakeholder, or lay interests to be combined in the exercise. The participatory techniques provide the tools and procedures for integrating those inputs and producing the required results that can be of rather different nature. Thus, PIAs can be proposed as a useful approach to synthesizing scientific knowledge for policymaking (Toth and Hizsnyik, 2008).

So, in the process of *social learning*, citizens may learn how scientists perceive the problem of climate change, which are the facts and which are the uncertainties. Scientists may learn how citizens respond to scientific input, how they judge the information and how they cope with the uncertainties involved in assessing climate change. The result of this process may be a better understanding of how citizens perceive and value climate change and how they interact with scientific information. These insights can then be used to improve future policy recommendations and research directions to better take into account the needs of regional policy-making (Schlumpf *et al.*, 2001).

Sadler (2001b) considers public participation in the *decision making* as a process of communication and involvement by those concerned with, affected by and interested in a proposal. However, this process is much larger and includes also the participation of the public in policy making as well as participation of non-scientists in the production and use of scientific knowledge. These three directions of public participation can be characterized as follows:

1. The importance of public participation in *environmental decision making* has been recognized internationally. The Rio Declaration on Environment and Development (UNCED, 1992), for example, considers public participation as a cornerstone of the efforts to integrate environmental and economic factors in the attempts to make the world more sustainable. The Aarhus Convention (1998) once again emphasized the importance of facilitating public participation in environmental decision-making. In the context of a project based EA the assumption that effective public participation is an important tool to ensure that making decisions help us become sustainable is consistent with the legislatively stated purposes of many assessment processes in Europe and the US (Doelle and Sinclair, 2006).

2. Participatory methods are increasingly used in *scientific research* endeavors. Van Asselt and Rijkens-Klomp (2002) refer the commencement of research on investigating public participation with respect to policy and decision-making to the 1960s. Just then it was highlighted that while representative democracy is a form of participation, it has significant deficiencies because is limited with respect to the range of values and preferences that it can elucidate. As a response, social scientists organized participatory initiatives and developed numerous methods focused on empowering people that were extensively applied in many countries to oppose the prevailing top-down mode of decision-making. Research on public participation in the field of science supports decisions and enriching assessments with lay-knowledge and opinions. Different social scientific theories argue that science is socially constructed and that science should not have the monopoly of knowledge; they demand new methodologies and a more societal orientation of science[1]. Summarizing different theoretical views, Van Asselt and Rijkens-Klomp (2002, p. 167) conclude: "…the engagement of non-scientific knowledge, values and preferences through social discourse will improve the quality of research by giving access to practical knowledge and experience and to a wider range of perspectives and options". They also believe that participation of non-scientists in scientific research is essential in case of the complex issues and unstructured problems, which concern a tangled web of related problems *(multi-problem),* lie across or at the intersection of many disciplines *(multi-disciplinary)*, and the underlying processes interact on various scale levels and on different temporal scales *(multi-scale).* Such characteristics of complex issues involve many different actors *(multi-actor)*, and to date it is increasingly acknowledged that input of contextual and practical knowledge, experiences and preferences through participatory processes enriches any endeavor.

3. A crucial point determining whether or not the political system is able to respond to environmental challenges seems to be the degree of integration of leading societal actors in the *policymaking process* and their capacity to build coalitions. A close inter-relationship among the various political actors may also contribute to a faster and easier diffusion of ideas compared with fragmented systems. Such an openness of the political system is also openness for actors that resist ambitious environmental policies. Countries vary regarding the degree of inclusion of environmental organizations, which in turn may explain policy outputs (Jost and Jacob, 2004).

---

[1] Policy-science interface is discussed in more detail in Sect. 6.2.1

Jänicke and Weidner (1995)[2] indicated that the effectiveness of political systems depends strongly on the relative strength, cooperation and integration of the actors involved in the policy-making process. They found the following to be true:

> *1. The relative strength* of different governmental and societal actors is a fundamental variable for the explanation of any policy outcome, although it is difficult to measure since there are different sources of power. Organizations may be powerful because of their economic resources, institutional influence, knowledge and competence or their credibility in the eyes of the public. The ability of a policy actor to influence a decision depends on several sources of power, that may be, to a certain degree, mutually substitutive. For example, compared with traditional interest groups such as industrial associations or trade unions, the environmental NGOs are usually much weaker and less established, regarding their participation in political institutions.
>
> *2. Cooperation* refers to the ability and readiness of the political and societal actors to cooperate in problem solving. Political systems with a cooperative culture can be expected to be more effective than those with conflict structures that lead to a waste of resources in terms of time, money and intellectual energy. Moreover, conflicts may provoke fragmentation if opponents are not successfully integrated in the policy process. The political systems of different countries vary considerably regarding the degree of integration and fragmentation among different sectors and levels of policymaking, although in cross cutting issues that affect almost every sector of government, such as the environment, it is necessary to cooperate in problem solving. Cooperation is facilitated by a balanced level of competence between these actors.
>
> *3. Integration* and consensual proceeding of all societal actors offers the best conditions for successful implementation. The degree of integration depends on institutional means of participation, as well as on different culture and personal factors. That is why the political systems vary considerably in their degree of integrating new and rather weak interests and their corresponding organizations.

Participation, free and equal access to information characterize openness of a political system. Based on the reasoning above, the systems that are open to inclusion of different actors and their interests are likely to perform better with regard to their environmental policy output.

Undoubtedly, different types of polities (e.g., democracies vs. authoritarian systems) encourage the adoption of distinct environmental policies and generate characteristic environmental impacts. A number of scholars (e.g., Pellegrini and Gerlagh, 2006; Winslow, 2005) tried to consider the relevance of a political regime type for protecting environmental quality and to show that polities that can be classified as democracies are likely to behave in ways that are more benign environmentally than polities that are authoritarian in character. Nevertheless, while there is some evidence to suggest that democracies are particularly sensitive to environmental concerns (Winslow, 2005), it is also evident that there are no simple relationships in this area. For example, the US, Australia and Canada – countries with well-developed democracies – have the highest national levels of GHG emissions per capita, along with Russia, which is also among the

[2] Jänicke M. and H.Weidner, 1995: *Successful Environmental Policy – A Critical Evaluation of 24 Cases*. Sigma: Berlin (Quoted, basing on Jost and Jacob, 2004)

list of countries with the highest emission levels, and China that is on the path to a rapid rise of emissions in terms of this environmental criterion.

In the opinion of Winslow, the type of regime is hypothesized to be important primarily because environmental quality is made up of public goods that cannot, in general, be purchased on the market. The protection or improvement of environmental quality requires coordinated actions at many levels, often conducted by a central government body. There are also many aspects of social organization that may affect the level of environmental quality, such as corruption, and there are many social features that may be important, such as levels of education and distribution of income. Specifically, Winslow (2005, p. 773) considers the proposition that *"higher levels of democracy in a nation are correlated with an increased likelihood of better environmental quality because democratic governments are more likely to make decisions that favor environmental quality"*.

Public involvement in policy making that increases the likelihood of environmental issues being identified and resolved is included by Winslow in the following list of reasons why a democracy is more likely to protect the environment:

- Many forms of environmental degradation benefit the few, but harm the many. The national elite tend to benefit from environmental degradation, while the costs are spread throughout the population. The sharing of power that occurs in democratic regimes can act to curb the degrading activities of the few;
- The accountability of leaders make it difficult for them to personally benefit from environmental degradation;
- Access to information is better in democracies, allowing people to be more aware of environmental problems;
- The presence of NGOs that can work to help inform the public about environmental problems, act as watchdogs for public agencies, and directly lobby members of government;
- The availability of civil litigation as a tool to enforce environmental protection; and
- International aspects of democracy such as the interaction of democratic nations in sharing information regarding environmental problems and regulatory techniques, and the development of international treaties for global environmental problems.

In contrast, authoritarian regimes are less likely to protect environmental quality, because:

- The lack of accountability for leaders;
- The concentration of power in a small number of elites who might use this power to personally profit from activities associated with high levels of environmental degradation;
- Restrictions on the free flow of information; and
- The need for coercion and/or legitimacy, which limits long-term investments in environmental quality.

According to Winslow's (2005) review, the empirical analysis of relationships between democracy and various aspects of environmental quality saw mixed results. Some studies find positive correlations with certain measures of environmental quality, others find negative, and some measures appear uncorrelated.

In particular, Winslow considered the dependence of three types of urban air pollution on two indices of democracy. From the viewpoint of this book, air pollution is of interest because of the evident impact of climate change on air quantity. Initial data, presented by Winslow, covered 46 countries, including three from CEE (Poland, former Czechoslovakia and Yugoslavia). Momentarily disregarding the specific research methods and analysis, the principal conclusion of the research supports the hypothesized relationship between environmental quality and democracy: *the more democratic a country, the less urban air pollution*. This suggests that when the wider population contributes to policy making, the government is more likely to regulate, at least, this one type of environmental degradation.

However, the author examined only one aspect of environmental quality, and not all environmental problems are expected to respond equally to the sharing of democratic regimes' power. Due to different characteristics, some environmental problems are more likely than others to be controlled in a democracy. Problems that have immediate and clear effects on the health or livelihood of many people, such as industrial pollution, are more likely to be controlled. Problems with distant, unclear or uncertain impacts (such as climate change), or affecting fewer people are less likely to be controlled even in a democracy. Certain characteristics that help determine the level of democracy in a nation and, consequently, the level of public participation in its policy- and decision-making, such as the free flow of information or the level of corruption, are important determinants of how successfully a democratic government can and will be at controlling environmental degradation. It's equally certain that democracy is not a panacea for protecting the environment. Even the most democratic nations exhibit severe environmental problems, although this does not necessarily suggest that democracy, as a type of regime, is unable to protect the environment. Rather, it may mean that some aspects of policies essential to protecting and improving environmental quality are failing.

Winslow (2005) also suggests that if one looks for macroeconomic methods for improving environmental quality, it may be better to focus on promoting political equity rather than on promoting generic economic growth. The latter may provide resources for a government to devote to environmental improvement, but the regime type may be a critical intervening variable that, among others, influences the level of environmental quality.

Pellegrini and Gerlagh (2006) presented an empirical contribution to debate on corruption, democracy and environmental policy. Their research supports the conclusion that institutional settings affect the way the policy makers respond to environmental concerns, and that democracy and corruption are two important variables in this process. The statistically significant (99% confidence) negative correlation between corruption and democracy variables amounted to –0.68, showing that a high level of democracy corresponds to a low level of corruption. The authors characterized democracy by competitive and free elections with a high level of participation that undoubtedly narrows its essence but is very representative from the viewpoint of the role of public participation in the efficiency of environmental policy. However, it is worth noting that there is no evidence of a causal relationship between democracy and corruption. Even though correlated, these variables can be considered independent in the analysis for the short and medium term. In addition, although democracy and corruption are connected, there are a number of countries that show high levels of corruption but are democracies, and there are autocracies with low corruption levels. Transition countries provide many such examples.

Finally, the proof of direct, sizeable and significant positive effects of democracy on environmental policy also depend on the 'measures' of democracy, specifically that of public participation and environmental policies. Thus, any evidence, results or conclusions should be interpreted carefully. From this viewpoint, public participation in decision-making is now a commonly stated objective across most sectors of environmental policy. Few *et al.* (2007) see it as the cornerstone of an inclusive/deliberative approach to planning and governance that places, for example, stakeholders' knowledge, opinions and aspirations at the center of decision-making, as opposed to a technical–rational approach in which professional expertise and bureaucratic control shape policy and practice. Participation has been promoted both instrumentally, as a 'means' of ensuring that decisions are better geared toward their objectives, and as an empowering 'end' in itself, ceding communities greater control over the decisions that affect their lives.

6.1.2 Public inclusion in climate change policy

6.1.2.1 Target setting

Public awareness and public participation, along with education, training and access to information, are essential for gaining public support for measures to combat and cope with climate change. Ban Ki-moon, Secretary-General of the United Nations, noted in a foreword to *'An UN Guide to Climate Neutrality: Kick the Habit'*: "…we are all part of the solution. Whether you are an individual, a business, an organization or a government, there are many steps you can take to reduce your climate footprint. It is a message we all must take to heart" (Kirby 2008, p. 7).

UNFCCC Article 6 seeks to spur action at a national level, as well as cooperation at the regional and international levels, to improve public participation and understanding needed for dealing with climate change impacts. To integrate Article 6 activities into existing sustainable development and climate change strategies, COP 8 (New Delhi, 2002) adopted the so-called New Delhi Work Programme. The Programme defined the scope of possible activities at the national and international levels, encouraged the spread and exchange of information and promoted partnership and networking efforts (UNFCCC, 2005). Involving the public in confronting the climate change issue is necessary because any successful implementation of policies to meet this challenge needs public support. Without including the public's points of view, an environmental policy runs the risk of getting stalled in the implementation phase (Kasemir *et al.*, 2000).

In the case of climate change (Yohe *et al.*, 2007), the participatory processes encourage local practitioners from climate-sensitive fields (e.g., land use or water management) to become engaged so that past experiences can be included in the study of future climate change and development pressures. Processes designed to integrate various dimensions of knowledge about how regional resource systems operate are essential; so is understanding of how resource systems are affected by biophysical and socioeconomic forces driven by a wide range of possible future changes in climate. This recognition has led to an increased interest in a number of participatory processes that can be used to facilitate the integration of biophysical and socio-economic aspects of climate change adaptation and sustainable development, creating opportunities for shared experiences in learning, problem definition, and design of potential solutions (Hisschemöller *et al.*, 2001).

According to Leary *et al.* (2007), advantages of participatory approach(es) to climate change research and assessment include: (i) empowering the participants to make informed personal decisions and participate in public decisions that can reduce their risks; (ii) accessing knowledge not otherwise available to researchers, leading to a more complete framing and analysis of the problem; (iii) targeting research more effectively to produce information that is actionable by users; (iv) providing greater transparency in the research process, which increases the credibility and legitimacy of the research results among stakeholders, and (v) increasing the likelihood that the research will be used and will result in actions that reduce risk.

Assessments of climate change and of related policy options touch issues of major public interest. Here, Jaeger *et al*. (2000) identified two policy options that have strong implications for all citizens:

1. What climate risks are we as a society ready to accept, not just for ourselves but also for future generations?
2. What changes in the way our economy uses energy and produces emissions are we willing to support in order to mitigate such risks?

It is essential to include wide-public views in policy debates on a far-reaching issue such as climate change impacts and response options. Failure to take public values and views into consideration when making decisions on climate risk management will inevitably cause problems for several reasons. First, climate policies will require a degree of ‘buy-in’ or acceptance from those who will be affected by them if they are to be successfully implemented. Second, where public policy and citizen frames of reference differ, the practice of risk communication becomes much more difficult. Third, policy implementation may be misunderstood, neglected or even opposed by the electorate (Lorenzoni and Pidgeon, 2007).

Citizens are considered important participants of regional climate change assessments, policy- and decision-making (Schlumpf *et al.,* 2001). Their lifestyle choices and their acceptance or rejection of climate-related policy options influence policy-making at all levels. Information about citizens’ framing of the problem, their value judgments and their attitudes towards climate risks can yield important insights for policymakers and the research community. Policymakers depend, either directly or indirectly, on citizens’ votes in elections; insights into their judgments can help to design policy strategies that are more adapted and more likely to be accepted by the public at large. Scientists can use citizens’ insights to better adapt their research direction, to better meet societal needs and to improve the way scientific knowledge is made available for a broader audience.

On the other hand, Jaeger *et al*. (2000) emphasized two dimensions where public participation in climate change policies differs from its application to other issues: (1) this participation has usually been explored for issues of local to national scales, and it is less clear how the voice of the public can be integrated in assessments of climate change as a global issue; (2) climate change is a problem of especially high uncertainties.

Given the high uncertainties, public participation in climate change assessment is crucial because, among other reasons, an unwarranted bias emerges if the subjectivity of the experts is not balanced by the subjectivity of laypersons. Jaeger and co-authors estimate the knowledge of subjective probabilities and preferences entertained by different laypersons just as important as the analogous packages entertained by experts. This factor requires adjusting some methodologies to allow people to express whether climate change matters to them and whether they are willing to support collective actions targeted at its avoidance, especially actions that would entail great sacrifice on the part of the public. Attention paid to climate change by the media, NGOs and local politicians has contributed to the social creation of the issue and to greater public awareness and debate. Nevertheless, despite the importance of public acceptance of any measure that involves a broad-scale policy change, researchers are only beginning to understand what factors motivate the public to support government initiatives aimed at reducing climate change risks (Jaeger *et al*., 2000; Kasemir *et al.*, 2000; Zahran *et al*., 2006).

A review of major studies on the public's views of climate change that was carried out by Lorenzoni and Pidgeon (2007) indicates some shared perspectives, specifically:

- Widespread awareness and concern about environmental issues and climate change, although climate change is generally considered less important than other personal or social issues.
- Limited understanding of the causes of, and solutions to, climate change.
- Climate change threats are perceived negativity, but remaining a psychologically, temporally and spatially distant risk.
- At the same time, risks of climate change are acknowledged as benefits. Some benefits are linked to climate change itself; others are felt to derive directly from the technologies and actions that cause climate change.
- Some evidence of willingness to address the perceived threats of climate change, mainly through contextually circumscribed and defined measures.
- Ascription of responsibility to take forward feasible measures to address climate change mainly to governments, although this may be mediated by the degree of trust that people have within any particular country.

As a principal conclusion, Lorenzoni and Pidgeon (p. 87) state: "…an unresolved question is: how far will individuals go to address the issue of climate change? People are not likely to support initiatives addressing climate change unless they consider the issue as a very serious societal or ecological problem, or one affecting them personally."

6.1.2.2 Human cognition and adaptive capacity

Environmental behavior

In social scientific literature there are different theories, models, and hypotheses for environmental behavior. Stern (2000) developed an analytic framework, which coherently organized this literature into typologies of behavior and variables that predict variation in behavioral types. His classification scheme of behaviors and predictors shows that different types of environmental behavior are governed by different ensembles of attitudes, personal capabilities, and contextual forces. The behavior is environmentally significant if it directly or indirectly causes environmental change. The empirical target is "the extent to which a human activity changes the availability of materials or energy from the environment or alters the structure and dynamics of ecosystems or the biosphere itself"

(Stern 2000, p. 408). Efforts to operationally define and measure environmentally significant behavior can be organized into two categories that are subsequently comprised of three environmentally meaningful types of behavior: environmental activism, private-sphere environmentalism, and non-activist public behaviors. The author identified also four types of causal variables commonly used in the literature: attitudinal variables, personal capability variables, contextual variables, and habits and routines. So, we need to 'kick the habit' of releasing large quantities of GHGs to achieve *climate neutrality* – the term used in the UN Guide to mean living in a way, which produces no net emissions (Kirby, 2008). *"Addiction is a terrible thing….and our society is in the grip of a dangerous greenhouse gas habit"*, – the Guide states (p. 6).

Applying Stern's approach to the climate change issue, Zahran *et al*. (2006) have based their study of relationships between climate change vulnerability and policy support on the ecological assumption that a person's physical vulnerability may be a pertinent factor in explaining his or her support for governing climate change policies. According to this concept, the behaviors that directly relate to climate change include, among other things, energy conservation or the purchase of commodities with positive inbuilt climate responses, for example, efficient automobiles or insulating homes. Behaviors that relate to climate change indirectly include individual preferences and actions toward mitigation/adaptation policies and regulations, the psychological motivations for climate-sensitive behaviors, the acts, laws and treaties that regulate production modalities with externalities harmful to climate systems.

Behaviors that impact the environment (both directly and indirectly) are meaningful if they are undertaken with the expressed intent of making a change. In particular, Zahran *et al*. (2006) study the non-activist public behavior, or citizens' willingness to incur personal costs by supporting policies designed to reduce human impact on climate systems. Climate change policies are costly for people because they require paying higher prices for consumer items, face tax penalties for climate unfriendly behaviors, and must observe the rules that regulate climate sensitive conduct. A climate change policy support is a behavior that indirectly impacts the environment, but carries potentially large societal effects because policies "change the behaviors of many people and organizations at once" (Stern 2000, p. 409).

Jaeger *et al.* (2000) showed that public participation in the decisions on accepting certain climate risks or on energy use in the future, which affect everybody, is necessary if we want to find policies supported by the public. As an example, they demonstrated that a discussion group (100 citizens from Switzerland), recognizing the moral dimension of the man-made climate change, tended to see a future characterized by high levels of energy use as a nightmarish option and low levels – as the attractive one. However, while they saw energy reduction as desirable, their willingness to engage in high-cost options like a hard-hitting carbon tax was practically nonexistent. The authors of this research interpreted such apparent contradiction as follows: the possibility of major climate impacts ignites the public imagination, but subjective probabilities associated with it are rather low. Under these conditions, the support for a low-energy society indicates that citizens expect such an option to be achievable at low cost. Rather than dismissing this expectation as unrealistic, the research on how low-cost options could lead to significant reduction in energy use would meet an important social need.

Individual perception of climate change, its danger and a need for adaptation

Levels of public concern are linked to the perceptions of where risks and vulnerabilities are located. Public opinion is not static, and it may be changing based on new information. So, climate change is increasingly present in daily conversations, and international comparative studies show that in many countries it is seen as a problem that is already occurring. However, climate change is usually not perceived as *the most important* of all environmental problems, and is often confused with other problems such as, e.g., ozone depletion. The fact that many people see climate change as an intractable problem is another barrier to action because it creates a sense of powerlessness (Kasemir *et al.*, 2000). There is a huge gulf between where we are now and the climate-neutral future that we need if we are to achieve sustainable development. But the message of the above-quoted UN Guide is *"that the gulf is not uncrossable, and that there is also a lot to gain. It will take patience, persistence and determination, but it can be done"* (Kirby, 2008, p. 12).

From both theory and evidence, Grothmann and Patt (2005) argue that policy makers ought to consider the *psychological aspects* of adaptation. They proposed a socio-cognitive model of adaptation and adaptive capacity that compensates for the weaknesses of adaptation theorizing from a cognitive perspective. The theoretical argument is derived from literature in the related fields of psychology and behavioral economics as well as from a growing amount of empirical research examining the link between cognitive factors and adaptation[3]. Two cognitive factors that are the focus of their paper are ***risk perception*** and ***perceived adaptive capacity***.

Leiserowitz (2006) also consider public risk perceptions as critical components of the socio-political context within which policy makers operate; they can fundamentally compel or constrain political, economic and social action to address particular risks. In particular, public support or opposition to climate policies (e.g., treaties, regulations, taxes, subsidies, etc.) will be greatly influenced by public perceptions of climate change risks and dangers. Grothmann and Patt (2005) believe that with regard to climate change adaptation the relative risk perception is the main determinant of a motivation to adapt (what an actor wants to do), indicated by motives like goals, values or norms. The relative risk perception expresses the perceived probability of being exposed to climate change impacts and to the appraisal of how harmful these impacts would be to things the actor values *(perceived severity)* relative to the appraisal of how harmful and urgent other problems or challenges in life are. If to use a natural-hazard example, the perceived probability relates to a person's expectancy of being exposed, for example, to a flood.

This notion is similar to Kørnøv and Thissen's (2000) demonstration of the distinction between expectation and perception in decision- and policy-making. Their vision of a distinction between what a person *likes* (preferences) and what a person *sees* (perceptions and expectations) in a decision situation is shown in Fig. 6.2. The interpretation of what we see and expect is affected by our past experiences, by availability of information and examples, by our norms and values (that is, what *we would like to see*), and by what we

---

[3] Leiserowitz (2006) argues that virtually all current theories of choice under risk or uncertainty are cognitive. These rational choice models typically assume that people analytically assess the desirability and likelihood of possible outcomes to arrive at a calculated decision. This assumption also underlies the expected-utility model that informs much of economic and psychological theory. Most theorists also assume that decision making about risk is essentially a ***cognitive*** activity

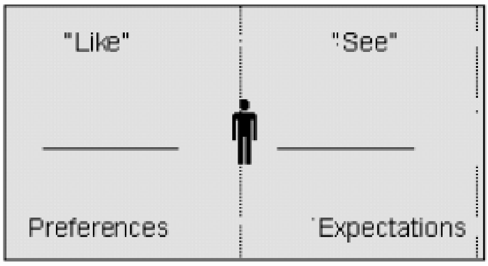


Fig. 6.2 A person's participation in decision-making defining by his (her) expectations and preferences. *Source:* Kørnøv and Thissen, 2000

expect to see. Typically, the first considered alternative tends to be close to the current situation when marginal changes are examined and the number of alternatives being considered is restricted. However, empirical researches also show that one's judgment of a situation is affected by the way it is framed, for example, by the ordering of alternatives and presentation of consequences.

In the case of a socio-cognitive model of adaptation and adaptive capacity, this process can be seen as a nominal/actual value comparison: the bigger the difference between the nominal value (what a person wants to happen or not to happen) and the actual value (what a person expects to happen), the more motivation or 'energy' is released for adaptation. However, Grothmann and Patt (2005) noted that "the understanding that this energy really goes into adaptation depends on a cognitive factor" is largely neglected not only in the large adaptation literature but also in the few psychological studies on climate change adaptation. The objective ability or capacity of a human actor only partly determines if an adaptive response is taken; even as important as this objective ability is the subjective or perceived ability, or in other words – perceived adaptive capacity of human actors. The subjective ability can be very different from the objective one, and *vice versa* human actors are not always aware of their objective action scope or perceive actions, which they could perform physically as impossible. A person can also overestimate their action scope.

Defining *'dangerous'* climate change (see Sect. 1.2) is of increasing importance for both scientific analysis and the climate policy debate. However, it is interesting to know not only how 'dangerous' climate change is interpreted through scientific risk assessments, but also how laypeople and experts perceive the issue and the implications of these factors for policy- and decision-making. In particular, whereas the scientific vision is built upon defining external thresholds and critical levels beyond which substantial change would occur, most people relate to climate change through direct personal experience. Unfortunately, as Lorenzoni *et al.* (2005) demonstrate, even in the most developed nations, such 'first hand' experience is perceived to be limited, and, in spite of widespread concerns about the issue, people are ambivalent about the threat of climate change and potential coping solutions. The discrepancy between expert and lay perceptions of climate change and its danger, especially under conditions of uncertainty, may prove problematic the implementation of policy options if public concerns over particular risks and their preferences for management will be not considered. Actions for combating climate change should be promoted and become a part of people's daily lives as well as weaved into related policy areas and included within the broader scope of sustainable development.

'Danger' is context and time specific, defined by social and political judgments. *Externa*l scientific interpretations of 'danger' through assessments of risk and vulnerability, based on thresholds and critical levels, differ with those defined *internally*, according to personal experience, beliefs and knowledge. Among the public the perception–action gap is still wide. Although climate change may be perceived through experience of today's weather anomalies, it is not an immediately intuitive phenomenon and is not considered as important as other more pressing personal or social issues. The individuals relate climate change to their everyday lives and behavior with difficulty; it persists as a certain 'virtual' risk. Psychologically, they tend to distance themselves from the issue, relinquishing it to other spaces and future times.

Public views are affected by many factors, including the balance of benefits and costs, values and cultural influences, trust in societal and individual actors, and so on. Moreover, people are usually unlikely to undergo significant change to their daily routine unless pushed by external forces, and only few take action based on a moral imperative. *"The question is whether individuals will want to act given that climate change is a psychologically, spatially and temporally distant phenomenon. People are not likely to support initiatives addressing climate change unless they consider the issue as a serious problem affecting them personally"*, – is one of Lorenzoni's *et al.* (2005, p. 61) conclusions.

Experimental studies have found that people generally misperceive the basic dynamics of renewable resources and the accumulation of GHGs in the atmosphere. Findings of Moxnes and Saysel (2009) point out that people are needed in help to develop proper mental models and in motivation to reconsider inappropriate decision heuristics. Unlike many environmental tasks, the global climate cannot be properly controlled by reacting to recent changes in climate. A long delay between changes in emission policies and a 'final' climate implies that a simple reaction to available information (*feedback strategies*) will lead to 'overshooting behavior'. That is, if unacceptable problems occur, feedback policies will not prevent the problems from getting much worse before the policies start to have an effect. Therefore, policies must be based on formal climate models, and the knowledge about key relationships in these models is essential for the formation of proper *mental models*[4] among politicians and voters, who in democratic nations have much to say over public policies. However, mental model approaches are still primarily cognitive, with a focus on the role of scientific information and knowledge in the formation of the public's environmental beliefs and misconceptions (Leiserowitz, 2006). "Environmental scientists, decision makers and risk communicators are increasingly aware, however, that simply providing more detailed and accurate information, while important, is not sufficient to generate appropriate public concern for some risks or to allay public fears about others. Mental model researchers have analyzed how people make inferences about the causes of climate change, but not how risk perception and behavior are guided by emotion and affect" (*ibid,* p. 47)[5].

For example, Weber (2006) – who tried to answer the question *"Why global warming does not scare us?"* – saw no 'surprises' here because behavioral decision research provided a series of lessons about the importance of *affects* in perceptions of risk and in decisions to take actions that reduce or manage perceived risks. He suggests that "…a worry drives risk management decisions. When people fail to be alarmed about a risk or

---

[4] A mental model is a person's mental representation of the structure of a system. It can range from a formal mathematical model which can be used to derive optimal policies to a simple classification which guides the choice among a repertoire of heuristics. See: Doyle, J.K. and D.N. Ford, 1998: Mental models concepts for system dynamics research. *Syst Dyn Rev* **14(1)**:3–29

[5] Leiserowitz (2006) refers ***affect*** to a person's good or bad, positive or negative feelings about specific objects, ideas or images

hazard, they do not take precautions. Recent personal experience strongly influences the evaluation of a risky option. Low-probability events generate less concern than their probability warrants on average, but more concern than they deserve in those rare instances when they do occur" (p. 103). However, personal experience with noticeable and serious consequences of global warming is still rare in many regions, and when people base their decisions on the hazard descriptions provided by others, characteristics of the hazard identified as psychological risk dimensions predict differences in alarm or worry across different classes of risk. These considerations suggest that one should find ways to evoke visceral reactions towards the climate change risk. At the same time, "the generation of worry or concern about global warming may be a necessary but not sufficient condition for desirable or appropriate protective or mitigating behavior on part of the general public" (*ibid).*

There are also differences between expert and lay perspectives related to the way in which societies experience climate change that are summarized by Lorenzoni *et al.* (2005) as follows:

(a) *Sense of urgency*: generally, science and some political leaders identify climate change as a serious threat to be addressed, whilst many members of the lay public perceive climate change as impersonal and removed from their daily lives;
(b) *Difficulties in associating climate change with the correct causes and solutions*: research shows that individuals interested in modifying their behavior often need to be given guidance on the correct actions;
(c) *Diffused sense of responsibility*: most individuals are ambivalent towards climate change as they attempt to balance perceived risks and benefits at different levels (individual vs. societal) and various timescales (present vs. future). Furthermore, the perceived need to act does not necessarily lead to action. Fatalism and withdrawal are common reactions to a crisis narrative.

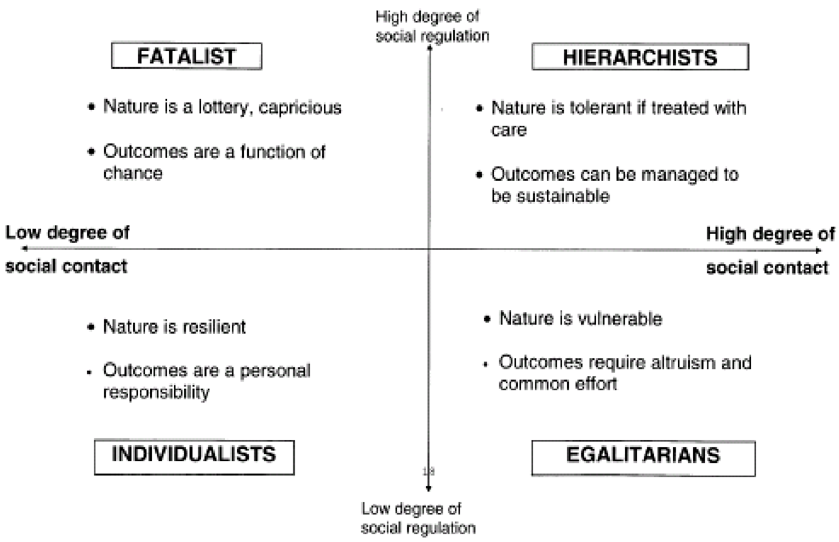


Fig. 6.3 The four 'ways of life'. *Source:* O'Riordan and Jordan, 1999

Findings indicate also that discrepancies exist between working definitions of danger by climate communities and non-experts' perception of climate change. Although both have the capacity to shape policy-making, the science is still in a privileged position because any decision taken on managing climate change involves making choices under conditions of uncertainty with far reaching consequences. Publics' risk perceptions can inform this process by presenting the concerns that people associate with particular risks and their preferences for management. The future of climate change rests effectively on moral and ethical judgments, on which citizens may be called upon to decide and will be expected to take action. *"Climate change will not be successfully addressed by dealing with it separately from other issues that affect individuals in their day-to-day lives. Wise and proactive leadership is essential in providing guidance to remain within 'safe' limits whilst enabling societies worldwide to effect the cultural and behavioral transition needed to slow down the threat to survival on Earth"*, – is the final clause of Tyndall Centre's strategic assessment of scientific and behavioral perspectives on 'dangerous' climate change (Lorenzoni *et al.*, 2005, p. 62).

O'Riordan and Jordan (1999) attracted to the study of risk perception some ideas of *Cultural Theory*[6], which suggests that personalities are of lesser importance than the individual as identified through various social settings and processes. In other words, cultural theorists argue that social and worldview values also play an important role in risk perception and behavior[7]. Social structures ('ways of life') define human interaction and generate attitudes to the World. Fig. 6.3 provides the classical approximation of Cultural Theory. Here, the axis *'group'* (axis of abscissas) refers to the extent to which an individual feels bonded to larger social units, while the axis *'grid'* (axis of ordinates) denotes the degree to which an individual's life is circumscribed by externally imposed order. Each 'way of life' generates a quite different interpretation of the world and is associated with a separate set of justifications for undertaking a given course of action.

Our discussion does not seek to repeat in detail the comments on this figure that can be found in the cited work. What is more interesting is their authors' interpretation of how Cultural Theory sheds light on why people as individuals find it hard to agree on how to respond to the risks caused by climate change. *Hierarchists*, for example, are likely to trust climate scientists and those in authority, and will show little anxiety over 'techno-fixes' so long as they are sanctioned by experts. They will also accept rules and state interventions so long as these are openly arrived at and appropriately legitimized. *Egalitarians*, on the

---

[6] The *Cultural Theory of risk* (usually referred as *Cultural Theory)* was developed in anthropology and political science to explain risk perception by different people and social groups. The theory arose out of the work of Mary Douglas, a British anthropologist, who proposed a functionalist explanation why different societies feared different sorts of threats. Social structures (which she called "ways of life") generate attitudes toward the world (the so-called "cultural biases") that serve to uphold these structures. Thus, differences in risk perception correlate with differences in social structures. Later, Douglas argued that social structures differ along two principal axes: *grid* and *group*. The former refers to the degree to which individuals' choices are circumscribed by their position in society; the latter refers to the degree of solidarity among members of the society. The grid/group concept was introduced to the risk analysis community in 1982 by a book *'Risk and Culture'* that Douglas wrote jointly with political scientist Aaron Wildavsky. See: *http://en.wikipedia.org/wiki/Cultural_Theory_of_risk*

[7] For example, Leiserowitz (2006) operationalized cultural theory as an independent set of variables to test the theorized relationship between worldview values and risk perceptions and policy preferences

other hand, are suspicious of anyone in authority. They fear risks, which are seen to produce irreversible consequences and impacts that are inequitable in their severity. This perspective is evident in different critiques of climate change policy. *Individualists* are particularly concerned about problems that impinge upon their freedom and autonomy. By its very nature, climate change involves just such responses. *Fatalists* are 'hypnotized' by the uncertainty of the climate change science. *Egalitarians* may also be confused as to the likelihood of global cooling or global warming, but see both as presenting a fearful challenge, translating it into a call for the application of the precautionary principle and the need for urgent action.

In Fig. 6.4, as an example, O'Riordan and Jordan (1999) show a cultural orientation towards two key aspects of climate change (fairness and acceptability) that was expressed in one survey of residents of Norwich, UK. This survey, which represented statistically the population as a whole, aimed at electing the outlooks on the climate risk perception based on different statements. The figure demonstrates cultural orientations for one of such prior statements.

In particular, *individualists* believe that 'the next generation may not regret what they never experience'; *heirarchists* accept that harming the futures may be 'wrong, but it is the lesson of history'. *Fatalists* also take a moral position of responsibility, but note that future generations are always 'better', so it is important to weigh these gains against any benefits. *Egalitarians* see themselves as 'irresponsible' for harm, inflicted on future generations, and see it as no more than the harm that is already being inflicted on innocent present generations.

Thus, Cultural Theory, if gently applied and not dogmatically pursued, may at least help to explain how certain patterns of thinking may shape the communication, information gathering and interpretative aspects of climate change politics and science.

Externally imposed rules

FATALISTS • we all have moral responsibility for each generation so we should not knowingly pass on harm • future generations have, in the past, been better off, so we should weight gains against losses	HIERARCHISTS • wrong to harm the future but this is the lesson of history • we cannot foresee all dangers, so some future dangers are inevitable • best quality information is the key to wise judgment
Unbonded	**Bonded**
• there is always some ignorance, but where reasonable the precautionary principle should be applied • individual had their own duty of care to be thoughtful and informed about future generations • the next generations may not regret what they never experience INDIVIDUALIST	• it is irresponsible to harm the future • it is equally irresponsible to harm present generations • there is less excuse to harm the future because we know more nowadays, but we still do so because present patterns of power lead inevitably to injustice EGALITARIANS

Internally imposed rules

Fig. 6.4 Cultural orientations of different individuals toward key aspects of climate change under a prior statement: 'A risk is less acceptable if it will affect future generations'. *Source:* Adapted from O'Riordan and Jordan (1999)

To analyze collective-action behavior in response to global warming, Lubell *et al.* (2007) adapted the ***collective interest (CI) model***. The authors see the main advantage of this model in providing an empirically testable approach of behavior that specifies the decision calculus, which people use in collective-action situations. The *CI* model posits that people will participate in a collective endeavor when the expected value of participation is greater than the expected value of non-participation. People judge the value of participation by assessing the total value of public goods, the probability that their participation will affect collective outcomes, and the selective benefits and costs of participation. The global extent of climate change creates a severe collective-action problem because the probability that a single individual can influence the climate is virtually zero, the benefits of actions by other people are non-excludable, and many of the recommended behaviors have relatively high individual costs. Such reality leads to supposition that a rational citizen will usually choose a free ride on the backs (efforts) of others. Nevertheless, the findings of Lubell *et al.* show that citizens do support global warming policies in a variety of political venues, and are also willing to implement these policies by engaging in sustainable behaviors.

These authors used the term '*global warming activism*' to encompass three dimensions of citizens' behavior: (1) support for policies designed to reduce the risk of global warming; (2) environmental political participation such as joining an environmental group; and (3) engaging in personal environmental behaviors that influence global warming. These dimensions are linked psychologically and substantively. People employ similar considerations to evaluate behaviors and to form attitudes towards policies that target those behaviors. *"Substantively, global warming policy will only succeed if citizens support these policies in a variety of political venues, and are also willing to implement these policies by engaging in recommended environmental behaviors"* (Lubell *et al.,* 2007*,* p. 2).

The CI model has a very close kinship to rational models of political participation as applied to non-environmental forms of political activity that focus on three factors: benefits of participation; the probability of an individual making a difference; and the selective benefits and costs of participation. Adaptation of the CI model integrates directly the additional concepts from the broader political participation models, such as citizen perceptions of *policy elites* and *political discussion* networks about global warming. Like these models, the CI model adopts an *expected value framework* that hypothesizes that people will participate in global warming activism when the subjective expected value of participation is greater than for non-participation. The calculation of *expected value* depends on five factors:

- *perceived value of the collective good produced by successful environmental action;*
- *increase in the probability of success if the individual participates;*
- *extent to which the actions of the group as a whole are likely to be successful;*
- *selective costs of participation, and*
- *selective benefits of participation.*

The authors of the CI model also believe that it can integrate the diverse findings on environmental behavior explored in many disciplines, which sometimes ignore the logic of collective action. Explicitly addressing the link between collective action and individual behavior, the model encompasses a lot of variables considered as important by environmental researchers and puts them into an integrated theoretical framework.

In the CI model, applied to climate change, the basic relationships are summarized in the following equation:

$$EV = [(p_g*p_i)*V] - C + B,$$

where:
EV (Global Warming Activism) – the expected value of participation;
p_g – the probability that the group will be successful (*group efficacy*);
p_i – the marginal influence of the individual's contribution on the probability of success *(personal influence);*
V – the value of the collective good;
C – the selective cost of participation, and
B – the selective benefit available from participation.

Table 6.1 lists major empirical variables that were used to put into operation the CI concepts. The signs in parentheses indicate the expected direction of influence for each variable on the level of global warming activism.

Table 6.1 Variables hypothesized to influence global warming activism

Collective interest variables	*(B) Selective benefits*	*(C) Selective costs*
(V) Perceived risk (+)	Environmental values (+)	Global warming knowledge (+)
(p_i) Outcome influence (+)	Political discussion networks (+)	Income (+)
(p_g) Expected reciprocity (+)		Education (+)
(p_g) Policy elite competence (+)		Age (+)
(p_g) County civic engagement (+)		Male (–)
		Minority (–)

Source: Lubell *et al.*, 2007

Based on a regression analysis, Lubell *et al.* (2007) concluded:

1. Several factors important to the core concepts of the CI model stand out as predictors of global warming activism: people who believe that the risk from global warming is high *(V)* believe that their actions will make a difference in collective outcomes *(p_i);* they subscribe to environmental values *(B)*, are more likely to express support for global warming policy and more willing to take action;
2. More educated and higher income citizens appear to have the civic skills and resources necessary to absorb selective costs and recognize opportunities for participation;
3. There are important differences between each dimension of global warming activism that highlight how collective action behavior must be understood in light of the broader political context. In particular, collective action behavior cannot be fully understood without reference to how individuals are embedded in a particular set of political relationships;

4. Should be revised view on collective action behavior as on a fairly ascetic world where the collective action problem at hand is isolated from other elements of the political system. The research results suggest that while citizen–government relationships are more relevant for policy support, the citizen–citizen relationships are more important for participation and environmental behaviors;
5. Whereas the CI model is not equally relevant for every type of environmental behavior, if there is a real link between individual behavior and collective outcomes, it is possible for public discourse to increase or decrease the salience of that link, which would have commensurate effects on the relevance of the model.

Thus, awareness and concern of the general public about climate change is not only a function of scientific information. Both psychological and sociological factors affect the willingness of laypeople to acknowledge the reality of global warming and to support climate policies in their home countries. So, Sandvik (2008) has analyzed a cross-national dataset of public concern about global warming, basing on data from 46 countries, including from FSU (all Baltic countries and Russia). He found that GDP was negatively correlated to the proportion of a population that regarded global warming as a serious problem and suggested that a nation's willingness to contribute to the reduction of emissions decreased with its share in these emissions. This is in accordance with psychological findings, but poses a problem for political decision-makers.

The study of Lorenzoni and Pidgeon (2006) highlighted the overall influence of geographical and cultural elements on climate change. Although individuals expressed concerns about future undesirable consequences of climate change impinging on the national good, this did not exclude them from considering the potential personal benefits deriving from future changes in the climate. On a more localized level, there were indications that even individuals in localities that could be considered potentially vulnerable to climate change had difficulties relating to its impacts on their day-to-day life.

In transition countries awareness and concern about climate change is relatively low. Only about 50% of the population in six EIT countries, interviewed in the survey carried out in the framework of the Pew Global Attitude Project (2007), consider climate change as a serious problem (lower than the 59% average across the full sample of 48 countries). For example, only 40% of Russians think that climate change is a serious issue, in contrast to 70% of Turks (Fig. 6.5). Part of this problem stems from the often confusing or misleading way in which climate change is communicated to the public. In addition, awareness or understanding of climate change does not necessarily lead to action and behavioral change.

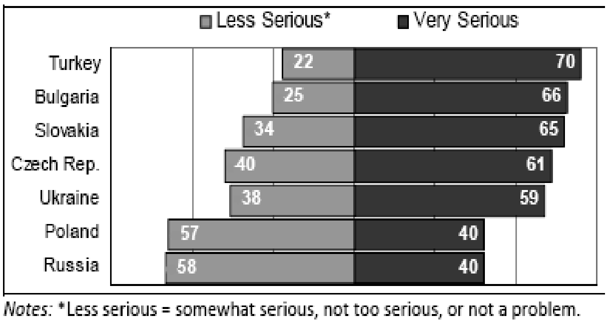


Fig. 6.5 Considering the seriousness of climate change in some transition countries. *Source:* Pew Global Attitudes Project, 2007

6.1.3 Stakeholder participation

6.1.3.1 Stakeholders as actors in environmental management

In recent years, stakeholder analysis has become one of the main ideas in environmental and development thinking. Global environmental challenges such as climate change, often labeled as persistent, complex or unstructured problems, are recognized by their strong linkages to other problems, the multitude of elements that play a role and are all interrelated, by severe scientific uncertainties, conflicts of interests as well as by social, organizational, political and technological constraints in their resolving. It has also become increasingly recognized that this task is not a job for governments alone, but is a joint challenge for science, policy and society worldwide. As a result, problem-solving processes, as it was shown above, explicitly require the involvement of actors from civil society, such as businesses, environmental NGOs, etc. These actors are also referred to as *'stakeholders'* that simply means those who have a stake in a certain issue or decision (van de Kerkhof, 2006) or "…who has a stake or special interest in an issue, policy, company, etc." (Welp *et al.*, 2006). A stake can also be a right (legal or moral) and/or an ownership (Madsen and Ulhøi, 2001). Many other definitions differ in some important ways. For example, sometimes actors are identified as stakeholders only if they are organized into a group, while in other definitions individuals can also be stakeholders; by some definitions, an actor needs to have a clear interest in order to be a stakeholder, whereas other definitions acknowledge that the stakes may sometimes be rather unclear.

That is the reason why Van de Kerkhof (2006) sees three general ***stakeholder features*:**

- Both individuals and socially-organized groups can be stakeholders in the decision-making process;
- In the case of complex problems, it is not always clear what the stake(s) of each actor is (are). Different actors may have a different perception of their own and each other's stakes, and these stakes may change over time;
- The relevant group of stakeholders may vary, and the number of stakeholders involved in the issue under consideration is not necessarily fixed but may change over time. As the decision-making process evolves, new stakeholders will enter the scene and others will leave.

Thus, let us accept that stakeholders are individuals or groups with a legal, economic, moral and/or self-perceived opportunity to claim ownership, rights or interests in any activity (Madsen and Ulhøi, 2001). Stakeholders with identical interests, claims or rights can be classified into different categories, e.g., employees, shareholders, customers, suppliers, regulators, NGOs, etc. Welp *et al.* (2006) make a distinction between individuals and groups who affect (determine) a decision or action and those who are affected by it. This concept originates from management literature where a distinction is made between shareholders, i.e. those who own the company, and stakeholders, i.e. individuals or groups, which are impacted by business activities or can influence the business environment.

Madsen and Ulhøi identify stakeholders through the actual or potential harm and benefit they experience, or anticipate experiencing, as a result of a firm's (in the particular case of their discussion) actions or inactions. They propose a stakeholder model (Fig. 6.6) as certain organizational construct, inasmuch as it describes the connections and their internal constituents and legitimacy. Here, the inner circle represents *primary stakeholders,* and the outer circle – *secondary stakeholders*. Analyzing this division with regard to a firm, they refer primary stakeholders to those, without whose continuing and direct participation or input the firm cannot survive as a going concern. Such stakeholders include owners, investors, employees, suppliers, customers and competitors, as well as Nature (physical resources and carrying capacity). Secondary stakeholders are those who in the past, present or future influence or might be influenced by the firm's operations without being directly engaged in transactions with the firm in question and thus are not essential for its survival. Examples of secondary stakeholders are local communities, local governments, social activist groups and business support groups. However, the term secondary does not necessarily imply that they are of secondary importance in relation to environmental issues in all circumstances. Some stakeholder groups, e.g., the company's shareholders, mainly have one type of stake (i.e. an ownership), whereas other stakeholders can have more than one. In such cases, the rights and the interests of the same stakeholder often conflict.

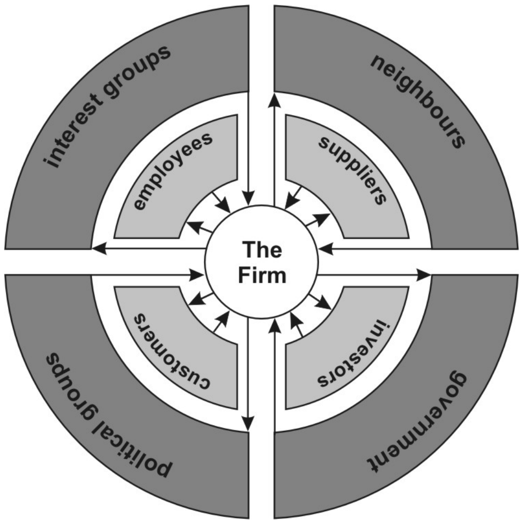


Fig. 6.6 The stakeholder model of Madsen and Ulhøi (2001)

Based on academic literature, van de Kerkhof (2006) justifies that ***stakeholder participation*** may potentially:

- → increase public awareness and acceptance of the problems that society faces and of the measures that need to be taken to solve these problems;
- → lead to better decisions as it enriches the decision-making process with relevant viewpoints, interests and information about the problem under consideration that could not have been generated otherwise;
- → increase the legitimacy of decision making, as it enables the stakeholders to engage in deliberation with policy makers and scientists about the decisions that need to be taken;
- → increase the accountability of decision making, as participants get an inside view in the decision-making process and they become co-responsible for the decisions that are made and the actions that are taken;
- → result in learning the stakeholders, government and scientific experts about the nature of the problem, its possible solutions and dealing with conflicting views and interests.

Stakeholder participation is often equated with allowing societal actors to influence the outcome of plans and working processes. Based on Mayer's (1997)[8] typology of strategies for participatory policy analysis, which includes different stakeholder roles, van de Kerkhof (2006) distinguished seven degrees of participation: from the lowest to the highest (Fig. 6.7).

Information	Consultation	Anticipation	Mediation	Co-ordination	Co-production	Mutual learning

Low degree of participation -- High degree of participation

Fig. 6.7 Van de Kerkhof's (2006a) classification of degrees of stakeholder participation

Information is the lowest degree of participation when the stakeholders have the rather passive role of 'consuming' the offered information. The following three degrees are the moderate degrees. In *consultation* the flow of relevant information is portrayed upwards – from stakeholders to initiators of the dialog. *Anticipation* enables the stakeholders to give their perspectives on the future and to formulate possible strategies to create or anticipate this future. In *mediation* the initiators want to learn what stakeholders know about their mutual values and interests, and what level of consensus or compromise can be reached. The last three degrees are the highest degrees of participation, in which stakeholders in mutual interaction and deliberation determine the outcomes of the process. *Coordination* enables stakeholders to coordinate interdisciplinary knowledge, objectives, and means in relation to a certain problem. In *co-production* stakeholders create a basis for the formation of coalitions to jointly work on projects or develop new initiatives. *Mutual learning* enables the stakeholders to interactively explore new styles and strategies for policy making; it enhances a change in stakeholders' core knowledge and attitudes.

Thus, addressing the problem with stakeholder participation is understood *per se* as a ***dialog process*** of learning in which scientists, policy makers, and stakeholders jointly explore options for dealing with matters of environmental complexity. As was noted earlier, dialogue processes in environmental assessment and appraisal are becoming important tools in the support of participatory processes, including the issue of adapting to climate change (Yohe *et al.*, 2007).

Rotmans (2006), considering different tools for Integrated Sustainability Assessment (ISA), relates a final challenge to the involvement of stakeholders in the process of ISA model development and model usage. In this process he distinguishes three types of stakeholders:

(i) Stakeholder as *advisor* when knowledge and expertise of stakeholders are used as well as possible, both *ex ante* and *ex post*, but in both cases the stakeholders directly influence the modeling process;

[8] Mayer I., 1997: *Debating technologies. A methodological contribution to the design and evaluation of participatory policy analysis*, Tilburg University Press, the Netherlands

(ii) Stakeholder as *user* when there are strategic or political, but also educational or moral reasons for using ISA models. Preferably, the potential user is already involved in the design of the model at the conceptual stage;

(iii) Stakeholder as *actor,* where an attempt is made to incorporate the dynamic behavior of the stakeholder in the model. In this case, one can speak of agent-based models, simulating the dynamic, cognitive behavior of both individual and collective (institutions and organizations) actors.

6.1.3.2 Stakeholder in policy analysis

In the policymaking processes that involve usually policymakers, stakeholders and scientists the stakeholders communicate their goals, objectives, and preferences to the policymakers who must then decide, with scientific advice, on the policies to be adopted (Walker *et al.*, 2003). Moreover, a stakeholder, if to use Rotmans's (2006) classification, can participate in policymaking not only in the role of a 'user' but also as an 'advisor' and 'actor', providing useful insights for problem solving including critical review of scientific information and evaluation of policy options in terms of feasibility and social acceptability. In the last case, the stakeholder policy dialogue "should be understood as a process of learning in which the stakeholders have the opportunity to articulate their knowledge, values, and preferences about specific problems and policy options" (van de Kerkhof, 2006, p. 11). In such processes of learning and argumentation, rather than urging participants to seek a consensus on a specific solution strategy, the dialogue design should

Table 6.2 Obstacles and opportunities for the use of biomass as a source of renewable energy as identified by the Dutch stakeholders

Opportunities for biomass	*Obstacles for biomass*
• New markets and the increase of revenues and employment • Use of degraded lands • Restoration of land and prevention of erosion • Technological innovation to increase crop yield per hectare • Development of conversion techniques in existing industrial infrastructure and export of technologies • Development of an international strategy for the implementation of biomass • Biomass fits the ideas of current climate policy • Cascading to optimize the use of biomass • Improvement of the image of the sector • Decrease of the negative environmental effects of transport.	• Large demand for land and competition with other claims on land • Dependence of other countries due to need to import biomass • Need for new and improved conversion techniques • High costs due to the need for a biomass transportation system and a new energy infrastructure • Environmental effects are not integrated into the price of energy • Low societal acceptance due to high demand for land • Need for institutional arrangements for large-scale implementation of biomass • Lack of interest in the automobile industry to switch to bio fuels • Uncertainty about the safety of fuel cells • Threat to biodiversity due to large scale growth of mono crops • The global climate regime hampers the optimal cascading of wood.

Source: Van de Kerkhof, 2006

prevent certain issues and viewpoints from being *ex ante* excluded from the analysis and facilitate the exploration of different, sometimes conflicting claims and arguments about the problem and its possible solutions (‘*learning by argument*’). As an example, van de Kerkhof overviews the obstacles and opportunities that were identified by stakeholder discussions on the large-scale implementation of biomass in the Netherlands (Table 6.2).

Because few stakeholders are ‘global’, for policy analysis to work the methods and tools need to be relevant to stakeholders at the scale of their interest, reflecting the multi-objective nature of places and the tradeoffs that are often made by various actors working within and outside these places.

6.1.3.3 Integrating stakeholders and sustainable environmental management

Stakeholders from the business sector, including NGOs, media, and public and financial institutions, play an increasing important role in awareness raising on different sustainability issues. Stakeholder consultations and stakeholder engagements assist in broadening business perspectives to take into account critical current and future ‘blind spots’ as well as in drawing attention to current and future sustainability risks and benefits. Descriptive, instrumental and normative approaches to stakeholder theory have, despite the different underlying rationales, a common assumption that business can profit from a mutual relationship with stakeholders and, depending on different scholars, the rewards may be of instrumental or moral value (von Geibler *et al.*, 2006).

For instance, Cain *et al.* (1999) have found that one of the main reasons of the fail of many Integrated Natural Resource Management strategies (while they had been able to formulate plans on an integrated basis) is the tradition that management plans were generally developed without participation of local individuals and institutions, and thus – without understanding the motivations of these important groups. The lack of stakeholder co-operation undermined any delivery mechanisms, designed to implement management plans, and the potential benefits failed to come to fruition. The first step in overcoming this barrier is to encourage stakeholder involvement in plan formulation, which is facilitated by a user-focused planning procedure that is accessible to people with a wide range of ability. Such an approach highlights the resulting benefits of plan implementation.

An increasing focus on stakeholder management in relation to business activities has been further extended to include environmental activities (Green and Hunton-Clarke, 2003; Madsen and Ulhøi, 2001). There are many pressures on today’s businesses to make decisions and perform activities that are environmentally responsible and socially acceptable as well as to distinctly recognize the need to identify and address environmental concerns that impact a wide circle of stakeholders. Considering and involving stakeholders and their concerns in the decision-making processes is now a critical long-term factor for anybody who wishes to be successful in a business, social, environmental and sustainability sense. However, despite the fact that stakeholder participation is widely accepted in the public sector, there is uncertainty in how best to implement it within business processes. For example, sometimes the use of stakeholder participation is still more about *informing* decisions and is not necessarily about *making* decisions (Green and Hunton-Clarke, 2003).

Madsen and Ulhøi (2001) guess that given the increasing general interest in environmental issues, it is expected that different groups of stakeholders will exert an increasing influence on business environmental behavior and attitudes in the future. Managing large and complex stakeholder relationships in the area of environmental issues should become a normal management task. In corporate environmental management it is important therefore to recognize that the number of stakeholders, directly or indirectly affected by the environmental consequences of business activities, is often much larger than it was expected. Integrating stakeholder and environmental concerns might be one way to achieve a more sustainable environmental development.

"Stakeholder management is about handling stakeholder relationships and the multiple and often conflicting interests (stakes) within the complex and dynamic web of persons and/or groups (holders) that at all times surround any company" (Madsen and Ulhøi, 2001, p. 79). These authors see a critical strategic issue here to be the fact that interactions, coalitions, differences in behavior, attitudes and preferences within and across the various groups of stakeholders are not static, but are in a constant state of flux. The individual stakeholders have various means of exerting influence, including formal control and market mechanisms.

However, today the simplistic model of the theory of a firm (formerly based on the view that business interacts with external parties only through the market) has been replaced by an understanding that the firm and society have many non-market interactions, some of which are governed by forces other than purely economic ones, e.g., by political, cultural and moral forces. A second key point is *"that stakeholders can – and often do – share decision-making power with corporate management. The stakeholder view of the firm assumes that the boundaries of the firm are becoming more and fuzzier as globalization and networking increase. Therefore, a firm's success can be seriously affected (negatively or positively) by its stakeholders, and failure to respond to stakeholder concerns can lead to unresolved conflicts"*, – Madsen and Ulhøi (p. 85) add. Continuing the explanation of their vision of the problem, the authors note that some individual stakeholders belong to more than one group which has some implications in the human resource management theory. Each individual not only must be recognized as being potentially different from all others, but also have a heterogeneous stakeholder profile, e.g., employee, neighbor or the member of a local environmental interest group. The stakeholder framework outlined in the quoted paper dismisses the strict demarcation between strategic management and human resource management and extends the traditionally intra-organizational concept of human resource management to include all stakeholders inside and outside the organization, thus providing corporate environmental management with new opportunities. The proposed moving towards improved environmental management considers the stakeholder framework as a whole; in turn, stakeholder management can improve management's prospects of getting as many stakeholders as possible to pull in the same direction.

6.1.3.4 Stakeholder perceptions of climate change

Stakeholders begin to afford climate change a higher level of importance where a link can be established between long-term and more immediate changes in climate, notably extreme weather events, and the problem became really interesting to stakeholders when talking about the impacts of recent droughts, flooding, fires, intensive rainfall events and so on (Shackley and Deanwood, 2002). Here, these authors distinguish two groups of stakeholders. Those from local government and local groups, NGOs and other organizations, who have a general interest in climate change as part of a wider 'sustainable development' portfolio, are typically less technical, more concerned about engagement of the public and more concerned about interconnections between different elements of sustainable development agendas. On the other hand, the representatives of agencies and companies operating at the regional or local level, who have already been involved in integrating the impacts of climate change into their decision-making processes, generally have a statutory responsibility for resource management and hence – a professional interest in incorporating climate change into decision-making frameworks and processes.

Kloprogge and van Der Sluijs (2006) discuss the inclusion of stakeholder knowledge and perspectives in the integrated assessment of climate change in more details. They consider managing the risks of global warming as a societal process, which has to deal with this long-term complex issue not only under conditions of high and partly irreducible uncertainties but also under multiple value orientations of many national and international stakeholders. The inclusion of stakeholder knowledge and perspectives in IA of climate change, in their consideration, can be motivated both from scientific and policy points of view.

From a scientific point of view, climate change is a problem in which facts are uncertain, values are in dispute, stakes are high and decisions may well be urgent. As other problems with such characteristics it cannot be handled in the framework of the 'normal, truth seeking science' alone, but requires a different problem coping strategy known as *post-normal science.* Because of the many uncertainties, traditional science is not able to sufficiently legitimize drastic steps that may be needed to deal with climate change. The assessment of risks and the setting of policy should therefore encompass public agreement and participation. In addition, participation is desirable because it enhances the quality of the scientific input in the process. Stakeholders' reasoning, observation and imagination are not bounded by scientific rationality; this can be beneficial when tackling an ill-structured complex problem. Consequently, knowledge and perspectives of the stakeholders can contribute valuable new views and relevant information on the problem, known as 'extended facts'.

In the view of post-normal science, a scientific and technical discourse in problems like climate change should no longer be restricted to expert communities but should include the non-specialist knowledge, wisdom, and perspectives of stakeholders on the problem at hand. Stakeholders add new knowledge in a number of ways, including the following (Kloprogge and van Der Sluijs, 2006):

- contributing knowledge on local conditions which may help determine what data are strong and relevant or which response options are feasible;
- providing personal observations of climate change and its effects which may lead to new foci for empirical research addressing dimensions of the problem that were previously overlooked; and
- creative thinking of mechanisms and scenarios through which projected climatic changes may affect different sectors of society.

Involvement of stakeholders' knowledge and perspectives in climate change assessment can be *active* or *passive.* In the first case, the stakeholders participate directly and actively in the assessment process, acting either as a representative of a stakeholder group or as an individual, and contribute their knowledge in the assessment. In the second case, the IA experts make an inventory of stakeholder knowledge and perspectives and subsequently incorporate these in the assessment.

Both forms of involvement can be *bottom-up* or *top-down.* When stakeholder are included, using a bottom-up approach, actual stakeholder viewpoints on specific issues are explored and then may be aggregated into more general classifications of ideas. If a top-down approach is used, viewpoints on specific issues are deducted from general classifications of ideas, e.g., storylines for GHG emission scenarios as they are used by the IPCC.

Equally, a risk management function of climate change assessment can be considered 'open' with respect to the participation of stakeholders if the contents and results of the function have not been *a priori* established by the experts, but can be co-shaped by the stakeholders. The degrees of 'openness' can be different – from consultation to co-production.

Thus, as Kloprogge and van Der Sluijs (2006, p. 383) argue, "it is important to include stakeholder knowledge and perspectives both in view of the nature of the problem of climate change, and in view of the developments in the policy field regarding climate change". Because the climate problem is of a post-normal nature, to take stakeholders' views into account is necessary in order to enhance the quality of the assessment, to legitimize actions taken in the policy process and the science underpinning a choice for that action, and to facilitate a democratic approach to addressing the problem. Here, the previously mentioned motives of legitimization and democracy can be seen especially clearly. The policy processes concerning climate change require active support from people that are affected.

The need of integrating stakeholder perspectives has been especially recognized in assessments of climate change from a regional point of view that is central in the formulation and implementation of comprehensive policy measures. Many of the systems affected by climate change are regional in scope. Furthermore, there is a better chance of mobilizing stakeholders and increasing their interest and concern if climate change impacts can be demonstrated 'on the ground', in familiar locations, upon landmarks and businesses, than if impacts are analyzed only at national or international scales. The implicit assumption is that "the experience of regional- and local-scale climate change impacts makes the issue 'real' and 'tangible' for stakeholders in the way that a global-scale impact would not do" (Shackley and Deanwood, 2002, p. 382).

However, differentiating here the *local* from the *regional* is problematic. In particular, the quoted authors define 'regions', in the English context, as "nascent socio-political constructs, born of historical and economic commonalities together with administrative expediency, although in the context of climate change their real value lies in acting as a bridge between national and local policy and decision making" (*ibid*). As an example, Shackley and Deanwood assume:

- ☑ *Water resource policy* is regionally focused because of the collection of water across large geographical areas, but is highly dependent upon detailed local and regional knowledge of source catchments and wastewater systems;
- ☑ *Coastal policy* is locally to the regionally oriented: a national approach would not make much sense given the specificity of local situations (topographical, geological, historical, political, public perceptions and economic, etc.);

☑ *Biodiversity policy* is arguably becoming more regionally and locally oriented, with regional and local biodiversity action plans being established to reflect species and habitats of regional/local importance and value;
☑ *Agriculture* is very different from the other three sectors in that the key defining policies are frequently depend on foreign policies and circumstances, and local or regional policies have limited scope for action. At the same time, the agricultural 'decision maker' is composed of thousands of individual farmers, each making a decision for multiple reasons. There is no mechanism for coordinating individual decision making, or for taking an overarching strategic view which can then provide the framework in which individuals make their decisions.

Shackley and Deanwood also think that whilst it is difficult to identify distinct regional impacts and responses, and therefore the primary focus of many stakeholders is still likely to be on the local scale, until the stronger regional identities emerge in the sustainable development context. Lastly, their findings suggest that "whilst local and regional impacts are of considerable interest to regional stakeholders, their ability to respond through adapted policy and practice depends upon their existing frames of reference with respect to their understanding of the policy- and decision-making systems, and the operation of current institutional processes and response mechanisms" (*ibid,* p. 381).

Several lessons on the engagement of stakeholders in decision-making processes at the city level were formulated by the Clear Air Partnership (Box 6.1).

In their other paper, Shackley and Deanwood (2003) consider the problem of the involvement of stakeholder communities in scenario-building processes in a way that

Box 6.1 Lessons on stakeholders engagement in decision making: An urban case

♦ Key stakeholders include municipal and regional government departments, transportation authorities, utilities, conservation authorities, and others.
♦ Engagement of key stakeholders is vital for understanding the specifics of how climate change may impact cities, for identifying practical adaptation strategies and for gaining support for implementing those strategies.
♦ Engagement of stakeholders often begins with an event designed to raise awareness and pique interest in climate impacts and adaptation. However, a plan for ongoing engagement of stakeholders after the event is also necessary.
♦ It is important to understand the general goals and concerns of stakeholders and to investigate the way in which climate change could affect these.
♦ While sign-off from senior management is important, an ongoing engagement may be more successful with mid-level stakeholders who are more likely to be consistent in their participation in the adaptation process, and therefore likely to develop a better understanding of impacts and adaptation strategies.
♦ Regular communications and meetings are required for sustained stakeholder engagement.
♦ Stakeholder engagement can be time consuming and costs money. Allowance for the use of staff time and adequate funds are essential for successful and sustainable stakeholder involvement.
♦ Processes that are overly focused on technical modeling issues and reports written in technical jargon will reduce stakeholder engagement.
♦ Researcher-led adaptation initiatives are in danger of coming to an abrupt end when funding is over. For these initiatives that go beyond research to action, it is important that stakeholders take ownership of the process.

Source: Reproduced from Ligeti *et al*., 2007 encourages their maximum possible engagement with the outputs of research and analysis. They suggest that stakeholders' ability to contribute to the development, characterization and use of scenarios depends upon their own past experience of using scenarios and their back-up resources (time and personnel). Some care has to be taken in identifying who is the stakeholder client, since some regional stakeholders are more locally oriented and others more nationally oriented. Usually, stakeholders rarely require information for climate adaptation policy assessment at the global or national scale, but rather at regional and local scales.

From this viewpoint, the UK Climate Impacts Programme (UKCIP)[9] developed the Regional Impact Simulator – the first PC-based simulation tool designed with stakeholders and for stakeholders wishing to assess the effects of climate and/or socio-economic change on the important sectors and resources at a regional scale (Fig. 6.8).

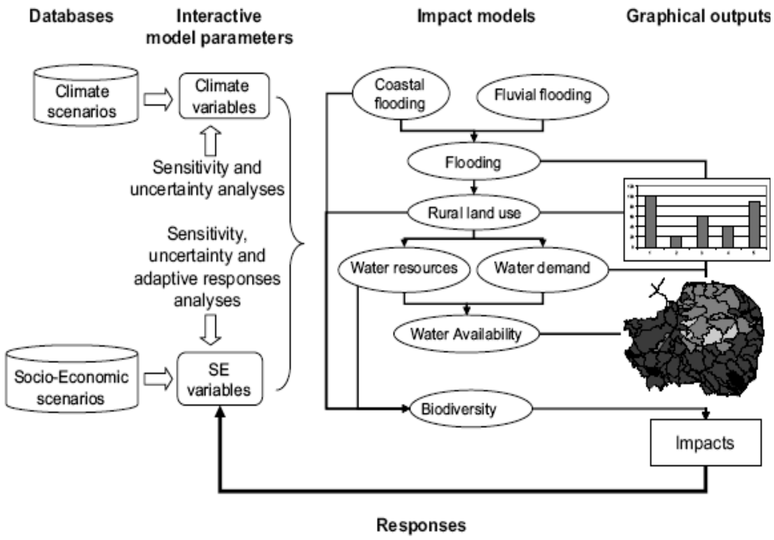


Fig. 6.8 Schematic diagram of the structure and functioning of the Regional Impact Simulator. *Source:* Holman and Harman, 2008

Stakeholder perception of climate change is well demonstrated by the behavior of investors. As 'universal investors' with a stake in all sectors, the *investment community* (asset management sector) has a key role to play because of its dominant position in the equities market which gives it the right, or even duty, to guide corporate strategy. Investors can also play a role through effective management, for example, of energy usage, both in-house and in their extensive property investment portfolios. Even if investors do not anticipate policy actively, they do provide a judgment on it through the markets. A number of studies have confirmed the potential importance of this role

[9] The UK Climate Impacts Programme (UKCIP) was established by the UK Government in 1997 with the aim of providing a research framework for the IA of climate change impacts in the UK. UKCIP works with stakeholders to co-ordinate research on how climate change might impact at regional and national scales, and how stakeholders might adapt to these impacts (*www.ukcip.org.uk*)

internationally (see Sect. 4.2.4.2) and identified key barriers to action (political uncertainty, lack of scientific and analytical capability, inefficient market structures, and so on). Measures to integrate climate assessment into the fund management process run up also against a number of structural obstacles (Dlugolecki and Mansley, 2005). These and other arguments, summarized by these authors, points to a number of opportunities and possibilities for investors to become involved in the policy debate on the climate change issues (Box 6.2).

6.1.3.5 NGO participation

Even though it remains arguable whether NGOs can play more than an additive role in the state's intervention in the field of environmental policy, it is plausible that the integration of NGOs in the policy process builds the governments' capacity for intervention and adds to the democratic legitimization of the process (Jost and Jacob, 2004). In particular, whereas environmental NGOs contributed to setting the issue of climate change on the political agenda, business NGOs have, to some extent, influenced the contents of the Kyoto Protocol mechanisms.

Arts and Cozijnsen (2003), summarizing the history of NGOs' activity in Germany, show that environmental organizations can intervene in the negotiation and decision-

Box 6.2 Opportunities, possibilities and actions areas for investors to be involved in the policy debate on climate change

Opportunities and possibilities:

- To play a greater role in intervening in the policy debate – at a minimum providing feedback on the likely market reaction in advance of policy implementation, but potentially actively involving themselves in the policy debate;
- To be more active in holding investing companies to account for their lobbying activities in the area of climate change;
- To have an independent review of climate change related policy with two-fold purpose: to indicate to investors the potential range of government actions, and to government possible inconsistencies that undermine the credibility of climate policy;
- To identify mechanisms that increase confidence in climate policy and would encourage investors to be more active in anticipating change, for instance, on principles for policy implementation, like pre-ordained review dates.

Action areas:

- Improvement of the quality and flow of information in a way that recognizes the different needs, and abilities of the investment actors could be assisted by regulatory guidance that climate change is a material for corporate reporting;
- Definition of the duties of investment professionals and trustees to include climate change as a long-term issue, and the revision of the asset management process to deemphasize short-term priorities e.g., by setting strategic priorities on a different basis;
- A stronger input from investors into the policymaking process to ensure that climate change policies and measures are conducive to active business engagement;
- Closer monitoring by investors of the activities of investing companies to include areas like climate change lobbying;
- Consideration of international aspects of climate change policy.

Source: Adapted from Dlugolecki and Mansley (2005) making processes in the climate arena, applying three different strategies: lobbying, advocacy and protests. In this triad, *lobbying* refers to informal and covert attempts to influence policymakers in the corridors of political events by transmitting information, knowledge, views, proposals, warning, etc. *Advocacy* refers to influence in the political arena practically by the same tools, but which are formally accepted and overt. *Protest* refers to informal and overt attempts outside, or at the margin of, political arenas to influence policymakers, for example, by protest marches, sit-ins, consumer actions and so on.

Since the 1980s, NGOs, both environmental and business, have played important roles in the development of international climate policy. If to take Germany further as a good example, NGOs can raise awareness among their constituencies, make science more understandable, advocate their views among the public and politicians, lobby policymakers, influence the contents of policy documents, are involved in project implementation, and so on. Originally, environmental NGOs tried to 'curb the trends' of global warming through strengthening measures aimed at controlling GHG emissions as much as possible, while business NGOs advocated 'business as usual', by blocking or softening these measures. The focus of NGOs has substantially changed since Kyoto because the Protocol moves the issue into another policy phase and heads towards implementation. The corporate world has changed also: insures are worried about their costs rising because of climate change consequences; gas companies see opportunities, while oil and coal production are increasingly vulnerable. Auditing companies are preparing to verify emission baselines and reductions.

History shows that some political decisions were influenced by NGOs actions. As examples Arts and Cozijnsen (2003) named the issue of Joint Implementation (JI), the emission budget approach and international emission trading. Business has become much more proactive and supportive in regard to climate measures, accepting climate change as a problem and seeing the chance to combine emission reductions with market opportunities. Environmental organizations, on the other hand, have become more responsive to flexibility, differentiation, and market solutions and are seeking ways to shape their role in a more market-oriented approach, thus making possible a co-operation between business and environmental NGOs.

6.1.4 Public participation in research and practice

6.1.4.1 Public participation from a methodological perspective

Although participatory processes can help to create dialogues that link and mutually instruct researchers, practitioners, communities and governments, there are challenges in applying these processes as a methodology for using, for example, to influence social learning and decision-making. *Social learning* of complex issues like climate change emerges through consensus that includes both scientific discourse and policy debate. However, social learning is more than just transferring information from one social group to another. It involves the development of a shared understanding of the problem among different societal groups and the formation of new institutions or transformation of the already existing. The process of social learning entails a polycentric understanding of policy making (Schlumpf *et al.*, 2001).

Generally, the use of the notion of participation in scientific literature refers "…to involvement in knowledge production and/or decision-making of those involved in, affected by, knowledgeable of, or having relevant expertise or experience on the issue at stake" (van Asselt and Rijkens-Klomp, 2002, p. 168). Based on the literature review, scattered over a broad range of disciplines, these authors propose to define *participatory approaches* "as methods to structure group processes in which non-experts play an active role in order to articulate their knowledge, values and preferences" *(ibid)*. This definition implies a reference to participation organized, and thus imposed, by analysts/scientists. Furthermore, the notion 'participatory method' they narrowed down to group methods and identified a number of participatory methods that were categorized and clustered according to the goals of participation (Fig. 6.9). It is easy to see from this figure that 'participation methods' is "an umbrella term embracing a variety of methods and approaches employed to enhance participation in assessments as means to different ends" *(ibid)*.

In particular, if the participatory methods are justified with regard to the nature of democracy, the participation is understood as a way to empower citizens and stakeholders, and, in this view, the participatory process is a goal in itself. In the case when participation is understood as a means to enrich assessment and decision-making through the involvement of citizens and stakeholders, it is a part of a decision-support process, instead of a way to organize the decision-making process itself. Process as a goal and process as a means can be considered as two ends of the axis. Both deal with the fundamental question of the weight and impact attached to the participatory process and its output.

Then, van Asselt and Rijkens-Klomp divide participatory methods with regard to the type of targeted output. The methods, which aim to uncover a spectrum of options and

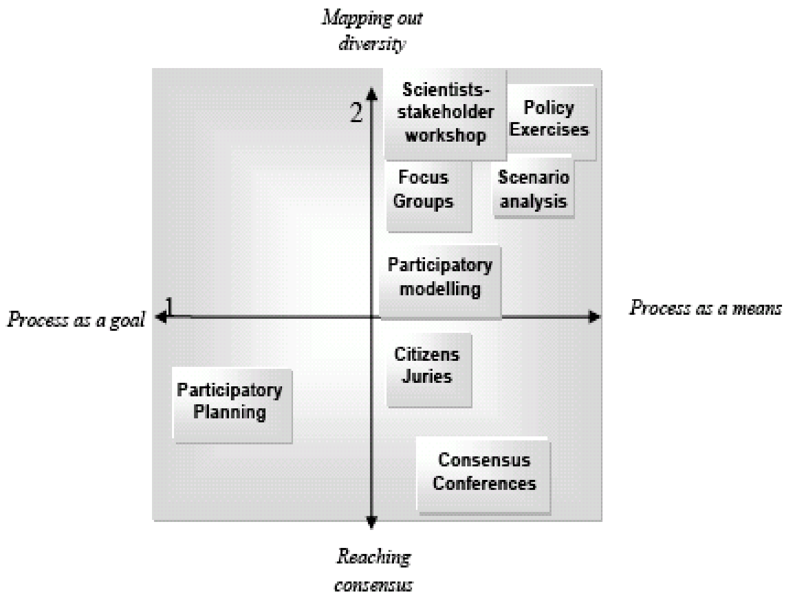


Fig. 6.9 Typology of goals of participation: (1) aspiration/motivation axis; (2) targeted output axis. *Source:* van Asselt and Rijkens-Klomp, 2002

information, to enable a group to disclose information and to articulate tacit knowledge or to test alternative strategies in a permissive environment, can be summarized as *mapping out diversity*. Other methods, which have the explicit aim to define or single out one perspective, option or strategy and enable the group to reach an informed decision on an issue, can be characterized as *reaching consensus*. These two types of goals can be considered as two other opposite poles in Fig. 6.9: *mapping out diversity* is focused on divergence; *reaching consensus* seeks convergence. Of course, it is not always possible to categorize a particular method unequivocally, and its position in the proposed scheme is especially meant to understand the relative general differences between goals associated with methods, and cannot be meant in absolute terms.

As a consequence of differences in goals, the design of participatory processes differs over the various methods, involving such issues as the number, tasks and roles of the participants and facilitators, the timely planning of the participatory meetings, the set up of the programs of the meetings themselves, input material and techniques, the expected outcomes of the process, etc. Thus, participatory methods are used "to map out diversity, either in the form of citizen's reports, as a wide variety of scenarios, through different policy strategies/options or as recommendations and suggestions for modelers" (*ibid,* p. 180).

There is no opportunity (moreover, no need) to describe in details the entire typology of participatory methods shown in Fig. 6.9. The overviews of many existing methods can be found in Carter *et al.*, 2007; Green and Hunton-Clarke, 2003; Sadler *et al.*, 2001b; Schlumpf *et al.*, 2001; van Asselt and Rijkens-Klomp, 2002; etc. One 'menu' of methods for different levels of public involvement is presented as Annex 6.1 to this chapter where the type of participation for use should be selected according to the situation or problem to be solved. Below is the summary of some methods and approaches, mainly related to policy analysis.

6.1.4.2 Some methods of public participations

a) Quick scan. This approach, which fits in the tradition of participatory policy analysis, is aimed at interactive problem definition/generation and screening of alternatives (Enserink, 2000). At the heart of the method lies a notion that in the early stages of policy preparation a quick acquirement of essential strategic information and insight into which part of the public to be highly involved should be considered as more important than acquiring extensive technical information. Thus, the author contrasts the word *strategic* with *content,* i.e. the focus is on a process that should allow for successful exchange of information between relevant parties. The *quick scan* assists in defining the problem and reducing uncertainty for all parties and stakes, involved or affected, by mapping the problem area, through recognition of constraints and opportunities for solving the problem and by assessing the prospects of proposed alternatives. In other words, the quick scan in the initial stage of a future project should be focused on the problem's essential characteristics, on the relationships between these characteristics and on the dynamics of a decision-making process. Information at this stage should be broad and superficial, and *political debate* rather than technical details is considered more important.

Designed as a problem recognition exercise, the quick scan approach should provide speed and transparency to the problem specification process; it also assesses and pre-selects promising alternatives and discloses information for everyone involved. Its activity should be executed by a multi-disciplinary team to generate rapidly new information for policy makers in the field. As such, the quick scan methodology should contain the following (Enserink, 2000):

- *interaction* – exchange of information and knowledge between stakeholders;
- *information* – open access to all sources available;
- *innovation* – no predetermined solutions;
- *society participation* of all stakeholders wanting to partake; and
- *iteration* – ongoing process of definition and redefinition of the problem.

b) Integrated assessment (IA)-focus group methodology aims to improve the understanding of local decision making through the explicit participation of decision-makers and stakeholders in the integrated assessment. The emerging methods of *Participatory Integrated Assessment* (PIA) utilize this methodology. As described by Jaeger *et al*. (2000), Schlumpf *et al.* (2001) and others, this approach has been specifically designed to allow the exploration of preferences and subjective probabilities as they emerge in social settings dealing with complex environmental issues. PIA complements existing analytical methods by assessing a broader context of societal decision making. Human participants are interacting with one another and with expert knowledge in a structured and decision oriented setting. Policy exercises, scenario exercises, and simulation-gaming are examples of such methods. One crucial part of PIA is to integrate scientific knowledge (facts and uncertainties) in participatory methods in order to improve the overall assessment.

In the fundamental survey of Schlumpf and co-workers (2001) the PIA methods are roughly grouped into three categories: dialogue methods, policy exercises and mutual learning.

> In *dialogue methods* the intended users are a source of information to design and test other assessment methods like IA-models. The long-term sustainability of dialogue processes is critical to the success of participatory approaches (Yohe *at al.*, 2007).
>
> *Policy exercises* are built on the tradition of simulation-gaming methods. Human participants play roles in a structured relevant decision and task setting exercise with a simplified representation of a complex system. A policy exercise is a means to get information on human behavior and policy preferences necessary for an integrated assessment. It also allows for detecting new and surprising policy options.
>
> In *mutual learning* methods, human participants enrich the assessment and are regarded as co-producers of knowledge. Participants are incorporated in the integrated assessment because their skills or competence complement the scientists' expertise and knowledge. The 'focus group approach' is an example of a mutual learning method (Kasemir *et al.*, 2000).

The overall objective of *IA-focus groups* is to produce policy recommendations on complex problems. The focus group methodology was initially developed by social scientists studying mass communication. Conventionally, the focus groups are groups of people with more or less the same problem perception, and who are exposed to some common stimulus: environmentalists, people living in the neighborhood, business representatives and administrators, and so on (Enserink, 2000). The stimulus usually is a television speech, a prototype of a new product, or some similar experience. The point of the exercise lies in the ability to observe opinions expressed in social processes, in which some new information is taken into account. The group is invited to engage in a free-wheeling conversation about a recorded topic that is then analyzed. In principle, the IA-focus groups generate policy recommendations that synthesize and integrate a wide variety of scientific information as well as social, political and ethical valuations. Integrated assessments based on such a process of social learning may complement and enrich other assessments because in this approach decision making is studied as a process of social learning among citizens, scientific experts and policymakers.

Schlumpf *et al.* (2001) introduced IA-focus groups to integrate scientific knowledge in participatory methods where citizens are additionally informed with the help of special software –'Interactive Citizens Information Tools' (*ICITs*). ICITs have a twofold role that is both supply and demand driven. Being designed to *supply* scientific information to a broader audience, they are also built in close collaboration with sociologists and tested in focus groups to comply with the *demands* of citizens for information to support their assessment.

c) The network approach to policy analysis contradicts the assumption of the State as the major authority in influencing and controlling societal activities. Instead, the emergence of policies is perceived as a process that includes both private and public actors (Jost and Jacob, 2004). *Policy networks* are defined as prevailing informal, but stable relations between actors that have different, but mutually dependent relations. The merits of such inclusive approach in policymaking can be expected due to the inclusion of major interests. Therefore, during the course of any decision-making process, relevant information is likely to be considered, and the implementation of policies should be easier than in a hierarchical mode. The analysis of information is usually focused on its exchange and the existence of scientific communities of professional and relevant actors. Inter- and intra-group cooperation of the network in a policy-making process is regarded as important for consensus building. For example, Wilbanks and Kates (1999) show how respected researchers from the local area, linked through a set of networks with local decision makers, can elicit information from local actors that would likely be unavailable to unfamiliar experts from distant sites. This kind of input to global change research is dramatically different in its approach, culture, and participation from the dominant top-down perspective.

d) Community risk assessment. Yet relatively little disaster management experience has found its way into climate change adaptation research and policy, however it provides insights in two specific areas that are relevant to climate change adaptation. The first area consists of risk reduction involving 'normal' climate hazards at the local level; the second – involves the linkages of hazard risk to livelihoods, involving natural resource and watershed management, income generating activities, poverty reduction, etc. Van Aalst and co-authors (2008) examined the experience of some of these activities in using *community risk assessments* (CRA)[10]. This experience included examples of vulnerability

[10] *Community risk assessment* is a generic term adopted by ProVention – an International Consortium of organizations involved in disaster reduction – to cover many methods used by NGOs and other organizations to assess local and community vulnerability and capacity. ProVention has compiled the resource base of CRA methods, which is available on its website: ***http://www.proventionconsortium.org/CRA_toolkit.htm***

and capacity assessments that were carried out at the village and urban neighborhood's level, and used participatory rapid appraisal (PRA) tools to diagnose vulnerabilities, assess a community's risk priorities, and work together with the people to devise ways of increasing their capacities to resist hazard impacts.

The methodology involved a range of PRA information-collecting tools. These included risk mapping, transect walks, asset inventories and livelihood surveys, historical and seasonal calendars, focus group meetings, surveys and discussions, and key informant interviews. A comprehensive library of CRA methods can be found on the ProVention Consortium website (see footnote 10). The process was carried out by trained facilitators (professionals or volunteers), who were intended to act as catalysts to engage members of the community to organize their own experiences and prioritize ways to address the issues they face. In addition, facilitators developed secondary data to provide context to the community-based information or to validate their findings.

e) Scientist–stakeholder workshops were proposed by van Asselt and Rijkens-Klomp (2002) as an additional participatory technique. The authors describe this approach as the involvement of stakeholders in the formation of research questions, generation of new information and discussion on results and recommendations through a series of structured, but open dialogue sessions involving stakeholders and scientists. A comprehensive understanding of the implications of extreme climate change requires an in-depth exploration of the perceptions and reactions of the affected stakeholder groups and the lay public. At such workshops, a heterogeneous group of stakeholders and scientists articulate and exchange their knowledge on a particular policy issue. The group of participants consists of scientists from different disciplines who are experts on special aspects of the central issue and various stakeholders, primarily decision makers, NGOs, representatives of business and other societal sectors.

Finally, it is clear that participation methods have certain *restrictions.* The principal two, which occur in climate change issues, are pointed out by Metz *et al.* (2003) as the following: (1) stakeholders may have a major interest in a specific decision or non-decision and thus frustrate optimal solution or result in decisions that favor the more powerful and resourceful groups; (2) the process of participatory policy-making or assessment may become unproductive when it is time-consuming, conflict-enhancing and cannot live up to the promises of democratic decision-making that it implies.

6.1.4.3 Mass media and communication

The (mass) media play a crucial role in informing and changing public opinion. Apart from its role in scrutinizing government actions and holding policymakers to account, the mass media are the main source of information for the general public on climate change science. Given the immense importance of the issues at stake for both people and planet, this is a role that carries great responsibility.

The recent rise in information coverage of climate change and development reflects an increasing sense of the impending catastrophe regarding the impacts that climate change will have on development. *"Climate change is big news, bigger news than ever before. Yet climate change is still a contested issue in all its dimensions—scientific, political, economic and social"*, – Doulton and Brown (2009, p. 191) have stated in their analysis of discourses of climate change and development in the UK press. Moreover, the climate discourse is changing to reflect more grave assessments of the problem. For example, Risbey (2008) divides this new discourse in assessments of the magnitude and urgency of the climate problem between a sense of alarm and a sense of alarmism**.** Some climatologists think that this shift is concordant with the science community understanding of the nature of the problem ('alarming'), but others think that the shift is rhetorical and inconsistent with the science ('alarmist'). The divide in the discourse among climatologists relates to tensions in the use of key phrases describing climate change. Risbey reviews evidence to support claims that climate change can be viewed as 'catastrophic', 'rapid', 'urgent', 'irreversible', 'chaotic', and 'worse than previously thought'. Each of these terms are imprecise and may convey a range of meaning.

Undoubtedly, the mass media is a critical arena for this debate and an important source of climate change information for the public. This matter is neither simple nor one-dimensional; public views, politics and policy also affect the news' agenda. But what is written in the media influences public perceptions and thence policy (Doulton and Brown, 2009). That is why Ward (2008, p. 17)[11] is convinced that "with an appropriate mentoring role by climate scientists and an appropriate open minded attitude by editors and journalists, we can avoid returning to a time when even a badly flawed over-reliance on formulistic 'balance' begins to look good. That's a prospect that should be unsettling both for the responsible climate science community and those journalists still committed to the somewhat romantic and idealistic notions that took them into journalism work in the first place".

The communication of climate change presents a challenge for the media**,** accustomed to representing a balance of opinions. However, the media is not set up to represent long-term, subtle and uncertain processes, and the transformation of its function is also a challenge if it aims to provide populations with a more realistic understanding of the difficulties involved in defining climate change policy (Lorenzoni *et al.*, 2005). Managing climate change means contending with this diversity, by judging what risks are 'acceptable' to society and what has obvious implications for institutional adaptation and behavioral responses. Until recently, the principle of 'editorial balance' has been applied in ways that have served to hold back informed debate, giving equal weight to the findings of the IPCC and climate science community and to the views of climate skeptics, many of which are funded by vested interest groups. *"Continued confusion in public opinion is one consequence of such policy"*, – recapitulated UNDP (2007a). At the same time, if there is a strong and overwhelming 'majority view' among the world's top scientists dealing with climate change, citizens have a right to expect to be informed of that view. Equally, they also have a right to be informed about minority views that do not reflect a scientific consensus. However, an informed judgment is not helped when editorial selection treats the two views as equivalent.

A common theme is also the acknowledgement that climate change is still a discourse defined by western (developed) nations; it also invariably influences the conceptualization of solutions to the problem. As a result, the global community is still subjected to the dominant western centric view of climate change issues. As a result, the manner in which

[11] Ward B., 2008: A higher standard than 'balance' in journalism on climate change science. *Climatic Change* **86**:13–17

climate change is addressed at international meetings and illuminated in the media raises issues of equity and inequality (Lorenzoni *et al.*, 2005).

Moser (2006), talking on engaging urbanites in climate change, argues that to tailor communication and outreach appropriately, the first question should always be: 'Who is the audience?' If communication and outreach are parts of the larger set of strategies to develop and implement GHG emission reductions or climate change adaptation actions, then the answer must consider what the communication effort is trying to achieve, i.e. what behavioral or social change is intended, and who actually has control over the relevant decisions. Some climate change communication efforts that have employed mass communication approaches typically not tailored to particular audiences, heavily focusing on the science and impacts of climate change.

'Effective' climate change communication is defined by Moser (2006, p. 3) as "any form of public engagement that actually facilitates an intended behavioral, organizational, political and other social change consistent with identified mitigation or adaptation goals". This definition implies a goal for communication that goes beyond a mere change in understanding of the problem, or a shift in people's attitude or concern about climate change. In fact, while a certain level of problem understanding is necessary, e.g., the increased level of personal concern and an intention to act on answering that concern, information or knowledge is demonstrably not enough to actually change someone's behavior. The key challenge of effective communication is to provide at once sufficient motivation to begin and sustain the desired social change and to help to lower any existing barriers or resistances to making that change. These four 'ingredients' of effective climate change communication (Fig. 6.10) are discussed in detail in the quoted work.

Depending on what social change is intended, the choice of the audience for climate change communication is a critical and strategic one. The obvious implication for its improving is to match messengers with audiences and to let trusted messengers recruit others into behavior change efforts. This principle underlies, for instance, the design of so-called EcoTeams – the neighborhood-based groups that try to reduce their ecological footprint and GHG emissions (Michaelis 2003).

Moser (2006, p. 6) also argues that "employing whoever is a credible, persuasive conveyor of information *in the eyes of the audience* then also means that the circle of communicators has to be broadened beyond those who have traditionally played key communication roles on climate change – scientist and environmental advocates". Designers of outreach campaigns must identify those credible messengers and give them the necessary information, training, and tools to translate climate change into relevant terms to those not yet reached. Sometimes that may mean not talking about climate change at all, but about air pollution, energy and cost savings, technological leadership, the moral

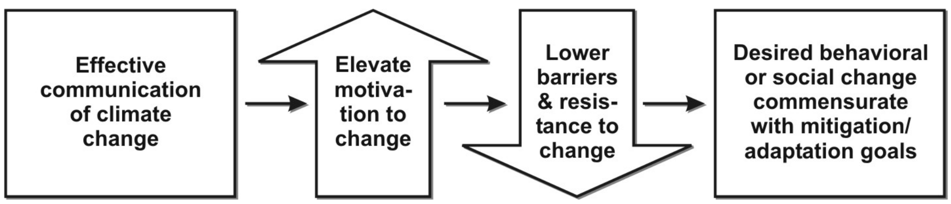


Fig. 6.10 The basic challenge of effective climate change communication. *Source:* Moser, 2006

obligation to be stewards of creation, or building a sustainable, safe, and livable environment. The author's key conclusion is that *"…climate change communication can be made more effective in facilitating societal response by using best practices and the insights from a variety of social sciences to help elevate the motivation to change and simultaneously contribute to lowering the barriers and resistances to change"* (*Ibid,* p. 8).

Thus, reframing the relevance of climate change, along with repeatedly communicating new meanings through a variety of trusted media sources, can generate the level of public engagement required for policy action (Nisbet, 2009; Stewart, 2007). Successful reframing means that it is true to the underlying science and makes the complex policy debate understandable, relevant, and personally important. This approach to public outreach requires a more careful understanding of citizens' views of climate change as well as a re-examination of the assumptions that have traditionally informed climate change communication efforts. To break through the communication barriers of human nature, messages need to be tailored to a specific medium and audience, using carefully researched metaphors, allusions, and examples that trigger a new way of thinking about the personal relevance of climate change. Moreover, because much weather and climate information is conveyed in a quantitative form (e.g., meteorological variables), it is necessary to convert these quantified variables into the experiential word symbols for the purposes of their description, comparison and communication. The characterization of atmospheric variables in a narrative form assists people in finding meanings in weather and climate.

Different studies in sociology, nuclear energy, food and medical biotechnology developed the general typology of frames[12] that appear to reoccur across science-related policy debates (see Nisbet, 2009). Table 6.3 outlines this general typology, describing the latent meanings of each interpretation.

6.1.5 Efficiency of public participation

6.1.5.1 Necessity and ways to strengthen efficiency of public participation

For most social analysts (e.g., Few *et al*., 2007), a meaningful interpretation of the term participation must imply a degree of active involvement in taking decisions. In particular, much of the debate surrounding climate change adaptation concerns the advocacy of a long-term precautionary approach that seeks strategic planning and action in advance of major climate impacts becoming manifest; because of the long-term and uncertain nature of climate change, anticipatory response to risks may be particularly complex and contentious. This presents difficult choices for society in formulating appropriate responses 'on the ground', especially in cases where adaptation might imply high costs or radical alteration of present-day activities. Therefore, references to effective 'participation', 'stakeholder engagement', 'bottom-up' processes and other terms associated with a discourse of inclusive governance are widespread.

[12] In Nisbet (2009), '*frames'* are understood as interpretive storylines that set a specific train of thought in motion, communicating why an issue might be a problem, who or what might be responsible for it, and what should be done about it

Table 6.3 Typology of frames applicable to climate change

Frame	*Defines science-related issue as . . .*
Social progress	A means of improving quality of life or solving problems; alternative interpretation as a way to be in harmony with nature instead of mastering it.
Economic development and competitiveness	An economic investment; market benefit or risk; or a point of local, national, or global competitiveness.
Morality and ethics	A matter of right or wrong, or of respect or disrespect for limits, thresholds, or boundaries.
Scientific and technical uncertainty	A matter of expert understanding or consensus; a debate over what is known versus unknown; or peer-reviewed, confirmed knowledge versus hype or alarmism.
Pandora's box/Frankenstein's monster/runaway science	A need for precaution or action in face of a possible catastrophe and out-of-control consequences; or alternatively as fatalism where there is no way to avoid the consequences of a chosen path.
Public accountability and governance	Research or policy either in the public interest or serving special interests, emphasizing issues of control, transparency, participation, responsiveness, or ownership; or debate over proper use of science and expertise in decision making ("politicization").
Middle way/alternative path	A third way between conflicting or polarized views or options.
Conflict and strategy	A game among elites, such as who is winning or losing the debate; or a battle of personalities or groups (usually a journalist-driven interpretation).

Source: Adapted from Nisbet (2009)

New conceptualization of vulnerability and adaptation – a set of competencies necessary to respond to the current and future climatic changes – helps to link adaptation to development and to guide the thinking of public engagement in adaptation activities. At the same time, it creates new opportunities and demands to strengthen the efficiency of public participation. Ziervogel (2007) outlines this aspect of public participation as follows:

- Adaptation can be viewed as a process of *social learning;* this helps to accommodate goals and processes that vary between stakeholders rather than focusing on a fixed method for 'reducing vulnerability'.
- Adaptation strategies and actions should be robust against a wide variety of future conditions. To achieve this, robust conclusions and critical uncertainties should be effectively *communicated* to enable stakeholders to evaluate the climate envelope within which current actions can continue.
- *Information* on climate change adaptation should be able to be integrated within existing risk management practices. While the state is required to respond to climate change impacts, the individuals and companies tend to respond when there is an immediate threat to them.

However, to make public participation really effective it is necessary to improve universal understanding of how it should be integrated into the policy and decision-making processes. Disagreements in this regard are often painted in black and white. Some people view the public as overly influenced by emotions rather than facts and believe that an environmental decision-making should be the domain of experts using analytical methods; however, others view the officials as attentive to special interests rather than the public interest and believe that the public should be intensely involved in all environmental decisions. In practice, as Tonn *et al.* (2000) noted, public participation should not be seen as an ‘either–or’ proposition. The public can be involved to different degrees and in different ways. Understanding these differences helps environmental policy- and decision-makers to choose both the appropriate mode for their problem and the appropriate approach to public participation.

At the same time, long-term experience with public participation in environmental assessment, for example in Canada (Doelle and Sinclair, 2006), brightened up one principal contradiction: although public participation is generally recognized as a vital tool in enhancing the sustainability of projects, it simultaneously has not been effective. Public participation processes are criticized as ineffective by participants, as costly and time consuming – by proponents, and as inefficient – by governments. These authors see at least two possible answers to the puzzling question of why something that is seen as so fundamental to effective decision-making appears to be so ineffective. The first answer – the assumption that public participation is valuable in decision-making is false – is considered as unlikely because much has been written on the importance and benefits of public participation, and this assumption is well established. Another possible explanation is that the process of engaging the public is deficient and ineffective in its current form. The starting point of their discourse is an opinion that “a major source of the problem with public participation in environmental assessment is the focus on process and access, rather than on outcomes” (*ibid,* p. 186). As necessary legislative ‘reforms’, they propose the following actions: to define the public and effective notice as well as acceptable processes for engaging the public; to establish participant funding programs; to define processes for policy issues, and to determine whether public participation was adequate.

Doelle and Sinclair believe that if public participation occurs early in the planning cycle and is aimed at achieving consensus around the desired outcome of a project, the benefits to all parties could be obvious, namely:

- The key benefits to *the public* are that the power balance between it and the proponent is shifted to encourage proponents to consider public concerns seriously and actually address those concerns;
- The *proponent* will benefit in terms of the certainty of process, improved project design through meaningful public participation in the design stages, and greater project acceptance in affected communities;
- The *environmental assessment* benefits with improved process and decision satisfaction of all parties as well as being able to be clearer about the contributions of a project to stated government goals (at all its levels) around sustainability commonplace;
- *Society* as a whole will benefit from better responses to pressing problems, including better attention to multiple sustainability purposes, better selection among possible options and better design and implementation of the projects that are selected and approved.

When considering ways to strengthen efficiency and effectivity of public participation, the following three factors are found to be necessary: *motivating public to take action, overcoming barriers to change* and *public enlightenment.*

Really, active and effective public participation is impossible without ***motivating the public*** to take action. In one of the previously quoted works, Moser (2006) discusses this problem from the vantage point of an urban population. It seems justly if to take into account that a growing percentage of the world's population lives in urban areas, and cities are major centers of energy use, waste production, and GHG generation. Due to their influence over energy supply and management, traffic control, urban planning, etc., cities are logical focal points for efforts to mitigate climate change. Simultaneously, urban areas are expected to be affected in numerous ways by climate change, requiring individuals as well as municipal decision-makers to identify and implement adaptation strategies. However, none of the confronting climate change efforts can succeed without engaging residents to support the development or realization of taken measures. The best intentions of countless individuals may be insufficient, inefficient and create possible unintended outcomes if they are not coordinated and guided by well-designed policy. *"Without concrete and actionable solutions knowledge, it seems even less likely to actively and constructively engage people on the issue"* (Moser 2006, p. 8)[13].

At the same time, simply knowing about climate change or feeling scared by its consequences may help, but is unlikely to suffice to initiate and sustain cardinal behavioral changes. Only effective and efficient communication will create the necessary motivations. Abiding concerns, for example, for the wellbeing of children and other deeply held values, fall into this category.

Another task to be solved in building effective participation is ***overcoming barriers to change*** in environmental behavior.

In particular, Fischer (2003) discerns investing, behavioral and organizational strategies to produce change, where:

- ➨ In *investing strategies* an actor changes or substitutes some factor of his environment that shapes his behavior. The action basically consists of making onetime investments, thereby changing the framework conditions for future action and 'enforcing' a sustainable consumption pattern;
- ➨ *Behavioral change* targets habits and practices of the actor;
- ➨ *Organizational change* means modifying processes, institutions and routines.

This distinction is important because different strategies pose different kinds of difficulties. *Investments* are often difficult to introduce in the first place because they need considerable resources and efforts as well as a supportive environment. However, once introduced they usually require less effort. *Behavioral change* shows the contrary pattern. One-time examples of alternative behavior can often be implemented without much financial or organizational effort. However, if the behavior is to be kept up over time, this usually means changes in lifestyle, which are difficult to achieve. *Organizational change*,

---

[13] As a positive example, one can name the research, commissioned by British government, on the public understanding of climate change. All information, relevant to this problem, is located at the well-known UK governmental website '*Public service: All in one place'*. See: *http://www.climatechallenge.gov.uk/*

like investment, requires much effort to introduce and less to keep up. However, it also shares some features with behavioral change because it involves adaptation of practices and habits. Therefore, similar psychological barriers may occur and similar persuasion strategies may be effective.

Moser (2006) sees the primary obstacle to overcome in reaching people is widespread disinterest, apathy, and filters against an overabundance of information. "Any communication, especially communication of an easily overwhelming, global, complex, uncertain, politically charged, and difficult-to-solve issue such as climate change, will have to contend with these barriers" (p. 7). Even individuals who are highly motivated to take seriously a climate policy or take a personal emission-reducing action may fail to carry through with it because of obstacles they encounter. Here, Moser distinguishes external and internal obstacles. The simplest example of an external obstacle named by the author is practical unfeasibility for a person to take public transportation rather than to drive to work, even if he is inclined to change his behavior. In much the same way, retrofitting existing infrastructure or building stock to adjust to new climate may be more expensive than individuals or governments can afford.

Alternatively, people may face internal obstacles. The heaviest argument 'against' is perhaps the long-term population skepticism as to the climate and weather prognosis that creates emotional barriers and resistances to the perception of the problem as such. A sense of isolation or futility may prevent individuals from taking personal action. But, and this is most important, simply lack of technical expertise or social support to make a change and sustain it could all prevent a good intention from turning into actual climate-friendly behavior.

Thus, we must recognize the sometimes substantial costs, and not only financial, involved in changing people's habits of thought and behavior. Neighborhood, organizational and other small-scale community approaches to support behavior change provide more adequate forums for engagement and the necessary social support and accountability to change. Communicators must also recognize that along with repeated news about the state of the science and potential impacts of global warming the people know far less about what *personal actions* they could take, what solutions are available, and what their costs, effectiveness or other implications may be. Without knowledge of such concrete and actionable solutions it seems unlikely that they will be successful in active and constructive involvement of people in the climate change issue.

Necessity of ***public enlightenment*** is related by Moser (2006) to the discussion about the two roles that population plays in climate policy and action: (1) as a political force, it can mobilize for policy changes at different levels of government; (2) as consumers of material goods and environmental resources, it can enact behavioral changes that are consistent with needed mitigation and adaptation measures. One of the most important factors in determining a population's productivity, behavior and values is human capital that is formed by the investment in education and health. These investments increase people's options, raise their productivity at work, and change their behavior. In the information age, human capital has become a primary source of wealth.

State-of-the-art technologies have created unprecedented opportunities for the ***dissemination of knowledge.*** To take advantage of these opportunities and to avoid falling behind, societies must expand and radically change the role of education, both formal and informal. Today, education, and particularly environmental and climate change education, is expressed as a priority in some national strategies for sustainable development (Box 6.3), but has not become a major component of these strategies in developing and transition countries (Muir-Leresche, 2002). The capacity of appropriate human resources to tackle the climate change problem is inadequate to meet its pressing, formidable tasks, and so far little has been done to address this situation.

A 'start' should be taken in elementary, secondary and higher-education schools, considering 'climate affairs' as a new breed of academic programs that specifically target capacity building, especially in transitioning and developing countries (Glantz and Adeel, 2000; Matkins and Bell, 2007). The notion of such programs is viable given the tremendous impact that climate has on society and the environment, and vice versa. Moreover, Matkins and Bell (2007, p. 138) argue that socio-scientific issues such as global warming provide "an ideal context for enhancing students' and teachers' understandings of the nature of science". Climate change illustrates many aspects of the nature of science and can serve as a model for studying this topic. Studies of changes in climate are empirically based, and theories about future climate are empirically driven. This complex and controversial problem is a common theme in media and is discussed regularly by different international political and scientific forums. Thus, it represents a scientific issue that is clearly embedded in our culture, and the common misconceptions about climate change are based upon portrayals in popular media. This presents also a special opportunity for instructors to use the climate change problem as an example of why citizens must be responsible for developing their own reasoned conclusions about scientific issues, and not be led by the press and persons promoting particular agendas.

Box 6.3 Education, training and public environmental awareness in Latvia

The Republic of Latvia authorities consider effectiveness of climate change policies as dependent directly on the general public's environmental knowledge, education and awareness. The main target groups include state administration institutions, local governments and their representative organizations, residents, business and non-governmental organizations, mass media as well as public and higher-education organizations. The current educational system has been developed at all levels (see Table), building on internationally recognized priorities, through considerable revisions of past practices and taking into account the national traditions and experience in education.

Main levels of environmental education in Latvia

Levels of environmental education	Tasks
Primary and general environmental education	Incorporation of environmental education elements in pre-primary, primary and general school curricula
Higher basic education in environmental science	Integration of basic concepts of environmental education and sustainability development in the higher education curricula
General higher environmental education	Well educated environmental specialists
Professional environmental education	Specialists in subsections of environmental sciences
Lifelong and further education in environmental science	Providing further education in areas of environmental science

Source: Fourth National Communication of the Republic of Latvia to the UNFCCC, Ministry of Environment, Riga, 2006, 162 p.

A second aspect of public enlightenment is '*education and sustainability'*. Speaking about confronting climate change in the framework of sustainable development, we should remember that addressing the danger changes in climate implies not only efficient and ecologically sound management, but also the need to establish social equity and political empowerment. Because for poor countries the emphasis should be on finding solutions to environmental protection that do not involve trade-offs with growth and equity, the education is an area where it is possible to promote environmental integrity, while at the same time contributing directly to both growth and equity. In the opinion of Muir-Leresche (2002), education holds the key to reducing the growing divide in perceptions of what is most important for environmental sustainability. For example, while developed countries are focused on global warming and species diversity, the transition and developing world is most concerned with reducing poverty and establishing sustainable well-being. Education can inform people from rich countries about concerns of the poor, and at the same time inform people in poor countries about why global warming and species diversity are also important.

Springett and Kearins (2005), summing numerous publications, endorsed some characteristics of education for sustainable development that underpinned the precepts and goals of this special issue[14]:

- education for sustainable development is interdisciplinary and holistic in its approach;
- education is value driven, and the assumed norms are made explicit in order to be examined, debated, tested and applied;
- critical thinking and problem-solving are called for in order to strengthen actor agency;
- multi-method approaches are employed along with different pedagogies that model the process;
- participatory decision-making processes are employed such that learners are participants in making decisions about how they learn;
- education for sustainability is locally relevant with local and global issues being examined and the language of the learners being employed.

In the FSU region the National Capacity 21 programs also make a concerted effort to develop the capacities of individuals. Support of awareness-raising and education are combined with other demonstrations of approaches to economic, environmental and social problems. Key objectives of this activity include (Cherp and Vrbensky, 2002, p. 36):

- Promoting awareness, understanding and positive attitudes about sustainable development concepts among opinion makers (especially journalists and politicians),

---

[14] As some other publications that can provide leadership for those working in the area of education for sustainability, can be recommended:

Galea C. (ed.), 2004: *Teaching business sustainability: From theory to practice.* Greenleaf Publishing, 336 p.

Scott W. and S. Gough (eds.), 2003: *Key issues in sustainable development and learning: A critical review.* Routledge Falmer, 274 p.

Scott W. and S. Gough (eds), 2004: *Sustainable development and learning: Framing the issues.* Routledge Falmer, 173 p.

technical specialists (especially planners, environmentalists and economists) and the general public;

- Strengthening the capacity of individuals and communities to cope with the challenges of economic transition without adopting non-sustainable life styles.

Undoubtedly, such efforts should also be extrapolated to climate change themes.

6.1.5.2 'Ownership' as a factor of active public participation in natural resource management

Contemporary natural resource issues are wicked in nature. Wicked problems involve multiple and conflicting or competing values and goals, little scientific agreements and great uncertainty about cause–effect relationships, limited time and resources, incomplete information, and structural inequities in the access to information and distribution of political power (Lachapelle and McCool, 2005). The authors of this statement have analyzed associated with natural resource management literature and revealed that in situations characterized as wicked the traditional planning processes emphasize technical analysis and limit citizen involvement. This often creates tensions between citizens and agencies in the form of inaction, distrust, litigation, and occasionally – even threats and violence. As a result, a new concept – '*ownership'* – is emerging that describes the potential for individuals to address wicked situations.

Lachapelle and McCool define term '*ownership'* as "…responsibility, obligation, and caring imbued by individuals in problem situations" (p. 279). As a shared definition of a problem, 'ownership' has also been described as "…an integral to addressing problems and seeking solutions" (*ibid,* p. 280). The meaning of 'ownership' has evolving from legal and jurisdictional issues of title over land and related resources to a more conceptual notion that the public has interest in and a sense of responsibility for the stewardship of public resources. When both citizens and agencies are intimately engaged, for example, in planning processes, a sense of ownership is created, leading to a greater chance for political support and implementation. Local and national actors should achieve ownership, defining their own needs and implementing their own solutions (UNDP, nd). People *"…are apathetic because they are powerless, not powerless because they are apathetic,"*– Barber (1984, p. 272)[15] noted. A better understanding of ownership can lead to improved community–agency interactions and more widely accepted natural resource decisions, while also better addressing the wicked problems in natural resource management.

Lachapelle and McCool (2005) expanded the discussed concept by including three characteristics: ownership in process (*whose voice is heard*), ownership in outcome (*whose voice is codified*), and the ownership distribution (*who is affected by the action*).

The *ownership in process* allows citizens and agencies to negotiate ideas and reconsider how problems are defined. It involves the processes by which different 'voices are heard' and considered legitimate or valid. Problems may be defined ('framed') so as to either benefit or harm individuals; the framing of problems drives underlying assumptions, guides strategies taken, and influences ultimately the quality and acceptability of a plan.

---

[15] Barber B.R., 1984: *Strong democracy: Participatory politics for a new age*. Berkeley, University of California Press (Quoted by Lachapelle and McCool, 2005)

Privileging the particular ideas, forms of knowledge and definition of the problem influences interactions between individuals and the choices they make to address a situation. Actors, which share problem definitions, consequently share ownership in problem-solving approaches and thus work together to achieve mutual goals. 'Ownership' is attained when the interpretation of individuals is accepted as correct and authoritative. Thus, "…ownership imposes a process that prioritizes deliberation and attempts to build mutual understanding of interests, agreement on data, and shared definitions of problems" (*ibid,* p. 281).

Ownership in outcomes signifies that it not only involves the association of citizens and agencies to collectively define and share the problem, but also challenges conventional notions of power and control over the outcome. In this sense, ownership reallocates influence or direct authority over decision making and the execution of actions.

The last characteristic – *ownership distribution* – means distribution of ownership across diverse social, political and ecological scales. It involves those affected by the action and how plans and decisions are distributed, accepted, and 'owned' spatially. In this sense, ownership involves both horizontal and vertical notions. Horizontal ownership is the interaction of interested agents in the physical place that is the subject of the plan; vertical ownership links local, regional, national and even international interests. Widely shared ownership across a complex cultural and ecological landscape results in broad social acceptability and the increase of political implementation.

Success of improved relations between citizens and agencies due to ownership can be measured both by ecological, on-the-ground changes and by social and political acceptability. It involves significant dimensions related to learning, relationship building, interest representation, and so on. Undoubtedly, creating a sense of ownership may not address all wicked problems, nor it will ensure that all voices are accommodated. However, ownership acknowledges alternative forms of knowledge and allows for more inclusive distribution of power over outcomes.

Ownership can be addressed in a number of ways, some of which Lachapelle and McCool define as the following:

- ⇨ sharing in discussions about the nature and need for policy changes before, e.g., a crisis emerges;
- ⇨ providing with more frequent and open forums for learning, deliberating, understanding, and expressing diverse opinions;
- ⇨ addressing the spatial and temporal issues cooperatively with other agencies and institutions;
- ⇨ asserting the adaptive planning and management, and actively taking risk and learning from experiences;
- ⇨ monitoring the projects and evaluating the results with the use of citizen groups;
- ⇨ incorporating both scientific and experiential knowledge and providing forums for the active interchange of the ideas generated; and
- ⇨ encouraging a deliberate and creative interaction with constituencies in the definition of problems and the design of strategies through on-site field trips, group-oriented chats, and other hands-on opportunities for learning.

Thus, "ownership involves the association of citizens and agencies to collectively define, share, and address problem situations with an implicit redistribution of power" and as a such "… may exist as a fulcrum in determining successful natural resource management" (*ibid,* p. 283). This emerging notion of ownerships raises some fundamental questions and issues that were formulated as a conclusion to the work we are referring to:

First, to what extent are natural resource agencies prepared to promote engagement and share responsibility for management of areas under their jurisdiction, including the design of planning processes? Do these institutions have the capacity to address issues of power and implement processes that enhance a sense of ownership? Can natural resource agencies effectively engage the public being under attack from all sectors for a variety of reasons and assist in constructing a sense of ownership? What social and political conditions would be needed to more effectively engage the public and create this sense of ownership?

Second, the quantity and quality of public engagement, required to create a sense of ownership, assumes an active and participatory citizenry, interpersonal trust, cooperative relationships, and other elements of social capital. Moreover, achieving a sense of ownership requires more than simply mandating public meetings or establishing citizen monitoring groups. It means that ownership becomes a fundamental objective of public engagement processes where the public becomes integral in the design and implementation of these processes.

Third, how can notions of ownership be evaluated and how successful processes of ownership are created? Who benefits from collaborative processes that result from an increased sense of responsibility and stewardship and who pays the costs? To what extent does ownership threaten or strengthen access to information and decision-making?

6.2 Science and scientific research in climate change policy

6.2.1 Bridging research and policy

6.2.1.1 Science in environmental and social policies

As policy quandaries, environmental problems are complex and difficult to tackle because at the root of their causal chain are intricate interactions between biological, physical and social systems, and because their solution depends on the collaboration between scientists, policymakers and the public. Moreover, implementing effective environmental policies is needed not only to support the combined efforts of many disciplines to understand environmental problems, but also for active interaction with stakeholders (Engels, 2005; Lemos and Morehouse, 2005). The first of these authors believes that an environmental science field is particularly prone to changing public and political expectations. Policy debates have begun to be dominated by a new understanding of environmental risk that, as it is now widely recognized, involve frequently unknown forms of uncertainty, including complexities and inter-linkages among ecosystems, the anthropogenic nature and potential irreversibility. These uncertainties and the high stakes in the policy process require "post-normal" science where the traditional quality control mechanisms are replaced by extended peer communities. This mostly inherently uncertain environmental knowledge forces policymakers to look for ways of making decisions under conditions of uncertainty, thereby increasing awareness that environmental policies require scientific expertise. When there are conflicting national interests, a scientific expertise is one of the few means available to harmonize these conflicts, to create a common interest and to address questions of policy relevance, scientific quality, and legitimacy. Engels (2005) called scientific warning and awareness, problem definition, *ex ante* impact assessment of policy options, *ex post* evaluation of policy choices, and monitoring of implementation as examples of possible functions for scientific expertise.

Cash *et al.* (2003) discuss three determinants of *effective scientific advice* in the environmental arena:

1. *Historical analyses of environmental issues* that trace their emergence from initial scientific discoveries to high-level policy agendas. The authors suggest that the 'effectiveness' of a scientific input needs to be gauged in terms of impacts on how issues are defined and framed, and on which options for dealing with issues are considered, rather than only in terms of what actions are taken to address environmental problems. A decade or more may be necessary to reliably evaluate the impact of science, technology and ideas on an issue's evolution.

2. *Evaluations of scientific advice in general and environmental assessments in particular*. Scientific information, which is likely to be effective in influencing the evolution of social responses to the extent of being perceived by relevant stakeholders, should not only be credible, but also salient and legitimate. Here, *credibility* involves the scientific adequacy of the technical evidence and arguments, *salience* deals with the relevance of the assessment to the needs of decision makers, and *legitimacy* reflects the perception that production of information and technology has been respectful of stakeholders' divergent values and beliefs, unbiased in its conduct, and fair in its treatment of opposing views and interests. These attributes are tightly coupled, since the efforts to enhance any one normally incur a cost to the others.

3. *Effective science advising of 'boundary work'* carried out at the interface between communities of experts and communities of decision makers. This work highlights the prevalence of different norms and expectations in the two communities regarding such crucial concepts as what constitutes a reliable evidence, convincing argument, procedural fairness, and appropriate characterization of uncertainty. It points out the difficulty in effective communication between the communities resulting from these differences, and stresses the importance of explicit development of boundary-spanning institutions or procedures.

Thus, science should explain or interpret the observed and recorded environmental phenomena. Explanations must be logical, based on sound inductive and deductive reasoning; the information to which this logic is applied must be accurate and reliable (Curtis and Epp, 1999). Interactive models of research are increasingly being adopted to understand complex environmental issues, their impact on human and natural systems, and the opportunities and constraints for policy-making.

Here, as Redclift (1998) argues, there are two very different traditions of thoughts and policies.

The first tradition is the natural science agenda that was manifested in the way IPCC was originally conceived: the initial taxonomy of GHG emission through certain scientific processes led to estimations of likely changes in climate and then – to impacts and responses. In this example, the etiology of the climate change problem is given by its physical characteristics, or the line of causation is from physical processes to human policies. It follows from a perspective that the purpose of exercises like that undertaken by IPCC is 'to get a right science', to ensure that science outputs are good, reliable, rigorous and objective. *Knowledge*, according to this view, "is a process of gradual accretion, through which we learn 'more', on a linear unidimensional basis. What we need to know is out there to be learned, to be humanized, and gathered together in the store of knowledge that every scientist is adding to" (Redclift, 1998, p. 177).

In contrast with the natural sciences, the second tradition in thought and policy is observed in social sciences, which are "pluralist in conception: the admission of differences is not held to weaken the authority of the science" (*ibid,* p. 178). The social sciences are not also 'timeless' or 'placeless', but are closely identified with particular times and places. The greatest challenge for social scientists is to identify the insights and understanding of the interpretive tradition, and to incorporate these approaches into the domain of environmental science. Redclift names several ways in which this might be done:

- *Making intelligible the social processes through which science works*
- *Public scrutiny and post-normal science*
- *Developing common tools and metaphors*
- *Incorporating 'users' into interdisciplinary environmental research.*

Today, when global hazards threaten all social classes, the concept of the risk society suggests that scientific results are becoming more relevant for policy decisions, and social science plays a decisive role in bridging the gap between public opinion and expert debates on complex environmental issues. For instance, there is a growing need for integration of social science into participatory techniques of the research on global change.

Kasemir *et al.* (2000, p. 170) have formulated a cluster of related problems in social science research that would be crucial to sound policymaking:

(a) The constructivist-realist debate about the ontological existence or *real* nature of environmental change. Most theoretical and empirical contributions in the field put much weight on the assumption of whether they take environmental problems as 'real' or as 'socially constructed'. Attempts to integrate the two approaches for the case of climate change are under way.

(b) The extent to which global change is understood either as the cause of social change, as its effect, or as being independent from it. This debate is rooted in the contrast between ecological determinism and socio-cultural autonomy.

(c) The epistemological discussion on which procedures are most adequate to obtain knowledge for framing and coping with global environmental change.

(d) The contested question of whether social science on environmental issues should develop independently from or in collaboration with natural science research. Is it still useful to proceed with a non-integrated environmental social science, or should both social and natural sciences inform each other.

(e) The open issue is whether social science methodologies are useful and legitimate to facilitate participation, and to democratize environmental research and its applications.

Exciting developments in the social sciences concerning these issues should be planned both at national and international levels. *"Science is a social process, yet scientists often pretend that it is not"*, – Cohen *et al.* (1998, p. 362) believe.

6.2.1.2 Building science-policy interface

Various opinions on the relationship between science and policy are subjected to ongoing debates regarding the role of science in public policy and about the justification for public funding of scientific research. As a result, extensive research has emerged over past decades to examine the social contacts between science and society, to explore and improve the science–policy interface, and provide specific recommendations on how to improve communication and interaction between these two worlds (Engels, 2005; Lemos and Morehouse, 2005; Litre and Mekjian, 2008; Livny *et al.*, 2006; Vescovi *et al.*, 2009; Vogel *et al.*, 2007).

Well informed policies are more effective in the identification of current needs and in the formulation of better strategies. However, as it was shown by the special Global Development Network (GDN)'s Project on bridging research and policy (Livny *et al.*, 2006), although there is a growing recognition of these basic principles, some countries, especially those developing and in transition, remain poorly informed about the pathways of research uptake. The very terminology 'bridging research and policy' implies the presence of a 'gap' to be 'bridged'. The questions arising here include (Livny *et al.*, 2006):

- How can policy-makers best use research and move towards evidence-based policy-making?
- How can researchers best use their findings in order to influence policy?
- How can the effectiveness of the interaction between researchers and policy-makers be improved?

However, while recognizing the inherent difficulties of defining and classifying research-policy gaps, there is no unique 'metric' by which they might be measured. Challenges surrounding the science-policy interactions are especially evident in environmental issues, where the resulting findings are inherently rife with uncertainty. Additionally, scientific conclusions are often poorly communicated to policymakers who then fail to take these conclusions into account (Litre and Mekjian, 2008).

Strengthening the capacities of research and policy communities to gain a shared understanding of the social causes and implications of global changes, and to facilitate dialogue between science and policy is also at the core of the IHDP's revised mission (Moser, 2008). The concept note guiding the 7th IHDP Open Meeting in New Delhi, India, shifts the focus *"from [merely] understanding the dynamics of global environmental change to using that understanding to devise ways to meet the challenges that we see emerge. This has pushed the scientific community to pay more attention to the relationship between science and policy, to include more use inspired and policy-relevant research,* *and to improve communication with government, business, NGO's and the civil society at large"*[16].

These and other considerations demand scientific communities to search more seriously for the ways in which their research can be made better interfaced with policy- and decision-making.

A mutually beneficial dialogue between science and policy requires framing and carrying out the research objectives with policy considerations in mind. At the same time, policymakers should be aware of the science available and encouraged to take policy relevant research into account. An open dialogue between the scientific and political communities is necessary not only for the development of well-guided policies but also for the formation of pertinent research agendas (Litre and Mekjian, 2008). Over four decades ago, H. Brooks (1964)[17] introduced this dichotomy within science advisory roles by distinguishing between *policy for science* and *science for policy,* defining the former as "concerned with the development of policies for the management and support of (national) scientific enterprise", and the latter – with "matters that are basically political or administrative but are significantly dependent upon technical factors".

Understanding the type of a policy problem and identifying the stage of a policy cycle may help in guiding the organization of ***science-policy interface*** (SPI). The dependence of using science in a policy process on these and other factors is seen (e.g., Engels, 2005) as a main challenge on this way. A growing number of policy problems have national or international context and are of a cross-sectoral nature. The higher degree of complexity implies often a greater need for scientific input, scientific assessment, and scientific modeling. Many new policy problems affect the vital interests of conflicting parties more fundamentally than traditional ones. In these cases, scientific expertise and opposing sources of information are used by all parties to strengthen their positions. Finally, there is a large variation in the availability of solutions to different policy problems and, moreover, science itself can be a source of new solutions and coping strategies. Engels (2005) sees the following as the most important questions in the design of a science-policy interface: (1) its frequency (SPI should be regarded as a continuous process rather than as isolated events), (2) the degree of formalization (SPI can range from highly formalized organizations to informal encounters), and (3) the way in which institutional boundaries between science and politics are organized.

Jones *et al.* (1999), evaluating the science-policy interface for climate change research, summarized various criteria that have been proposed for characterizing the quality of the interfaces, either in general discussions or in analyses of specific programs. The criteria for the integration of scientific information with policy-making can be seen in terms of four conditions:

- Research results must be *relevant* to currently pending decisions;
- Research results must be *compatible* with existing policy-making processes and models;

---

[16] 7th Open Meeting of the International Human Dimensions Research Community in New Delhi, India, *Concept Note*, p. 2, emphasis in the original. Available at: *http://www.openmeeting2008.org/doc/concept_note.pdf*

[17] Brooks, H., 1964: The scientific adviser. In: R. Gilpin and C. Wright (Eds.), *Scientists and National Policy-Making*. Columbia University Press, pp. 73-96 (cited by Agrawala, 1999)

- Research results must be *accessible* to the appropriate policy makers;
- Policy makers must be *receptive* to the research results.

Fig. 6.11 details these criteria, as they would apply to a policy arena, defined as a set of policy decisions with a common focus and the involvement of one or more organizations:

- *Determining relevance.* The relevance of research to a policy-making process depends on the potential of its results to affect estimates of the impacts of those choices.
- *Determining compatibility* means that research that is relevant in principle still must be usable in practice, or should be compatible with existing policy-making procedures and decision models.
- *Determining accessibility* means that relevant and compatible research must still make its way to the potential users.
- *Determining receptivity* means that even if policy makers have access to relevant, compatible climate change information, they will only use it if they are open to it.

Evaluating these fundamental screening criteria requires considering a set of inter-dependent questions listed in the corresponding boxes under each criterion.

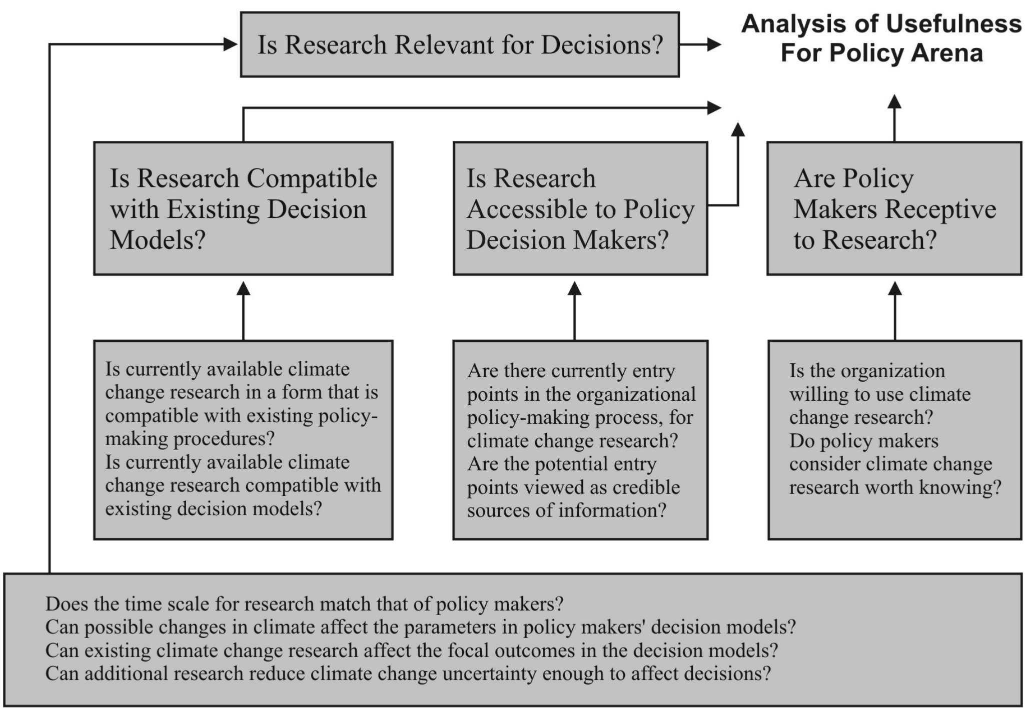


Fig. 6.11 Indication of the usefulness of climate change research for a decision arena. *Source:* Jones *et al.*, 1999

6.2.1.3 Knowledge systems for sustainable development

Science can contribute to the transition to sustainable development by providing knowledge and guidance for navigating the journey from unsustainable contemporary patterns to a sustainable future (Swart *et al.*, 2004). Nevertheless, the literature developed around sustainability science, as Lövbrand (2004) noted, sometimes seems more focused on building bridges between conceptual worlds, than forwarding a deeper understanding of the range of cultural, political and social processes that affect the adaptive capacity of specific social entities.

In response to mismatch between the humanity '*demand*' and the nature '*supply*', a number of efforts were initiated in the 1990s to reconsider how science might be better harnessed to achieve social goals of environmentally sustainable human development. The results of those efforts were synthesized by the Johannesburg Summit (UN, 2002) as part of the international scientific community's input to this meeting. The strongest message that emerged from dialogues induced by the Summit was that "…the research community needs to complement its historic role in identifying problem of sustainability with a greater willingness to join with the development and other communities to work on practical solutions to those problems" (Clark and Dickson, 2003, p. 8059).

The array of increased movements to mobilize science in quest for a transition toward sustainability take as the point of departure a widely shared view that the challenge of sustainable development is the reconciliation of society's development goals with the planet's long-term environmental limits. Meeting this challenge is focused on the dynamic interactions between nature and society, with equal attention to how social change shapes the environment and how environmental change shapes society. These movements seek to address the essential complexity of those interactions, recognizing that only understanding of the individual components of nature–society systems provides insufficient understanding about the behavior of the systems themselves. Research are problem-driven, with the goal of creating and applying knowledge in support of decision making for sustainable development, and are grounded in the belief that for such knowledge to be truly useful it generally needs to be 'co-produced' through close collaboration between scholars and practitioners. The research and applications program that has begun to emerge from these movements are the essence of *'sustainability science'* (Clark and Dickson, 2003). Thus, "while the link between science-driven research activities and sustainability policy development remains weak, the call to strengthen the contribution of science to a sustainability transition identified a framework for an emerging 'sustainability science'," – Swart *et al.* (2004, p. 138) echo.

Generally, sustainability science seeks to illuminate the dynamics of global change, i.e. the fundamental character of interactions between nature and society, and to explore ways to collectively create a sustainable world. It plays an important role (involving different social actors) in a sustainability transition at different geographic scales, from global to local, and addresses the behavior and responses of the combined socio-environmental systems to multiple and interacting stresses. It also develops tools for monitoring key environmental and social conditions, and guidance on effective management systems (Kates et al., 2001; Swart *et al.*, 2004; Welp *et al.*, 2006). An interesting view on the role of geography in sustainable science has been suggested by G. Clark[18].

Sustainability science can identify critical drivers of global change and plausible risks, such as a rising sea-level or the loss of biodiversity; it also analyzes and models their impacts and corresponding vulnerabilities. In spite of various kind uncertainties, the sustainability science aims at exploring and finding workable potential solutions to such problems, especially if it is embedded in a transdisciplinary context. However, when detached from the 'real world' (e.g., from technological innovations, expectations and mental models of actors), it "may remain a purely academic endeavor with little social relevance. Therefore, science needs to have access to the insights and expertise of different societal actors and incorporate their knowledge bases. On the other hand, scientists need to communicate the results of their inquiries in a comprehensible way" (Welp *et al.*, 2006, p. 170).

It has also become widely accepted that development in general (and sustainable development in particular) is a knowledge-intensive activity (UNDP, 2002). Clark *et al.* (2005) consider a need to mobilize the humanistic perspectives that would help to understand where ideas about environment, development, and sustainability interact with other dimensions of human thoughts about what they are and want to be as increasing 'knowledge'. A final insight that emerged from the reconsideration of the role of science in achieving sustainability is a shift of emphasis from the importance of *knowing* to the centrality of *learning*. Understanding sustainability means understanding "a complex, dynamic system of nature–society interactions – a system made all the more unpredictable by both our interest in what goes on in particular places and by our active, reflective engagement in the system whose behavior we are trying to predict" (*ibid*, p. 18). Sustainable development thus becomes viewed as a process of adaptive management and social learning in which knowledge plays a central role. And at last, "an even more important reason for the shift of emphasis in sustainability thinking from 'knowing' toward 'learning' is simply that we have so much to learn" (*ibid*, p. 15).

In a joint paper (Kates *et al.*, 2001) a very large group of well-known scientists have formulated four general research strategies that should be followed in the adequate sustainable science (Box 6.4). Other activities, which should be highlighted or implicit in these generic

Box 6.4 Generic research strategies to pursue adequately sustainability science

- spanning multiple spatial scales from local to global processes;
- accounting for temporal inertia and urgency of problems that are both long-lived and perilous;
- reflecting functional complexity and multiple stresses in human and environmental systems;
- recognizing the wide range of outlooks in order to generate knowledge usable for people with different perspectives.

Source: Based on Kates *et al.* (2001)

[18] "***Sustainability science*** reaches across many different disciplines, encompassing natural sciences, social sciences, and policy research—but the discipline of geography comes closest to tying it all together. Geography is a core discipline of sustainability science. Five of the 23 eminent scientists and policy analysts who coauthored the seminal 27 April 2001 *Science* article "Sustainability Science" (see an extended preprint at *http://www.hks.harvard.edu/sustsci/ists/docs/2000-33.pdf*) are geographers, including lead authors. The ability to approach environmental and other problems from many perspectives at once is one of geography's key strengths, but this very breadth makes it difficult to define" (Clark G.E., 2009: Academic Geography for Sustainability. *Nature* **51(3)**: 5)

strategies in order to draw attention to the critical problems of the sustainable future, are the following:

- → *integrating across policy themes and issues* to capture the intricately linked ecological, social, economic, ethical and institutional dimensions of sustainability problems;
- → *reflecting uncertainty:* incorporating large uncertainties of very different kinds, surprise, critical thresholds and abrupt change that are immanent in non-linear natural and social systems;
- → *accounting for human volition* as a key conditioning factor of combined human and environmental systems;
- → *combining qualitative and quantitative analysis* to elevate non-quantifiable cultural, institutional and value aspects of the integrated systems;
- → *making sustainability science more relevant* to policy development and action through stakeholder participation.

The most developed issues in the problem under discussion is mobilizing the appropriate science and technology (S&T) for sustainable development (Clark, 2003; Clark and Dickson, 2003; Clark *et al.*, 2005).

In one of his earlier work, Clark (2003a) guesses a dual challenge here. *The first* is to assure that S&T conducted in the name of sustainability should be focused on the most pressing problems of sustainable development as they are defined by stakeholders. Meeting this challenge requires institutions that avoid the pitfalls of R&D agendas that are set to reflect topics of most concerns to donors or to people selling particular technologies, or to scientists pursuing the latest theoretical developments in their fields. Whereas they all may do fine things, they are unlikely to address priority needs of sustainable development.

The *second challenge* is to assure that the most appropriate S&T is indeed mobilized to serve particular problems. Meeting this challenge requires institutions that select the most appropriate expertise for the task to be resolved rather than allowing particularly 'favored' disciplines or technologies to monopolize the input of S&T to problem-solving efforts. There is a general agreement that a more effective use of S&T on this way requires highly-integrative institutions. Even the 'boundary-spanning institutions' which set themselves between science and politics and are partially responsible to both are not expected to operate fully by the norms of either. At their best, they facilitate two-way communication and provide neutral 'sites' for the co-production of useful knowledge by scientists and problem-solvers. This means bringing S&T to bear on the highest-priority goals of transition to sustainability; these goals are defined not by scientists alone but through a dialogue between scientists and the people engaged in the practice.

The community-wide dialogues, discussed by Clark (2003a), share the view that S&T are central to both the origins of the sustainability challenge and to the prospects for successfully dealing with it. Promotion of transitions toward sustainability requires much more than improvements in S&T production and effective use. The questions are: *how* society can better do this and how S&T can better support the transition? Decisions to which the experimenters might want to hold themselves accountable for are the following:

- ☑ A goal of finding solutions, not just of characterizing problems;
- ☑ An integrative, holistic approach to sustainability instead of a preoccupation with single stressors or single solutions;
- ☑ A commitment to the co-production of usable knowledge by scientists and stakeholders in sustainability;
- ☑ To conduct themselves more as facilitators of social learning and less as sources of social guidance.

Thus, *"sustainability science is not yet an autonomous field or discipline,* – Clark and Dickson (2003, p. 8060) note, – *but rather a vibrant arena that is bringing together scholarship and practice, global and local perspectives from north and south, and disciplines across the natural and social sciences, engineering, and medicine. Its scope of core questions, criteria for quality control and membership are consequently in substantial flux and may be expected to remain so for some time"*. Sustainability science acknowledges this close interaction between science and policy. With the clear aim to identify resilient human-environment interactions, it overtly enters the policy domain and hence brings issues of scientific accountability and legitimacy to the forefront. In contrast to traditional top-down impact studies, any vulnerability assessments conducted under the umbrella of sustainability science try to address the legitimacy gap of earth systems science by including local stakeholders in the analysis of appropriate response (adaptation) measures (Schröter *et al.*, 2005)[19].

6.2.2 Science in climate change–policy discourse

6.2.2.1 From policy for science to science for policy

Research on climate change is driven by at least two motivations: first – the desire to answer questions about the world – is shared with all other sciences; second – to provide guidance for society in its attempts to prevent adverse climate change impacts. The latter goal, however, cannot be achieved with scientific information alone and requires the wider participation of political decision-makers and the general public which are influenced by many forces, e.g., national wealth (Sandvik, 2008). Thus, information about scientific findings is only one component. Additionally, like many environment and resource issues facing policymakers, the problem of climate change is plagued with uncertainty (see Sect. 4.4) which in the context of climate change also falls within the domain of scientific research. On the other hand, Arval *et al.* (2006) attribute adaptation and mitigation to 'the purview of the climate policy community', considering confronting climate change as 'difficult to interpret (from a policy-relevance perspective) array of scientific studies'. Therefore, this team of authors suggests (p. 218) that "viewing the relationship between uncertainty, adaptation, and mitigation … is problematic because it discounts the importance of climate policies as means of reducing uncertainty about the overall climate system. Just as laboratory research in biology complements field studies in ecology, so too

[19] For more information on Science and Technology for sustainability one can visit *http://sustainabilityscience.org/ists*

can the comparative assessment of climate policies and their outcomes complement more traditional research being conducted by climate scientists".

The threats associated with anthropogenic global warming have already sparked the creation of an unprecedented format for the dialogue between researchers and policy-makers. However, acknowledging the political context in which climate science operates, it is difficult to draw a clear line between science and policy. The solid history of climate change research has been described in different works (e.g., Agrawala, 1999; IPCC, 2004; UNFCCC, 2005). Climate change science in a policy context has been analyzed by Cohen *et al.* (1998); this work is taken as a basis for the following discussion.

In particular, Cohen and co-authors identified three features of the scientific and political discourse on climate change that were noteworthy then: its reductionism, its technical and instrumental rationality, and its alliance to both moral-liberal and rational-technocratic politics. It seems that in part these features are relevant now as well.

The ***reductionist formulation*** of climate change is "a legacy of the way in which it was initially conceived as an object of scientific knowledge and then brought to widespread public attention" (*ibid*, p. 344). The scientific reductionism of climate change, excluding any obvious social or political matters, makes some consensus possible, but the result, to some extent, is irrelevant. Scientific certainty is not necessarily the most important. As an example, GHG emissions can be named, since science agrees about their physical sources, but this knowledge is insufficient if we refuse to consider the far more important and deeply political question of why GHG emissions are increasing and how they should be curtailed. As long as climate change is seen primarily through the lens of climate science, the contribution of science to policy could be provided through climate models and corresponding research. But any reducing the uncertainties in the physical climate science is not able to reduce uncertainties in impacts and response strategies that have complex physical, biological, economic and social components, far outside of the expertise of atmospheric sciences. Thus, being firmly within the 'reductionist science' mode of discourse, which strongly separates science from policy issues or values, the climate change research attempts to profit from the high natural and physical understandings of the world, but at the cost of addressing the social, political, cultural, ethical, and other questions that are critical in order to address climate change issues in a meaningful way.

A second, equally unacceptable feature of the climate change discourse is its narrow scientific and technical bent, which was characterized by Cohen *et al.* (1998) as ***'technical and instrumental rationality'***. In this case also, as was mentioned above, the social context under which GHGs are produced is largely ignored, and climate change science "is predicated on the idea that the objective of properties of greenhouse gases can and should be distinguished from their human meanings or any social objectives in managing them" (*ibid*, p. 347). As a result, in the early decades of climate change science, the vast majority of research funds have been devoted to technical questions about rates and physical processes of GHG production and to reducing scientific uncertainties in these questions rather than exploring the social context in which they are understood and experienced. "Because of the overwhelmingly instrumental character of the climate change discourse, the national and international politics of global climate change have not only been driven by the claims of science, but founded upon them" (*ibid*, p. 347).

The reductionism and instrumentally rational tone of climate change discourse are closely related to a third feature: its ***moral-liberal and rational-technocratic views*** on politics and science. Cohen *et al.* (1998) believe that both these views assume that the proper role for science is "to provide certain knowledge on which to found political decisions" (p. 349). In this case, the first obstacle to addressing climate change is the scientific uncertainty that impedes the formation of democratic consensus *(moral-liberal*) and the optimization of policy (*rational-technocratic*). Such formulation of the relationship between science and politics also provides a weak foundation to respond to climate change effectively. The moral-liberal politics to convince individuals to change their lifestyles to avert global climate change has collided with public apathy and mistrust, while the rational-technocratic politics is vulnerable to being discredited when the social and political commitments of its science-driven agenda become apparent. Evidently, the narrow focus on the emissions, whose effects will not be felt for a generation or more, is sometimes understood in developing and transition countries as the displacement of their attention from far more pressing and immediate concerns. The continued scientific uncertainty is a principal rationale for political inaction in the face of climate change.

At present, when there is a firm belief that climate change must be integrated into the routine decision-making frameworks, the challenge is to make relevant scientific knowledge more politically 'tied' to human problems, while still remaining credible. The way forward lies in involving more meaningfully the use of scientific knowledge as well as those, affected by scientifically based policy decisions, into the practice of science, for example, into hypothesis formulation or data gathering, analysis and interpretation, considering confronting the climate change as "a hybrid between interdisciplinary science and science-policy bridge building" (Cohen *et al.*, 1998, p. 362).

6.2.2.2 Trends in vulnerability and adaptation research

Some time ago, Burton *et al.* (2002) distinguished two directions and purposes of adaptation research: adaptation research for mitigation policies and those for adaptation policies, but the overwhelming preponderance of adaptation research has been conducted in response to the mitigation issue. The interest in adaptation as a response has been comparatively low and often absent, and to the extent that it was presented at all it was in the context of mitigation debates. Undoubtedly, such a situation was the reflection of adaptation *vs.* mitigation discourse at that time.

The need for better understanding of the requirements of adaptation policy has assumed a prominent place on the research agenda. Admission the necessity of adaptation helps in appreciating the gulf between the impacts and mitigation orientation of adaptation research, which Burton *et al.* (2002) called their '*first generation',* and the adaptation-policy orientation – the '*second generation'*. The first generation of adaptation studies mainly spans 1995–2001. The COP 1 meeting in Berlin (1995) formulated and adopted Decision 11/CP.1 that set in motion studies of adaptation and laid out a broad timetable over which these studies would be conducted. Later, the scientific contribution to the study and assessment of adaptation has crossed several disciplines. It has drawn off a long tradition of studying vulnerability to natural hazards and identified many ways in which traditional practices allow for greater adaptive capacity, making them less resilient to environmental stresses (Grothmann and Patt, 2005).

As a result, although social vulnerability studies have been criticized for representing adaptation as a self-realizing activity at the local level, with little regard to the wider economic and geopolitical context in which adaptation must be carried out (Brooks, 2003), now "they indeed represent an interesting shift in focus both for climate science and policy. While adaptation issues for long have been a politically incorrect focus for scientists and policy-makers, the increasing number of vulnerability studies indicates that adaptation is turning into a more accepted agenda on the international climate policy arena", – Lövbrand (2004, p. 30) states. Significant efforts that were made to understand how development strategies can increase the adaptive capacity of vulnerable countries and social groups are recorded in AR4 (IPCC, 2007d).

From the perspective of Reilly and Schimmelpfennig (2000), the social science research might hope to cast different views on adaptation to climate change as testable hypotheses that can be investigated through analytical and empirical means. Such a research agenda might resolve the extent to and conditions under which adaptation is easy and costless versus those under which it is difficult, costly and disruptive. In particular, different views about the ease of adaptation and the extent to which different strategies for fostering adaptation are useful stem from subtle differences in assumptions about the characteristics of the system that must be adapted. Therefore, different researchers with different maintained hypotheses use different methods that generate different results. Evaluating characteristics of the systems that must adapt is critical to determining what strategies for fostering adaptation, if any, would be useful, and only science can provide the guidance on what might be done to foster adaptation, reduce vulnerability or improve resilience to climate change. Thus, an active research system, whether public or private, which is evaluating new developments in the environments in which it must perform, must include changes in climate as part of the changing environment. Studying these systems and making adaptation response autonomous, according to these authors, is the best insurance that adaptation will occur.

6.2.2.3 Incorporating local knowledge in climate change research

Knowledge about climate change adaptation and sustainable development can be translated into public policy through processes that generate *usable knowledge.* The idea of usable knowledge in climate assessments stems from the experiences of national and international bodies (academies, boards, committees, panels, etc.) that offer credible and legitimate information to policy-makers through transparent multi-disciplinary processes (Lemos and Morehouse, 2005). This requires including the local and indigenous knowledge to complement a more formal technical understanding, generated through scientific research. Research on local[20] environmental knowledge has been undertaken in many countries, often in the context of understanding local questions and cultural attachment to place. With the increased interest in global environmental change many studies have emerged that explore how indigenous knowledge can contribute to shared learning efforts to address climate-change impacts and adaptation. Some examples are summarized as a case study to IPCC AR4 (Parry *et al.*, 2007c).

---

[20] Hereafter, the term *local* is understood in wide meaning: traditional, native, indigenous, etc.

Leary *et al.* (2007) believe that engagement and communication with traditional communities as well as the use of traditional knowledge warrant special consideration. These authors share a common understanding that traditional communities are among the most vulnerable to climate change and have a compelling need for improved knowledge and other resources for managing and adapting to climate related risks. Members of traditional communities can have intimate knowledge of past variations in climate, the sensitivity of natural systems to climate variations, and the ways their livelihoods and wellbeing are affected by climatic and environmental variations. They can also have knowledge of risk management strategies that are adapted to their specific social, cultural, economic, and environmental circumstances.

Indigenous knowledge is particularly important for sustainable development, since effective knowledge of the use and preservation of natural resources is only possible with the active participation of local populations. Their capacity to develop resource-use strategies that are more sustainable than conventional systems is widely recognized. Indigenous knowledge needs to be better understood, and efforts to incorporate it into the development process must be accelerated. As Muir-Leresche (2002, p. 91) noted in the special issue of *Development Policy Journal* dedicated to the capacity for sustainable development, "there is an urgent need to combine indigenous and contemporary knowledge, and to apply both traditional and modern low-cost technologies in the transfer and application of knowledge. This is a two-way process; much of the undocumented knowledge in isolated communities would benefit the world community. The importance of adapting advanced technology to impoverished realities is a challenge to which the education system can contribute". This author urged to understand the value of traditional systems and cultures, but without romanticizing them. Traditional attitudes and values bring new angles to innovation, and their preserving and adapting can contribute to and participate in the national and global economies. Western societies have begun to appreciate and incorporate some of this knowledge into health systems, management styles, and other areas, however local societies themselves need also to understand and evaluate their secular heritage, to use it and to develop relevant and effective technological and organizational systems.

The strength of traditional knowledge is based also on its goal of increasing community ownership and trust. This can contribute to the well-being and empowerment of native communities and helps to ensure that people are invested in the process of observing and documenting the health of their environment. Cochran and Geller (2002) present a very typical example of how native people from Alaskan communities understand their indigenous knowledge (Box 6.5).

Box 6.5 How native people define traditional knowledge

- It is practical common sense based on teachings and experiences passed on from generation to generation;
- It is knowing the country and covers knowledge of the environment—snow, ice, weather, resources—and the relationships between things;
- It is holistic and cannot be compartmentalized or separated from the people who hold it. It is rooted in the spiritual health, culture, and language of the people;
- Traditional knowledge is an authority system. It sets out the rules governing the use of resources – respect and obligation to share. It is dynamic, cumulative and stable. It is truth;
- Traditional knowledge is a way of life.... It is using the heart and the head together. It comes from the spirit in order to survive;
- It gives credibility to the people.

Source: Cochran and Geller, 2002

These authors argue that “traditional knowledge can provide scientists with more accurate and timely hypotheses to use in their search for the causes of declines in wildlife, saving time, money, effort, and undue delay in action. It can provide an early warning system for emergent biological or environmental trends and anomalies” (p. 1407). Native people possess a wealth of knowledge about the environment that often precedes scientific data collection by many years and decades. Such is the case with the environmental effects of global warming. For example, Arctic native communities reported changes that now are attributed to global warming, such as changing weather patterns, thinning ice, diseased and deformed wildlife, and changes in the look and taste of such subsistence foods as fish and meat, much earlier that it was scientifically confirmed.

Nevertheless, although native peoples, e.g., in the Arctic, demonstrate great resilience and adaptability to environmental changes, some traditional responses have been compromised by recent socio-political changes (Box 6.6). Their ability to cope with substantial climatic change in future, without a fundamental threat to their cultures and lifestyles, cannot be considered as unlimited. For Inuit people, expected warming will disrupt or even destroy a culture based on hunting and food sharing, as reduced sea ice causes the animals on which they depend to become less accessible and possibly decline in numbers towards extinction. Current social, economic and cultural trends in some communities, predominantly among younger generations, towards a more ‘civilized’ lifestyle has the potential to erode the cycle of traditional knowledge generation and transfer, and hence its contribution to adaptive capacity. Undoubtedly, that “generation and application of traditional knowledge requires active engagement with the environment, close social networks in communities, and respect for and recognition of the value of this form of knowledge and understanding” (Parry *et al*., 2007c, p. 866). Climate change provides a reminder of the symbiotic relationship between human culture and ecological systems that is especially evident again in the Arctic where some of the world’s most fragile ecosystems are being affected by rapid warming, and indigenous people have become sentinels for a world undergoing climate change (UNDP, 2007a).

Box 6.6 Traditional knowledge for adaptation among Arctic peoples

The selection pressures for the evolution of a strong knowledge base among Arctic people have been driven by the need to survive off frequently varying natural resources in the remote and harsh environment. The effective knowledge concerning natural resource availability as well as weather, snow and ice conditions as they relate to hunting and travel is an adaptive response in the Arctic. The systems of knowledge, belief and practice, which have been developed through experience and culturally transmitted among members and across generations, offers detailed information that adds to conventional science and environmental observations, as well as to a holistic understanding of the environment, natural resources and culture. There is an increasing awareness of the value of Arctic indigenous knowledge and a growing collaborative effort to document it. This local knowledge is essential for understanding the effects of climate change on indigenous communities and is an invaluable potential basis for developing adaptation and natural resource management response strategies.

Source: Parry *et al.*, 2007c

6.2.2.4 Climate science-policy interfaces in international contexts

In the previous discussion it was identified that climate change is a field in which policy programs could be useful and relevant. In the international climate policy arena, research interests interact with political interests in a way that indirectly involves science both in the framing and legitimization of policy options. Climate change is one of the issues that cannot be addressed by individual states, but require international cooperation.

At the same time, a science-policy interface in international contexts is even more difficult to organize than at a national or local level. Engels (2005) distinguishes here the following problems:

- National differences in the way scientific expertise is traditionally used in the policymaking process; the cross-national differences influence the ways in which scientific expertise is used;
- An international science-policy interface must balance scientific quality with geographical representation; thus, political conflicts are easily carried into the assessment process;
- Science-policy interface in international contexts must deal with uncertainties about the appropriate form and style that will secure maximum political legitimacy and social acceptability;
- Institutional boundaries between science and politics; the policy programs start with a clear distinction between science and politics, and became slowly more open to an overlap between spheres.

Agrawala (1999) added to the above mentioned problems that *institutional design* is of paramount importance in determining how advisory panels make complex trade-offs between three divergent requirements: scientific credibility, policy specificity and international political legitimacy.

There are very few instances in which science-policy interface have been established at the international level and successfully framed and influenced the international policy process. Among the interfaces that are crucial for progress in international negotiations, most authors (e.g., Agrawala, 1999; Skodvin, 2000) name the IPCC – a real example of co-establishment of global assessment power where scientific and political interests are compromised best of all. On the one hand, the IPCC attracts exceptionally large numbers of qualified scientists in an assessment process that involves multiple, worldwide peer reviews. On the other hand, the Panel enjoys a formal intergovernmental status; its reports are officially endorsed and their policymaker summaries subject to consensus approval by national governments. Through this innovative two-tier mechanism the IPCC attempt to straddle simultaneously the demands for scientific credibility and international political legitimacy. Skodvin (2000) also views the IPCC as the primary mechanism for merging climate science with politics. IPCC's scientific reviews, free from political pressures, are smoothly coupled to the political process without losing their independence.

Some additional strategies that could be useful to build science-policy interface in Europe were proposed by Engels (2005):

- Policy orientation at the level of individual projects
- Policy outreach at the level of individual institutes
- Self-organized policy networks among research centers
- Formalized networks centered around European institutions
- Creation of a European Advisory Board on Climate Change
- Formation of a European think tank.

Table 6.4 Russian participation in the systems of global climate observation

Number of stations	*GSN*	*GHAN*	*GAS*
Stations under Russia responsibility	139	14	42
Stations functioning at present	139	14	42
Stations functioning accordingly to GCOS	126	14	42
Stations expected to function in 2010	140	14	42
Stations giving data to IDCs	136	14	32

Note: GCOS – Global Climate Observing System; *GOSN* – Surface Net of *GCOS; GHAN* – Higher Atmosphere Net of *GCOS; GAS – Global* Atmosphere Service of WMO. *Source:* The Fourth National Communication of Russian Federation, 2006

In addition to research, all Parties under the UNFCCC commit themselves to cooperative activities on observation of the global climate system (UNFCCC, 2005). Common concerns include the deterioration of climate observing systems in many regions, including the territory of FSU, and the need to increase participation of developing and transition countries in climate observation networks. Progress was made at COP 5 when Parties adopted guidelines for reporting global climate observation activities in national communications. To date, the most input into this task has been made by the Russian Federation (Table 6.4).

After the breakup of the Soviet Union, new opportunities have emerged for collaboration of FSU researchers with their international colleagues in the frameworks of different research initiatives (see Box 6.7 as an example).

Box 6.7 The Northern Eurasia Earth Science Partnership Initiative (NEESPI)

NEESPI is a rapidly growing program that involves national government agencies, academia and private organizations in the US, Europe, Japan and Northern Eurasia. This region is of special interest for study due to dramatic socio-economic shifts during the past decades and strong land cover–climate interactions that are not yet well understood, creating a possibility for large and significant biological and climatic regional feedbacks of global importance. Here, changes in land use, coupled with climate change, will likely affect a number of important sectors, such as forestry, agriculture and coastal zones. The goal of NEESPI is to communicate and apply the enhanced knowledge developed for this region to specific societal concerns that face national and international decision-makers of the partnering institutions and countries. The NASA-supported NEESPI projects about equally split into two groups: one focusing on the processes in the boreal zone and the other – on the non-boreal zone of Northern Eurasia. Practically all these projects relate, directly or indirectly, to carbon and climate change impact assessments.

Source: Groisman and Ivanov, 2008; Gutman, 2007. More information on the NEESPI can be found at *http://neespi.org*

6.2.3 Implementation of scientific knowledge

6.2.3.1 Science and practice

The traditions of *'pure'* science in which "…scientists remain unfettered and untouched by the surrounding political context while producing objective 'out-the-door' knowledge, which in turn can be adopted for use by society, including policymaking institutions", result in the perception of "the effective utility of scientific knowledge as an automatic outcome of providing information" (Lemos *et al.*, 2002, p. 481). Policymakers, for their part, are driven by the demands of constituents and practicality of the knowledge; accordingly, they seek scientific and technical information that is timely and readily applicable to their most pressing problems and can be used as an authoritative and legitimizing policy tool. As a result, scientists and policymakers become two very different social actors bound by distinct sets of goals and rules. "While scientists are mostly concerned with the state of their science, policymakers are often constrained by such time-sensitive considerations as stakeholder demands, political agendas, and the need to demonstrate practical results" (*ibid*).

We must also agree with Moser (2008, p. 20) that scientists, who traditionally socialize in their professional sphere, keep a certain objective distance from the world of practice "…frequently perceived as being messy, political and value-laden, where engagement potentially undermines scientific credibility". The scientists' system of incentives, rewards, training, cultural norms, and so on prefers interaction within the small circle of experts like themselves, sharing and advancing a common understanding. However, global change challenges, addressed by the corresponding world of policy- and decision-making, increasingly require multi- and inter-disciplinary scientific and interagency collaboration and demand to cross over the science-practice line, which "seems even higher than that between scientific disciplines or decision-making bodies, respectively" (*ibid*).

Such a situation results in the persistent misunderstanding of how the 'other side' works, what actually it needs and is possible to give, and how best to communicate and interact at the science-practice boundary.

Starting from these distinct cultures, Lemos *et al.* (2002, p. 481) discuss two basic models of how policymakers recruit scientific information. The first is a problem-driven model where policymakers, faced with a specific problem, seek solutions in the pool of pre-existing research solutions, or they commission new research to meet their needs. In other words, "science is more directly recruited and expected to have clear and practical utility for policymakers". The second approach is a knowledge-driven model where science, being independent of a specific problem, discovers new knowledge that displays a potential application. This model assumes that the existence of knowledge itself presses it toward development and use, or toward a solution, thus providing the main recruitment avenue rather than a policy problem.

In the opinion of Susanne Moser (2008), some metaphors such as "bridging the science-practice gap" by way of a unidirectional, linear 'knowledge transfer' process are the simplistic mental models that do not account for the real-world, spider web-like actor networks, the ambiguity of roles and the complexity of interactions. Such models also don't help in fostering mutual understanding of needs and feasibility of knowledge production and use, and can undermine the building of trusted relationships among those involved and, ultimately, may impair a productive relationship where a use-inspired research serves *de facto* the pressing needs of decision-makers.

Lemos and Morehouse (2005), also noting the existence of dichotomy between science produced for policy (*applied* or *decision-driven*) and science grounded in research alone (*basic* or *knowledge-driven*), see nevertheless a more recent and increasingly interesting third approach in which "the division between science and policy is blurred, and *usable* knowledge is co-produced in the context of everyday interaction between scientists, policy-makers, and the public" (p. 59). One illustration of such interactive

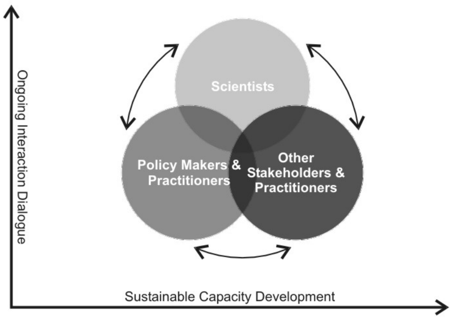


Fig. 6.12 INDP's strategy for continuous interactive dialogue and capacity development between scientists, policy-makers and other stakeholders. *Source:* Moser, 2008

dialogue is Fig. 6.12; here, the science-practice interface, proposed by the IHDP for framing its worldwide research[21], is schematically shown.

Within the field of climate research (where there is increasing recognition of the need to involve stakeholders) the questions revolve around the extent to which scientists should reach out to potential users, and whether the needs of users should shape research agendas (Agrawala *et al.*, 2001[22]). A widely embraced research approach, the so-called *end-to-end* model, seeks to link research with social concerns through conceptualizing a system in which interactions flow "from climate researchers to consumers of climate information, and back again" (*ibid*, p. 459). The components of the *end-to-end* system are identified as three concentric circles: (1) a core circle focusing on fundamental research on climate, human, ecosystem, and decision processes; (2) an applications ring focusing on climate forecasts, decision analysis, and communication; and (3) an outer outreach shell connected with decision makers in various sectors such as farmers, water resources managers, disaster relief agencies, and insurers.

The concept of *iterativity*, proposed by Lemos and Morehouse (2005), emphasizes the need for assessment models to build effective internal and external networks, including the capability to sustain ongoing flows of information and participation between science and decision makers from the public, non-governmental, and private sectors. This concept involves three essential components: sustained stakeholder interaction, usable science, and interdisciplinarity (Fig. 6.13).

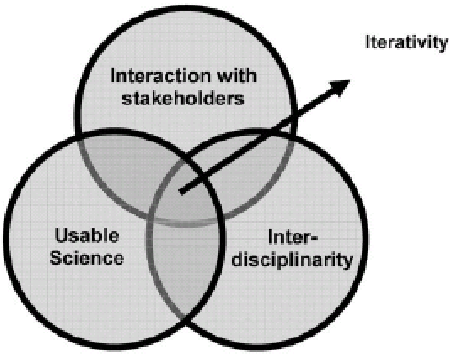


Fig. 6.13 Model for co-production of science and policy through integrative science (the concept of iterativity). *Source:* Lemos and Morehouse, 2005

Stakeholder interaction refers to the degree to which representatives of the constituency base are involved in all aspects of the research: defining the problem, formulating research questions, selecting methods, and so on. In the model, besides the flow of information between 'producers' and 'users', there is an actual re-shaping of both groups' perceptions, behavior and agendas that occurs as a function of their interaction. Well carried out research produces

[21] IHDP, 2007: *Strategic Plan 2007-2015: Framing Worldwide Research on the Human Dimensions of Global Change.* Bonn, Germany. Available at: *http://www.ihdp.uni-bonn.de/Pdf_files/WebStratPlan.pdf*

[22] Agrawala, S., K. Broad, D.H. Guston, 2001: Integrating climate forecasts and societal decision making: challenges to an emergent boundary organization. *Science, Technology & Human Values* **26(4)**: 454–477 (Hereafter quoted according to Lemos and Morehouse, 2005)

sustained, regular interactions among participants and creates relationships between science and decision-making that can shape the way by which knowledge is produced as well as how the usefulness and value of knowledge is perceived.

Usable science refers to the degree to which the produced science results in knowledge that meets constituent needs. The produced knowledge should directly reflect expressed constituent needs, be understandable to users and be available and accessible to the user community at any time and place. Achievement of usable science must also consider how the knowledge will be operationally delivered, and assure that maintenance, updates and improvements occur in a satisfactory fashion. Thus, *usable science (knowledge)* is that, which can be incorporated into the decision-making processes of all stakeholders and which enhances their ability to avoid, mitigate, or adapt to stressors in their environment.

Interdisciplinarity is defined by Lemos and Morehouse (2005, p. 61) "as the effort of scientists from different disciplines to work together to tackle problems whose solutions cannot be achieved by any single discipline".

The degree to which these three components of the model are achieved depends on three crucial variables:

- The *level of fit* between the state of knowledge production and application that reflects the process through which the knowledge being produced increasingly matches the information stakeholders need to address their problems;
- *Disciplinary and personal flexibility* among assessment participants that affects their ability and willingness to engage in interdisciplinary research and in stakeholder interactions; and
- *Availability of financial and human resources* that means that scientists conducting research must not only have sufficient flexibility to operate beyond their customary boundaries, but also be able to call upon sufficient resources to achieve effective co-production of usable science and policy.

A capacity for mobilizing and using 'knowledge systems', in particular, science and technology (S&T), is increasingly recognized as an essential component of strategies for promoting sustainable development (see Sect. 6.2.1.3). Cash *et al.* (2003) suggest that efforts to mobilize S&T for sustainability are more likely to be effective when they manage boundaries between knowledge and action in ways that simultaneously enhance the salience, credibility, and legitimacy of the information they produce. Three functions that contributed most to such 'boundary management' are communication, translation, and mediation where:

- Linking knowledge to action requires open channels of *communication* between experts and decision makers. Active, iterative, and inclusive communication proves crucial to systems that mobilize knowledge that is seen as salient, credible, and legitimate in the world of action;
- *Translation* provides understanding of each other for the participants in the resulting conversation;
- *Mediation* appears to be most important in facilitating the legitimacy of efforts to mobilize S&T, while retaining adequate levels of salience and credibility to multiple actors. Mediation works by enhancing the legitimacy of the process through increasing transparency, providing rules of conduct, establishing criteria for decision making, etc.

These three 'boundary management' functions can be performed effectively through various organizational arrangements and procedures, and can be institutionalized in 'boundary organizations', mandated to act as intermediaries between the arenas of science and policy. Cash and co-authors distinguish at least three features of the 'boundary organizations': (*i*) they involve specialized roles within the organization for managing the boundary; (*ii*) they have clear lines of responsibility and accountability to distinct social arenas on opposite sides of the boundary; and (*iii*) they provide a forum in which information can be co-produced by actors from different sides of the boundary through the use of 'boundary objects'. The *'boundary objects'* are collaborative efforts & outputs that involve joint production by experts and decision-makers of models, scenarios, assessment reports, etc. Such collaboration creates a process that is more likely capable to produce salient information because it early engages end-users in defining data needs. It can also increase credibility, by bringing multiple types of expertise to the table, and can enhance legitimacy by providing multiple stakeholders with more transparent access to the information production process.

These newer paradigms describe the interface between science and practice as a complex terrain that is best described as a multi-level system of governance and knowledge production among a range of actors engaged in understanding and managing environment–society interactions. "As a result, substantial scientific and practical interest has grown in 'boundary organizations' that can form a communication link and provide information brokering services between the science and practice worlds" (Vogel *et al.* 2007, p. 352). Where the science–practice interaction is not taken seriously or carefully designed, a number of disconnections can emerge. The cited authors conceive of the policy- or decision-making process as cyclical, iterative, and ongoing where scientific input can occur at any stage (Fig. 6.14). To be most effective, this input should be equally ongoing,

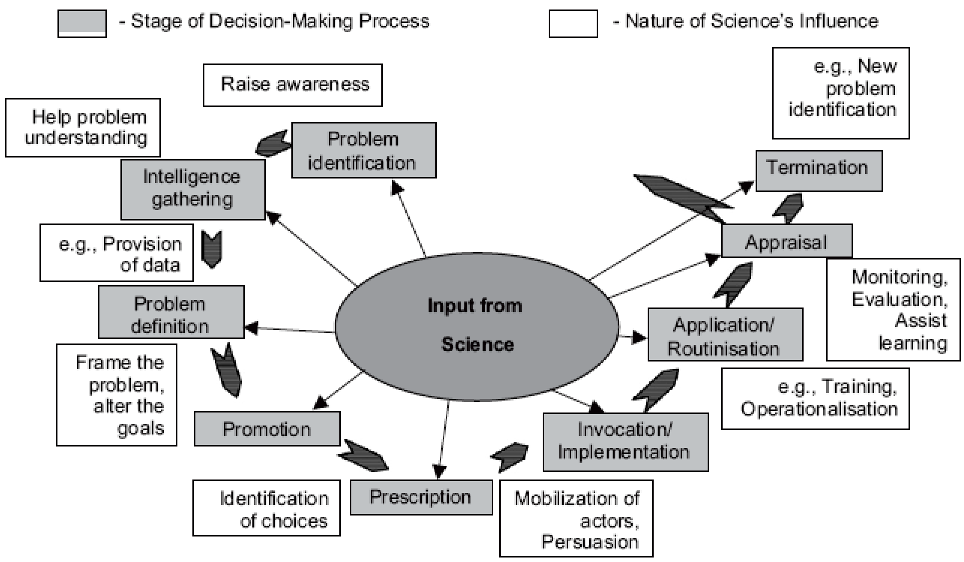


Fig. 6.14 Scientific input at various stages of the decision-making process and the nature of science's influence. *Source*: Vogel *et al.*, 2007

even if the type of impact differs from stage to stage. Each stage in the decision-making process, depicted in the figure, "has its own requirements in terms of how and when data or analyses are communicated, at what level of details, and from whom to whom. Each stage also requires some degree of negotiation between the two sides" (*ibid*, p. 353).

In particular, along with effective communication, adaptation to climate change requires knowledge transfer between researchers and decision makers. As it has been discussed above, although individual efforts in research, innovation, monitoring, and assessment clearly contribute to common science, the full utility of such independent contributions depends on developing *integrated knowledge systems*. The lack of knowledge of political and scientific facts can combine with decision biases to further undermine successful policy actions. This transfer of knowledge is needed to address multidisciplinary and integrated approaches, the language used by researchers in relation to users of study results, the management and integration of uncertainties, etc.

Vescovi *et al.* (2009), focusing on Ouranos' ongoing projects along the coastline of the Gulf of St. Lawrence in eastern Québec (Canada), provide an overview of how climate-change-science knowledge transfer is achieved in support of vulnerability, impact assessments and adaptation activities in coastal regions. Fig. 6.15 illustrates the framework of this project. Three-way communication and knowledge transfer among the project's three groups (climate, vulnerability, adaptation & users) is ensured through a variety of means, such as face-to-face meetings, brainstorming sessions, surveys, forums and symposiums that take place throughout the project stages.

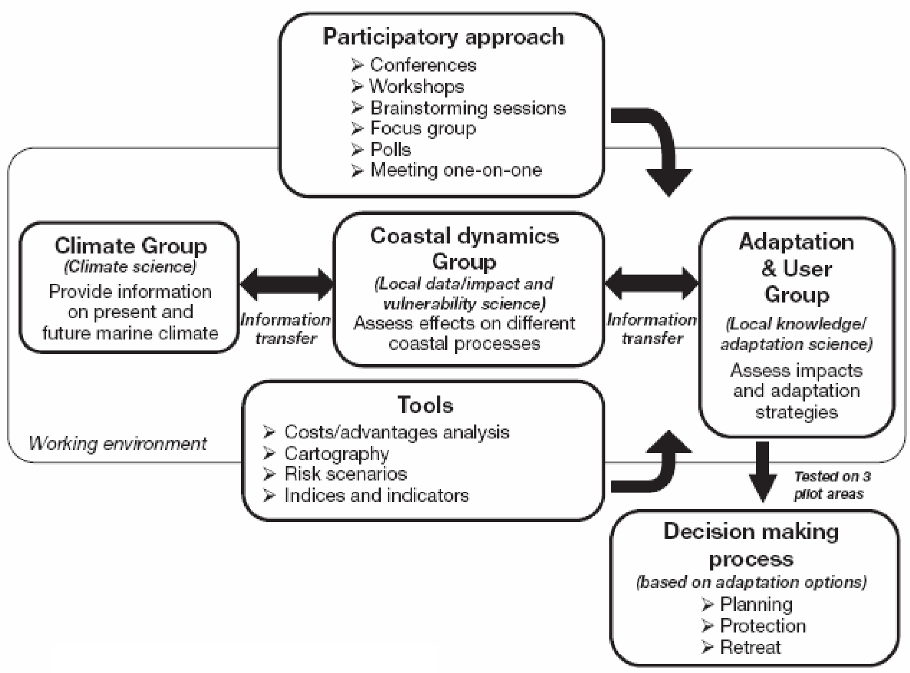


Fig. 6.15 Climate change-science knowledge transfer in a coastal project framework. *Source:* Vescovi *et al.*, 2009

6.2.3.2 Information and communication in science-practice interface

The European Commission's White Paper on adapting to climate change (EC, 2009, p. 7) states: *"to be able to take decisions on how best to adapt, it is essential to have access to reliable data on the likely impact of climate change, the associated socio-economic aspects and the costs and benefits of different adaptation options. More knowledge is needed on climate impacts and vulnerability so that appropriate policy responses can be developed"*.

Why the available information on these issues is often not used and embraced by decision-makers is one of the key problems in the implementation of scientific knowledge. This problem mainly arises from a poor understanding of how to use climate information; such understanding is often based on the naïve assumption that knowledge can be transferred as an unambiguous signal. Meinke *et al.* (2006, p. 102) think that "this is not an intrinsic deficiency of scientifically based climate knowledge; it is more likely a consequence of the complexity of the decision-making process and the difficulties of decision makers and scientists to recognize that the knowledge of managing risk resides with both communities". Any changes of established risk-management practices without fully understanding the possible impacts of such changes can inadvertently increase exposure to climate risks, thereby increasing rather than decreasing vulnerability.

Cash and Buizer (2005)[23] once more emphasize that translation of climate information into real-life action requires three essential components: salience, credibility and legitimacy.

Here, *salience* relates to the perceived relevance of climate information: does the system provide information, which the users think they need, in a form and at a time that they can use it? The authors show that salience requires that scientists expand their horizons beyond disciplinary boundaries and fully explore tensions and interactions between science and policymaking, as well as between science and socio-economic forces. Participatory engagement is required to increase the capacity of policy advisers to make informed purchases of multi-disciplinary systems science.

Credibility addresses the perceived technical quality of information: does the system provide information that is perceived to be valid, accurate, tested, or at least as likely to be 'true' as alternative views? Essentially, credibility is derived from social contracts between climate scientists and those affected by climate risks. Science derives credibility not just from its technical precision, but also from the appropriate design of engagement processes via which it is delivered.

Legitimacy concerns the perception that the system has the users' interests in mind or, at least, is not simply a vehicle for pushing the agendas and interests of other actors. Legitimacy is essential for scientific content to have influence; without it no potentially valuable information will be translated into 'actionable knowledge', and the scientific content will remain without its intended benefits for society.

---

[23] Cash D. and J. Buizer, 2005: Knowledge–action systems for seasonal to inter-annual climate forecasting: summary of a workshop, report to the Roundtable on Science and Technology for Sustainability, Policy and Global Affairs. The National Academies Press, Washington, D.C. Available at: *http://books.nap.edu/catalog/11204.html* (Accessed 25 August 2010)

Leary *et al.* (2007) add that to be communicated an information message has also to be *defensible* (in that there is a clear process based understanding of the physical and social systems response), and *actionable* (that is, the message is appropriately tailored to the needs and robust to the point that adaptation action becomes a viable risk management choice). Also, lack of 'ownership' of information by the intended end-users is considered by Meinke *et al.* (2006) as one issue that leads to a growing acceptance among climate scientists that they must move out of their disciplinary confines and engage in a process of shared learning and joint problem solving. This means that "… everyone is a stakeholder, and everyone will be affected by the decisions made. This is easy to say, but extremely difficult to implement" (p. 102). For instance, Leary *et al.* note that climate change projections, which are based on GCM experiments and archived at the IPCC DDC, have been selected primarily for understanding climate dynamics, with little weight being given to the data needs of end-users. As a result, an urgent paradigm has shifted in the climate modeling community to greater emphasis on the needs of users of climate data who are more directly applicable to risk-management decisions in terms of the chosen temporal and spatial scales and variables.

Shwom *et al.* (2008) believe that understanding of local and regional impacts makes this issue clearer to individuals, and that such information is needed in order to mobilize people to take actions. In their study, these authors tested whether local and regional information and geographic location influence climate change policy support and showed that "the more local the resource or impact, the more it resembles a private rather than a public good, and thus the more willing those within the area under consideration might be to take action" (p. 346). However, this study also indicates that more empirical research is needed before the scientific community can conclude that public support is greater for localized issues. "While it is certainly true that high resolution local information on impacts is necessary for enabling specific groups of decision-makers to adapt, we ought not to assume that the public cares only about regional impacts" (p. 353).

For instance, climate information, especially seasonal climate forecasts, is heralded as a promising tool for early-warning systems and risk management. Nevertheless, there are concerns that it does not always reach its potential value. So, using southern Africa as a case study, Vogel and O'Brien (2006) consider the actual and potential roles of climate information in reducing food insecurity (Fig. 6.16). Two alternative perspectives are compared. The first relates to the improved understanding of the contextual environment in which end-users operate and use information. Usually, they operate in the environment of considerable uncertainty, reacting to and coping with multiple stressors whose impacts are not always clear or predictable. The second perspective relates to improving the current design and variety of mechanisms (e.g., climate outlook forums) for the dissemination and uptake of climate information. It is argued that climate information, used in isolation (e.g., in 'stand alone' climate outlook forums) and undertaken in a traditional, linear fashion (information is moved from producers to users) is divorced from the broader, complex social context in which such information is embedded. This current articulation of a climate information flow represents an ineffective means of dealing with climate variability and food security. Therefore, alternative modes of interaction (e.g., using existing platforms to 'piggyback' information or seeking appropriate 'boundary organizations') should be found to sustainably manage regional climate risks.

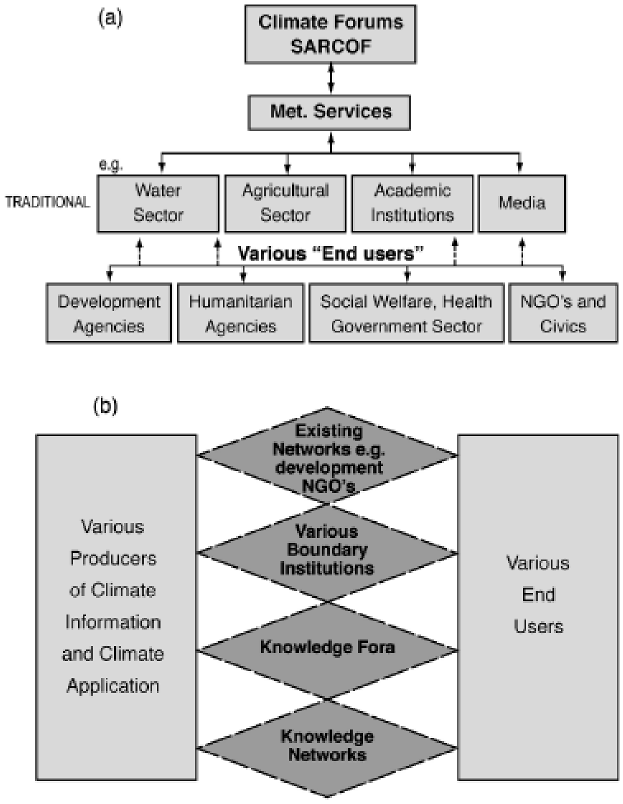


Fig. 6.16 Examples of climate information flows and organizational 'modes' that may be conceptualized in reducing food insecurity: (a) Current climate information pathways in southern Africa. Only limited engagement occurs with organizations not 'traditionally' perceived to be users of climate information; (b) A suggested alternative model of climate information and user interaction. *Source:* Vogel and O'Brien, 2006

In any effort to improve the science–practice interface a central role is played by ***communication*** that is "…the means and indeed the very foundation for engagement between the worlds of science and practice" (Vogel *et al.*, 2007, p. 353). Good communication is needed to match information emanating from the research community to users needs, to incorporate user knowledge in research and decision-support analysis, and improve their under-standing, interpretation, and application of tailored information for effective risk management decisions. Researchers can also be users if they require data and knowledge from others as inputs to their own research.

Science that intends to inform users and be applied in policy-decision making needs a coherent communication strategy (Leary *et al.*, 2007; Vogel *et al.*, 2007). Everything in the interaction between climate science and policy (practice) comes down to what, how and when it is communicated, through what channels or in what form and for what purpose, by whom and for whom. Thus, communications need to be multidirectional so that research considers users needs and knowledge, the users gain access to relevant scientific knowledge in forms, which are understandable and applicable to the decisions they face, and the process produces knowledge that is viewed as credible and legitimate by researchers and users alike.

Vogel *et al.* (2007) combined some common challenges in communication across the science/policy/practice interface that should be taken into account:

1) Building effective communications is time-consuming. Much of the necessary relationship-building that makes communication effective occurs in the background, is certainly not directly rewarded, and at times is penalized in some scientific circles.

2) While many in the scientific community hope that their research is relevant and some conduct research that is use-inspired, the traditional 'applied science' tends to have less prestige and rewards than 'pure' curiosity-driven basic science.

3) Achieving the balance between credibility and salience is not a trivial undertaking as decision-makers frequently have high expectations as to how soon decision-specific information can be made available.

4) Scientists and practitioners can have very different notions of what constitutes 'legitimate' knowledge.

5) For professional and ethical reasons, many scientists strongly object to, or at least resist, closeness to the world of politics.

And, at last, communications can be more effective when they provide opportunities for feedback from intended audiences and take into account their current knowledge, concerns, decision contexts, and information needs. Communication touches on the relationship between those engaged in the dialogue and their level of mutual understanding of institutional cultures, professional codes of conduct, modes of operation, information needs, decision contexts, and so on. Vogel *et al.* (2007, p. 353) believe that "while communication typically does not easily or directly translate information into policy or action, we argue that science has little chance to enter into decision-making or inform action at all when communication is poor or nonexistent". Therefore, there is a need for an enhanced dialogue between researchers and the user-communities, greater collaboration between producers and users of information, engaging users in framing the research questions early in the process as well involving them in the design and evaluation of communication materials. Common to all these elements is enhancing user's capacity to engage in the interpretation and understanding of communicated information.

6.2.3.3 Science-based stakeholder dialogue

Undoubtedly, along with the relevance of local and contextual knowledge, *"to aspire to the ideal of 'democratization' of knowledge, science needs to include multiplicity, admitting different perspectives of stakeholders"* (Van Asselt and Rijkens-Klomp, 2002, p. 167). In recent years, research institutions have become increasingly involved in science-based stakeholder dialogues to help communicate research results to stakeholders and to get their reaction. Because the terms 'stakeholder dialogues' and 'public participation in science' are sometimes used ambiguously, Welp *et al.* (2006, p. 172) defined a *science-based stakeholder dialogue* as "a structured communicative process of linking scientists with selected actors that are relevant for the research problem at hand. These actors possess specialized knowledge and have insights which are of relevance to the scientific process".

Such dialogues are partly driven by researchers themselves, but also to a great extent by funding agencies and the general public's demands for greater accountability in science. The science-based stakeholder approach recognizes the social context in which scientific knowledge is produced and assumes that usable knowledge requires that scientific exploration and practical application occur simultaneously (Kates *et al*., 2001; Welp *et al.*, 2006). Due to the inherent scientific uncertainties that characterize complex environmental problems, scientists can no longer be seen as neutral advisers who provide the policy process with hard facts and unambiguous information. Stakeholder knowledge is considered to be of a complementary value to scientific knowledge, and scientists and policy makers are as much stakeholders as any other actor[24] involved in the problem concerned; they all have their own agendas and interests in the problem and in the solutions to this problem (van de Kerkhof, 2006). One example of the conceptual framework of actor archetypes in science-policy interface is detailed in Box 6.8.

The communication with stakeholders is just as important as research. Cohen (1999, p. 267) suggests "that stakeholders could contribute insights that could influence research directions, and that this contribution could occur both within and outside a modeling exercise". He thinks also "that there is no one group or paradigm that has a monopoly on science, tools, and communication about these to stakeholders". Part of the challenge to bring complex and uncertain information to decision-makers "…rests with the gulf between lab-based science/models and 'street smarts' of resource managers, planners and harvesters, people who are stakeholders because their livelihoods and lives depend on their

Box 6.8 Conceptual framework of actor archetypes in science-policy dialog

The political actors (policy makers and stakeholders) want to protect their own interests, to realize their personal political ambitions and therefore have a so-called political rationality. Scientists aim to conduct research that is scientifically valid and of interest to them and have a scientific rationality. Thus, political actors and scientists are on the extreme ends of the problem situation-analysis spectrum that can be constructed to show the difference in perspectives between actors involved in a policy analysis study. Between these two very different archetypes, Karstens *et al.* (2007) identified two additional archetypes that are both different from political actors and scientists: the *commissioner* – the client of a policy analysis, and the *analyst* – the leader of an analyst team. A commissioner assigns a policy analysis study to an analysis team. The objectives of the study have to be achieved, and the study has to deliver results that are useful for the commissioner as well as concrete and actionable recommendations. Often, the commissioner is also a political actor working for the government. Therefore, the commissioner also has a degree of political rationality. The analyst is responsible for integrating information from disciplinary studies into one impact assessment. The analyst has analysis design rationality. In general, analysts aim for a broad analysis and a balance between the other three rationalities: meeting the commissioner's wishes within the constraints of time and budget, demonstrating sensitivity to political issues, and producing a study of good quality by scientific standards. The short overview of the four actor archetypes is given in the following Table.

Actor archetype	*Rationality*	*Goal in study*
Political actor	Political	Protects own interest
Commissioner	Managerial and political	Finishes project successfully (gets useable results)
Analyst	Analysis design and political, managerial and scientific	Finishes project successfully (satisfies commissioner of the study)
*Scientis*t	Scientific	Preserves scientific validity and does interesting research

Source: Karstens *et al.*, 2007

[24] As relevant dimensions for characterizing actors, Fischer (2003) considers their internal structure and economic orientation. *Groups* rely strongly on face-to-face-communication and, in the absence of many formalized rules, depend on the social skills of and the personal relations among their members. They are therefore rather flexible, but also susceptible to ruptures in the social relations. Furthermore, in this rather informal situation personal skills and character traits of individual members may gain special weight. In *organizations*, in contrast, the formal structures and rules may be more important for shaping the process. Finally, in *meta-collectives* information processing and conflict settlement is supposed to become a special problem due to the size and complexity of these actors

abilities to do what they do on a day-to-day basis, and whose activities are highly visible to other stakeholders (e.g., investors)" (*ibid*).

The practice of science-based stakeholder dialogues is seen by Welp and co-authors (2006) as an effort to link different domains of discourse, or context needed for a reasonably coherent exchange of arguments. From these authors' point of view, such dialogues are needed mainly for four reasons (Table 6.5). Here, besides science-based stakeholder dialogues, there are summarized key features of three other types of stakeholder-oriented dialogues: 'policy dialogues', 'multi-stakeholder dialogues for governance', and 'corporate dialogues'. All four types share the basic concept of learning and exchange of knowledge and opinions. The intention is to create a safe space for the exchange of arguments that is based on mutual trust. In such a setting, participants can learn from each other and as a group.

Table 6.5 Science-based dialogues in comparison with policy, governance and corporate dialogues

Type of dialogue	*Initiator/principal coordinator*	*Objectives*	*Who are the stakeholders?*
Science-based stakeholder dialogues	Researchers, scientific institutions or networks	Deepening our understanding, combining knowledge bases, checking social relevance	Corporations, SMEs, NGOs, policy-makers, citizens
Policy dialogues	Policy-makers, bureaucrats	Creating support for policies, ultimately passing laws and regulations, creating a monitoring structure	Various organized interest groups, corporations, SMEs, NGOs, researchers, citizens
Multi-stakeholder dialogues for governance	Intergovernmental organizations; International non-profit organizations	Creating multi-stakeholder partnerships, influencing policy and business practices	Governments, corporations, international and national NGOs, researchers
Corporate dialogues	Corporations	Taking society's expectations into account in business practices and in the transformation of business strategies	Government, NGOs, customers, employees, suppliers, communities, researchers

Source: Welp *et al.*, 2006

One may learn from the above discussions and Table 6.5 that stakeholders are not only utility maximizing agents, but rather actors that have limited information-processing capacity, have to make decisions when uncertainty exists and have different degrees of risk aversion, namely (Welp *et al.*, 2006):

1. Stakeholders can play an important role in identifying socially relevant and scientifically challenging research questions.
2. Dialogues with stakeholders can provide for scientists certain 'reality check' of the research they are doing. Stakeholders may be actively involved in evaluating the research methodology and models used, as well as in evaluating the final results. Such an early and regular involvement creates a sense of 'ownership' of the research process so the results are more likely to be used by stakeholders.
3. Social science research on global change faces limits to scientific reasoning and requires the incorporation of ethical considerations and value judgments.

4. Scientists need to have access to data and knowledge that otherwise would remain unknown or at least very difficult to access. Relevant knowledge that they may obtain from stakeholders ranges from quantitative (e.g., datasets) to qualitative information on sectoral specificities and stakeholders' understanding of global change. Thus, these dialogues create an interface to combine different knowledge domains, and as such may play a key role, for instance, in Integrated Assessments.

Usually, the aims of science-based stakeholder dialogues differ from those conducted by policymakers, international organizations or corporations and may not primarily aim at reaching a consensus. A dissent can be as valuable as consensus, since it reveals areas that need more research. Besides, these dialogues, explicitly encouraging mutual learning, may have other implicit goals which should not be ignored, for example, seeking legitimacy and financial support for the research as well as acceptance of the produced results.

A distinction between five different types of stakeholder participation in science is presented in Table 6.6. As we see, the roles of stakeholders may range from commenting concepts to substantial involvement in the scientific inquiry; the selected methods vary accordingly.

Table 6.6 Types of stakeholder participation in science

Role of the stakeholder	*Methods*	*When?*
Commenting concepts, drafts and results	Written reviews Interviews Group discussions	Throughout the research process
Eliciting quantitative data, stylized facts and expert judgements	Data mining Expert elicitations	Beginning of a research process
Exploring values, preferences, expectations and risk perception	Interviews Focus groups	Beginning and end (if focus is on changed values and preferences)
Identifying research questions	Workshops Surveys	Beginning/end of a research process (open/new questions)
Substantial involvement in the process of modelling and generating scientific insights	Research visits Team work	Throughout the research process on a regular basis

Source: Welp *et al.*, 2006

A key requirement for the practical theory relevant for stakeholder dialogues is that it integrates the different domains and layers: from the layer of personal relationships where trust building, sympathy, antipathy, etc. play a big role to the dialogue about exchanging arguments and creating common meaning. Since climate change has become an issue of great public interest, the interface between science, policy and society needs new methods of inquiry and dialogue, and stakeholder dialogues will play a vital role here and over a long period of time, concurrently with a research process usually including several iterations. Cycles of stakeholder dialogues may start with identifying relevant research questions and move on to phases of consultation, reviewing drafts and modifying concepts and models.

Science-based stakeholder dialogues are an extension of the practice and efforts to link research on global environmental change with knowledge domains outside the academic world, mainly in the interdisciplinary teams where scientists from different fields have regular discussions. At the same time, "stakeholder dialogues are not a substitute for scientific thinking but rather they foster the art and practice of thinking together" (Welp *et al.*, 2006, p. 180).

The above mentioned work, partially quoted here, also examines the relevance of three theoretical frameworks for science-based stakeholder dialogues – *Rational Actor Paradigm, Bayesian Learning*, and *Organizational Learning* – that can be recommended for those who are interested in such methods.

6.2.3.4 Science and policy in the environmental assessment process

Scientific assessments play a pivotal role in the interaction processes between public policy making, on the one side, and scientific research and policy advice – on the other. From a social-science perspective, Siebenhüner (2003) understands scientific assessment as social processes which help to translate expert knowledge into policy-related forms of knowledge that exert some form of influence on actual decision-making processes. In other words, scientific assessments are intensive communication processes between scientists and policy makers that aim at integrating knowledge from different scientific disciplines in such a way that it provides useful information for decision making (Tuinstra *et al.*, 2006). Assessment processes are embedded in a variety of institutional settings, within which scientists, decision-makers and other stakeholders communicate to define relevant questions for analysis, mobilize certain kinds of experts and expertise, and interpret findings in particular ways.

Assessments depend on scientific research, but sometimes identify research priorities or even sponsor research that they consider as necessary. At the same time, assessment is different activity from research, because, as Parson *et al*. (2003, p. 26) think, *"it serves different purposes, is judged according to different criteria, and requires different methods, processes, and skills to be done effectively. The purpose of assessment is not primarily to advance scientific knowledge, but rather to synthesize available knowledge to support decisions, whether by government officials or other actors, in pursuit of societal goals"*. The distinct purpose of assessment derives from the differences in its methods.

Being located between the scientific and political realms, scientific assessments have to balance between science and policy, or *"...moderate between a dedication to notions of truth and credibility in the scientific world and claims of interest, power and legitimacy in the political word,"* – Siebenhüner (2003, p. 114) notes.

Really, in the assessment process it is not easy to draw a sharp line between scientific and policy making activities. Neither can scientists' nor policy makers' roles as actors in such processes be always precisely defined. Therefore, an important aspect of science–policy communication in assessment processes is the negotiation of the division of labor between science and policy. The negotiation takes place about the identity of practices (e.g., *science* and *policy*) or actors (e.g., *scientists* and *policy makers*) and their collaboration. This process of maintaining and withdrawing the boundaries between science and policy, as well as of shaping and reshaping the science–policy interface has been referred to by Tuinstra *et al.* (2006, p. 352) as *'boundary work'.* The concept of 'boundary work', or "the fluid image of the dynamic of the science–policy interface" is different from the concept of a 'gap' between science and policy that has to be bridged, or a ‘boundary’ between them that has to be crossed. “The negotiation and establishment of the boundary itself and the definition of science and policy are part of the science–policy communication process. It is through boundary work that boundaries are made ‘real’” (*ibid*).

In the ‘boundary work’ Tuinstra and co-authors emphasize two sides: a demarcation side separating two actions or groups by defining distinguishing characteristics and prescribing proper ways of behavior for science and policy, and a co-ordination side defining how the two relate to each other by identifying the proper mutual conditions of exchange. Thus, the boundary work leads to a division of labor between science and policy.

There are different options how to design interactions between scientists and policy-makers within assessment processes. In one extreme case, interaction could be limited to an absolute minimum, by isolating scientists from the policy process; the other extreme would be an intense and thoroughly crafted collaboration between these two fields. The interaction could take place in formalized settings, with clearly defined individual roles, or in loose forms of cooperation mostly maintained through the personal engagement of some individuals. Hence, the influence of national governments hinges largely on the design of these forms of interaction (Siebenhüner, 2003).

Based on the necessity of balancing between science and policy, Mitchell *et al.* (2006) developed a conceptual framework to capture the relevant factors that determine effectiveness of assessments in the process of policy making in particular fields of policy. In their framework, as applied to climate change mitigation, the relationship between science and policy is not seen only as a linear one but is conceptualized as a circular influence from science to policy-making and from the political sphere back to science and assessments. From this perspective, the role of political actors, e.g., of representatives from national governments, is of particular interest since they have a twofold function: (i) they have to pursue political interests of their country, and (ii) they are part of a scientific process which is dedicated to informing policy-makers on the basis of the latest research findings. These roles don’t always coincide and therefore political actors involved in assessments often are confronted with conflicting interests.

Parson *et al*. (2003) discuss two other very basic concerns relating to the effectiveness of assessments: appropriate evidentiary standards and the role of prediction. The authors believe that scientific research use a conservative *evidentiary standard* to control the assimilation of new claims necessary to develop a stable and progressive body of validated knowledge. However, in assessment this standard must be replaced by an approach that considers the relative costs of both types of possible errors – rejecting true claims or accepting false ones – in view of the decisions that would likely be made based on each conclusion and their consequences.

The differences between science and assessment regarding the role of *prediction* are even more fundamental: in scientific research, a successful prediction is the primary test of understanding; in assessment, an understanding supports prediction. A major activity of assessment is to harness advances in understanding (such as it is now occurring in climate science), to support projections of likely environmental characteristics, and how their evolution may vary under alternative assumptions about climate, socio-economic development and relevant decisions. But pervasive uncertainties and limitations to knowledge inevitably mean that projections of the details, specificity, and confidence, which decision-makers might desire, cannot usually be provided.

Thus, the making of clear, practical statements that provide the best possible guidance for decisions that must be made, while appropriately representing the uncertainties inherent in present knowledge and the limits to predictive power that they imply, is the basic challenge of assessment. There is no general prescription stating the best way to manage this challenge; how to do it in any instance will depend on the specifics of available knowledge and decision needs.

Developing better methods to manage this challenge is an area of work needed to advance further assessments of climate impacts and vulnerabilities. The U.S. National Assessment (Parson *et al*., 2003) identified several areas of weakness or immaturity in present assessment methods. These weaknesses impose limits on the effectiveness of present assessments that are different in character from the limits that arise from gaps in scientific knowledge, and which are unlikely to be resolved by progress in scientific knowledge alone. To improve future assessments, further development in the assessment methods will be as important as further scientific research. Moreover, since the merit of assessment methods is determined by their actual utility in decision and policy settings, the empirical studies of the consequences and effectiveness of particular assessment activities and methods is also needed. These studies should identify what processes, methods, and strategies have provided the most useful inputs to policy-makers under various conditions. In particular, they should examine how to design interactions between researchers and stakeholders in order to involve stakeholders in identifying and assessing key issues, risks, uncertainties, and potential responses, while also making effective use of advanced analytical methods.

Tuinstra *et al.* (2006) addressed the role of science–policy interactions in shaping assessment frameworks, proceeding from the assessment processes of air quality policy-making in Europe. Their paper focuses on how the participants of the assessment divide and co-ordinate work between science and policy, and how this enhances *credibility, legitimacy* and *relevance* of assessments with multiple audiences. The article builds further upon the concept of effectiveness as it was developed in the Global Environmental Assessment (GEA) project[25]. This concept considers effectiveness as an emerging property based on the three above-mentioned qualities that participants and users attribute to the assessment. These qualities are co-determined by the characteristics of the assessment itself, the characteristics of the users of the assessment, and the context in which the assessment takes place, thus adapting the GEA framework by connecting it to the concept of 'boundary work' between science and policy.

The quality of the assessment as a scientific product is especially relevant for adaptation research strategies. For example, if to return to the above discussed concerns of Parson *et al*. (2003) regarding the role of prediction and forecasting in the scientific assessment, Reilly and Schimmelpfennig (2000) identified four possible strategies:

- If adaptation is autonomous, or there are no adaptation possibilities at all, then weather monitoring and evaluation of weather and climate trends**,** climate forecasting, or efforts to assist system adaptation are of no value;
- If agents must consciously recognize that climate has changed (for example, in agriculture), then climate monitoring and analysis of climate trends to detect whether change has occurred is the useful and necessary component of adaptation;

[25] See: ***http://www.hks.harvard.edu/gea/***

- If there is irreversibility, then accurate weather and climate forecasting can be useful, but there will still be adjustment costs stemming from the fact that investments must be made for the 'average climate' that is forecast to exist over the life of the investment; and
- Where the responses one might take are not well known, research and evaluation of strategies will be a useful part of an adaptation strategy.

The difficulties of projecting climate, additionally to predicting weather, are substantial. Climate projection is important only to the extent allowed by the irreversibility, that is, clearly, in almost all systems.

Lemos *et al.* (2002) examined the use of early climate forecasting by policy-makers and end-users to reduce the negative impacts of drought. At the policy-making level, it was the assessment of the use of climate information to formulate public policy in agricultural production, water management, and emergency drought-relief provisioning. At the end-users level, such as farmers and ranchers, it was assessment of the opportunities and constraints that defined the success of seasonal forecast applications, given the nature of socio-economic vulnerability to climate variability in the region. These authors argue that socio-economic, political, and cultural conditions can compromise the use of these forecasts both by farmers and policymakers. The forecasting faces a 'new technology adoption' problem in the sense that the potential uses and limitations of the technology are not fully understood, and a process of learning must ensue in order to determine appropriate uses. At the same time, the presentation of the forecast and its mode of communication to policy-makers and end-users is critical to its success. While much attention has been paid to the science of climate forecasting and its application, there is limited understanding of the socio-political environment through which climate forecasts are channeled and interpreted. Once in the hands of policy-makers, the scientific product loses its desired objectivity and becomes woven into a complex mesh of social, economic, and cultural realities that influence how information is in fact used. Thus, the interaction of policy-makers, end-users, and scientists has to be provided.

Moreover, while climate forecasters use large scale models to make low-spatial resolution but long-term predictions, the policy-makers desire high-resolution information relevant at the local level, especially for agricultural decisions. Although 'downscaling', empirically linking large-scale data to specific small-scale geographic regions, has become a common aspiration of scientists and policy-makers, the climate forecasting science is still far from the temporal and spatial accuracy level expected by users. As a result, *"the use of climate information in policymaking is first limited by this fundamental gap between the science product that is offered and the one that is demanded by policymakers and users,"* – is the opinion of not only Lemos *et al.* (2002, p. 482).

6.2.4 A long-term strategy: Tasks on the future

Uncertainties, unknowns and priorities for research, formulated in the IPCC Fourth Assessment, illuminate the confidence statements that modify scientific conclusions delivered to members of the policy community (IPCC, 2007a). For the research community, these can be translated into a series of tasks designed to improve understanding and increase confidence. They could be formulated as follows (Yohe *et al.*, 2007):

- Expand understanding of the synergies in and/or obstacles to simultaneous progress in promoting enhanced adaptive capacity and sustainable development.
- Integrate more closely current work in the development and climate change communities.
- Search for common ground between spatially explicit analyses of vulnerability and aggregate integrated assessment models.
- Recognize that uncertainties will continue to be pervasive and persistent, and develop or refine new decision support mechanisms that can identify robust coping strategies even in the face of this uncertainty.
- Characterize the full range of possible climate futures and the paths that might bring them forward.

In turn, Winne *et al.* (2005) identified several areas of research that are of critical importance and need further work before a long-term strategy on climate change policy can be developed (Box 6.9). Additionally, they have formulated some key insights into future science-policy discussions:

- Science can contribute to the exploration of what might be the elements of, and preconditions for, adequate institutional frameworks for addressing climate change.
- Because the role of technology in tackling climate change is a key issue, the exciting new research on induced technological change and on the diffusion of new technologies is increasingly able to provide insights into how to adequately utilize the potential contribution of technology.
- The scientific community is challenged to continue to demonstrate the extent to which the science justifies action in the short term and to show how GHG trading and technology can reduce the costs of early action.
- It appears that emerging surrounding policies that pay for adaptation may become increasingly attractive, especially where such policies can be seen as stimulating economic growth and contributing to development objectives. Such policies must be carefully balanced against investment in mitigation in order to avoid perverse incentives. Scientific research is needed in order to first expose this point and then to explore how such adaptation-mitigation linkages could work in practice.
- The importance of a sustained dialogue between groups of policy-makers and scientists (including both social scientists and climate scientists) requires personal commitment from both sides to build up a common knowledge base. Without this it is very difficult to achieve the depth of discussion required to really add value to policy debates. This demands of the scientists involved that they are cognizant of the subtleties and pace of the policy debate, rather than being wedded to narrow scientific research agendas.

Box 6.9 Areas of critical importance for European climate change research strategy

(a) costs of inaction and benefits of climate policy;
(b) costs and consequences for individual sectors;
(c) options for dealing with competitiveness problems;
(d) regional climate change impacts in relation to extreme events;
(e) coping capacities and (limits to) adaptation and adaptation costs;
(f) ways to better integrate climate change into sector and structural policy decisions; and
(g) perceptions and social acceptability of climate impacts and policies.

Source: Adapted from Winne *et al.* (2005)

Annex 6.1 Menu of methods for different levels of public involvement

Technique	*Description and use*	*Advantages*	*Disadvantages*
Level 1. Education and information provision			
Leaflets/ brochures	Written material used to convey information. Care should be taken in establishing the boundaries of distribution	Can potentially reach a wide audience, or be targeted towards particular groups	Information may not be readily understood and may be misinterpreted. May be treated as junk mail.
Newsletters	Written material used to convey information that may involve a series of publications. Care should be taken in establishing the boundaries of distribution.	Ongoing contact; information can be updated. A flexible form of publicity that can be designed to address the needs of the audience. Useful to support liaison groups. Potential for feedback.	Not everyone reads a newsletter.
Unstaffed exhibits/displays	Exhibits or displays set up in public areas to convey information.	People can view the displays at a convenient time and at their leisure. Graphic representations, if used, can help people visualize proposals.	Information may not be fully understood or misinterpreted. No staff available to respond to questions or receive comments.
Advertising	Advertisement placed to announce proposals, arrangements for meetings and other activities.	Depending on the circulation of the publication, the advert could potentially reach a large audience.	The information will only reach those who read the publication in which the advert is placed. Only limited information can be provided.
Local newspapers	An article published in a local newspaper to convey information about a proposed activity.	Potentially a cheap form of publicity and means of reaching a local audience.	Circulation may be limited. There may be problems associated with limited editorial control and misrepresentation of information.
National newspapers	An article published in a national newspaper to convey information about a proposed activity.	Potential to reach a very large audience.	Unless an activity has gained a national profile, it may be of limited interest to the national press and a national audience.
Television and radio	Use of television or radio to convey information about a proposed activity.	TV and radio have a potentially large audience. People may be more likely to watch or listen to a broadcast than read leaflets and brochures.	Broadcasts alone may be insufficient. Further information may need to be available in other forms so that people can find more about the issues raised. Relatively expensive.
Video	Production of a video to convey information. May incorporate computer graphics and other images.	Under the control of the producer. Can be watched at the viewer's convenience.	Can be perceived as biased propaganda. Relatively expensive to produce if the final product is going to look professional and credible.
Site visits	Organized case studies through site-oriented meetings to provide firsthand experience of a particular activity and the issues involved.	Issues brought to life through real examples.	Often difficult to identify a site which replicates all issues under consideration. Not suitable for large groups of people.

Annex 6.1 (continued)

Technique	*Description and use*	*Advantages*	*Disadvantages*
Level 2. Information feedback			
Staffed exhibits/ displays	Exhibits or displays set up in public areas to convey information and staffed by specialists who can provide information, answer questions.	People can view the displays at a convenient time and at their leisure. Graphic representations, if used, can help people visualize.	Requires a major commitment of staff time. May attract a small proportion of third parties.
Staffed telephone lines	A telephone number for people to call to obtain information, ask questions or make comments about proposals or issues.	A convenient way of receiving comments from interested parties. Not intimidating, therefore easier for people to participate and provide comments. Promotes a feeling of accessibility.	Discussions over the telephone may not be as good as face-to-face. Operating staff may not have technical knowledge available to respond to questions.
Internet	A Web site on the Internet used to provide information or invite feedback. Care should be taken to keep the information up to date. More interactive forms of participation on the internet may also be developed, e.g., online forums and discussion groups.	The audience is potentially global. Costs are reduced as no printing or postage costs are incurred. A convenient method of participation for those with Internet access.	The audience is potentially global. Costs are reduced as no printing or postage costs are incurred. A convenient method of participation for those with Internet access.
Public meetings	A gathering of interested and affected parties to present and exchange information and views on a proposal.	If run well, can provide a useful way of meeting other stakeholders. Demonstrates that the proponent is willing to meet with other interested parties.	While appearing simple, can be one of the most complex and unpredictable methods. Public meetings may be hijacked by interest groups or vocal individuals. May result in no consultation, only information provision.
Surveys, interviews and questionnaires	Encompasses a range of techniques for obtaining information and opinions. May be self-administered, conducted face-to-face, by post or over the telephone.	Can gather information from people who could not attend public meetings or become involved in other activities. Confidential surveys may result in more candid responses. Can identify existing knowledge and concerns.	Can have a poor response rate. Responses may not be representative and only reflect opinion at that time. Opinions may change. Designing and administering a good survey/questionnaire can be costly and time consuming.
Level 3. Involvement and consultation			
Workshops	Meetings for a limited number of participants which can be used to provide background information, discuss issues in detail and solve problems.	Can provide a more open exchange of ideas and facilitate mutual understanding. Useful for dealing with complex technical issues; allows for more in-depth consideration. Can be targeted at particular stakeholder groups.	To be most effective, only a small number of individuals can participate, therefore, a full range of interests are not represented.
Focus groups/ forums	A meeting of invited participants designed to gauge the response to proposed actions and gain a detailed understanding of people's perspectives, values and concerns.	Provides a quick means of gauging what public reaction to a proposal is likely to be	Selection of group members may exclude some sectors of the community, groups; require facilitation and serving, time consume.

Annex 6.1 (continued)

Technique	*Description and use*	*Advantages*	*Disadvantages*
Open house	Interested parties are encouraged to visit a designated location (site or building), on an informal basis to find out about a proposal and provide feedback.	An effective way of informing the public and other interested parties. People can visit at a convenient time, view materials and ask questions at their leisure.	Preparation for and staffing require considerable time and money.
Level 4. Extended involvement			
Community advisory/ liaison groups	Small groups of people representing particular areas of interest or areas of expertise, e.g., community leaders, meet to discuss issues of concern and provide an informed input.	Can consider issues in detail and highlight the decisions-making process and the complexities involved. Promotes a feeling of trust.	Not all interests may be represented. Requires commitment from participants. A longer-term process requiring more resources than some other methods.
Planning for real	A community model is made prior to the exercise to identify problems and issues and generate ideas and priorities through group working. Can be used to identify features of importance and collective aspirations.	Allows the community to take control and set the agenda, allows participation without the need for good verbal or written skills.	Community needs to be aware of the constraints. Models need to relate to the real world.
Citizen juries	A group of citizens brought together to consider a particular issue. Evidence is received from expert witnesses and cross-questioning can occur. At the end of the process a report is produced, setting out the views of the jury, including differences of opinion.	Can consider issues in detail and in a relatively short period of time.	Not all interests may be represented. Limited timescale may reduce time available for participants to fully consider information received.
Consensus conference	A forum at which a citizen, selected from the general public, questions specialists on a particular topic, assesses responses, discusses the issues raised and reports conclusions.	Can provide a unique insight into the ways in which issues are perceived by members of the public. Suited to dealing with controversial issues of public concern.	Not all interests are represented. Limited timescale for consideration of issues.
Visioning	A technique for developing a shared vision of a desirable future for a local community.	Develops a common view of future needs, promotes trust and a sense of purpose.	Lack of control over the outcome. Needs to be used in the early stages of the decision-making process.

Source: Fell A. and B. Sadler, 1999: Public involvement in environmental assessment and management: a preview of IEA guidelines on good practice. *Environmental Assessment,* 7(2): 36-39 (Quoted by Sadler, 2001b)

References

Addink, H., B. Arts, and A. Mol, 2003: Climate change policy in changing contexts: globalization, political modernization and legal innovation. In: van Ierland E.C., J. Gupta and M.J. Kok (Eds.): *Issues in international climate policy: theory and policy*, 2003, Edward Elgar, Cheltenham, UK, Northampton, MA, US, pp. 75–94.

Adger, W.N., 2006: Vulnerability. *Global Environmental Change* **16**:268–281.

Adger, N., 2004: Uncertainty in adaptive capacity. In: Manning, M., M. Petit, D. Easterling, J. Murphy, A. Patwardhan, H.-H. Rogner, R. Swart, and G. Yohe, (Eds.), *IPCC Workshop on Describing Uncertainties in Climate Change to Support Analysis of Risk and Options*. Intergovernmental Panel on Climate Change, Geneva, pp. 49–51.

Adger, W.N., S. Agrawala, M.M.Q. Mirza, C. Conde, K. O'Brien, J. Pulhin, R. Pulwarty, B. Smit and K. Takahashi, 2007: Assessment of adaptation practices, options, constraints and capacity. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change,* M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 717–743.

Adger, W. N., N.W. Arnell, and E.L. Tompkins, 2005: Successful adaptation to climate change across scales. *Global Environmental Change* **15**:77–86.

Adger, W. N., N. Brooks, G. Bentham, M. Agnew and S. Eriksen, 2004: *New indicators of vulnerability and adaptive capacity*. Tyndall Centre for Climate Change Research Technical Report 7.

Agenda 21: Earth Summit – The United Nations Programme of Action from Rio, 1992. Available at: *http://www.un.org/esa/sustdev/documents/agenda21/english/agenda21toc.htm* .

Aggarwal, P.K., N. Kalra, S. Chander and H. Pathak, 2006: InfoCrop: a dynamic simulation model for the assessment of crop yields, losses due to pests and environmental impact of agro-ecosystems in tropical environments – model description. *Agricultural Systems* **89**:1–25.

Agrawal, A. and M.C. Lemos, 2007: A Greener Revolution in the Making? Environmental Governance in the 21st Century. *Environment* **49(5)**:36–45.

Agrawala, S., 2004: Adaptation, development, assistance and planning: challenges and opportunities. *IDS Bulletin* **35**(3):50–54.

Agrawala, S., 1999: Early science-policy interactions in climate change: lessons from the Advisory Group on Greenhouse Gases. *Global Environmental Change* **9**:157–169.

Agrawala, S. and M. van Aalst, 2008: Adapting development cooperation to adapt to climate change. *Climate Policy* **8**:183–193.

Ahonen, P., 1999: General considerations and user experiences of project cycle management in a small donor-transitional country context. *Impact Assessment and Project Appraisal* **17(2)**:97–105.

Alberini, A., A. Chiabai, and L. Muehlenbachs, 2006: Using expert judgment to assess adaptive capacity to climate change: Evidence from a conjoint choice survey. *Global Environmental Change* **16**:123–144.

Albrecht, J., 2004: Climate change policy after 2012. *European Environment* **14**, 259–260. DOI: 10.1002/eet.358

Alcamo, J., N. Dronin, M. Endejan, G. Golubev, and A. Kirilenko, 2007: A new assessment of climate change impacts on food production shortfalls and water availability in Russia. *Global Environmental Change* **17**:429–444.

Alcamo, J., J.M. Moreno, B. Nováky, M. Bindi, R. Corobov, R.J.N. Devoy, C. Giannakopoulos, E. Martin, J.E. Olesen and A. Shvidenko, 2007: Europe. *Climate Change 2007: Impacts, Adaptation* *and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change,* M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 541–580.

Aldy, J.E. and R.N. Stavins, 2008: Climate policy architectures for the Post-Kyoto world. *Environment* **50(3)**:6–16.

Alic, J.A., D.C. Mowery and E. S. Rubin, 2003: *U.S. technology and innovation policies: Lessons for Climate Change.* Pew Center on Global Climate Change, Arlington, VA, 48 pp.

Allen, M., 2003: Liability for climate change. *Nature* **421(27)**:892–893.

Anantram, K. and L. Noronha, 2005: *Financing adaptation.* The Energy and Resource Institute (TERI), New Delhi, 12p.

Andresen, S. and S. Agrawala, 2002: Leaders, pushers and laggards in the making of the climate regime. *Global Environmental Change* **12**:41–51.

Annandale, D., 2001: Developing and evaluating environmental impact assessment systems for small developing countries. *Impact Assessment and Project Appraisal* **19**(3):187–193.

Arts, B. and J. Cozijnsen, 2003: Between 'curbing the trends' and 'business-as-usual': NGOs in international climate change policies. In: van Ierland E.C., J. Gupta and M.J. Kok (Eds.): *Issues in international climate policy: theory and policy*, 2003, Edward Elgar, Cheltenham, UK, Northampton, MA, US, pp. 243–261.

Arvai, J., G. Bridge, N. Dolsak, R. Franzese, T. Koontz, A. Luginbuhl, P. Robbins, K. Richards, K.S. Korfmacher, B. Sohngen, J. Tansey and A. Thompson, 2006: Adaptive management of the global climate problem: Bridging the gap between climate research and climate policy. *Climatic Change* **78**:217–225. DOI:10.1007/s10584-006-9094-6.

Aslam, M.A., 2002: Equal per capita entitlements: A key to global participation on climate change. In: Baumert, K.A., O. Blanchard, S. Llosa and J.F. Perkaus (eds.), 2002: *Building on the Kyoto Protocol: Options for Protecting the Climate.* World Resource Institute, pp. 175–201.

Attali, S. & K. Tillerson (eds.), 2005: *Energy Savings: What Works & Who Delivers? eceee 2005 Summer Study Proceedings.* eceee secretariat, Stockholm, Sweden.

Bailey, I. and S. Rupp, 2006: The Evolving Role of Trade Associations in Negotiated Environmental Agreements: The Case of United Kingdom Climate Change Agreements. *Business Strategy and the Environment* **15**:40–54. DOI:10.1002/bse.465.

Bailey, I. and S. Rupp, 2004: Politics, industry and the regulation of industrial greenhouse-gas emissions in the UK and Germany. *European Environment* **14**:235–250. DOI:10.1002/eet.355.

Bals, C., K. Warner, and S. Butzengeiger, 2006: Insuring the uninsurable: design options for a climate change funding mechanism. *Climate Policy* **6**:637–647.

Barker, T., 2008: The economics of avoiding dangerous climate change. An editorial essay on The Stern Review. *Climatic Change* **89**:173–194. DOI 10.1007/s10584-008-9433-x.

Barker, T., 2003: Representing global climate change, adaptation and mitigation. *Global Environmental Change* **13**:1–6.

Barnett, J., 2003: Security and climate change. *Global Environmental Change* **13**:7–17.

Barnett, J., 1998: In defense of the nation-state: securing the environment. *Sustainable Development. Sust. Dev.* **6**:8–17.

Bartholy, J., R. Pongrácz, 2006: Regional analysis of extreme temperature and precipitation indices for the Carpathian Basin from 1946 to 2001. *Global and Planetary Change* **57(1-2)**:83–95. DOI:10.1016/j.gloplacha.2006.11.002.

Bartiaux, F., 2003: A socio-anthropological approach to energy-related behaviours and innovations at the household level. In: Attali, S., E. Métreau, M. Prône, K. Tillerson (eds.), *Time to turn down energy demands. eceee 2003 Summer Study Proceedings,* eceee Secretariat, Stockholm, pp. 1239–1250.

Batabyal, A.A. and H. Beladi, 2006: Renewable Resource Management in Developing Countries: How Long Until Crisis? *Review of Development Economics* **10(1)**:103–112.

Baumert, K.A. and N. Kete, 2002: Introduction: An architecture for climate protection. In: Baumert, K.A., O. Blanchard, S. Llosa and J.F. Perkaus (eds.), 2002: *Building on the Kyoto Protocol: Options for Protecting the Climate.* World Resource Institute, pp. 1–30.

Baumert, K.A. and S. Llosa, 2002: Conclusion: Building an Effective and Fair Climate Protection architecture. In: Baumert, K.A., O. Blanchard, S. Llosa and J.F. Perkaus (eds.), 2002: *Building on the Kyoto Protocol: Options for Protecting the Climate.* World Resource Institute, pp. 223–235.

Baumert, K., and J. Pershing, 2004: *Climate data: Insights and observations*. Pew Center on Global Climate Change, Arlington, VA, 43 pp.

Baumert, K.A., O. Blanchard, S. Llosa and J.F. Perkaus (eds.), 2002: *Building on the Kyoto Protocol: Options for Protecting the Climate.* World Resource Institute, 252 pp.

Bazerman, M.H., 2006: Climate change as a predictable surprise. *Climatic Change* **77**:179–193.

Beg, N., J.C. Morlot, O. Davidson, Y. Afrane-Okesse, L. Tyani, F. Denton, Y. Sokona, J.P. Thomas, E.L. La Rovere, J.K. Parikh, K. Parikh, and A.A. Rahman, 2002: Linkages between climate change and sustainable development. *Climate Policy* **2**:129–144.

Behrens, A., A. Georgiev and M. Carraro, 2010: *Future impacts of climate change across Europe.* CEPS Working Document No. 324.

Bektashi, L. and A. Cherp, 2002: Evolution and current state of environmental assessment in Azerbaijan. *Impact Assessment and Project Appraisal* **20(4)**:253–263.

Benestad, R.E., 2006: Can we expect more extreme precipitation on the monthly time scale? *Journal of Climate* **19**:630–637.

Benestad, R.E., 2004: Record-values, nonstationarity tests and extreme value distributions. *Global and Planetary Change* **44**:11–26.

Benestad, R.E., 2000: Empirically downscaled multimodel ensemble temperature and precipitation scenarios for Norway. *Journal of Climate* **15**:3008–3027.

Beniston, M., D.B. Stephenson, O.B. Christensen, C.A.T. Ferro, C. Frei, S. Goyette, K. Halsnaes, T. Holt, K. Jylhд, B. Koffi, J. Palutikof, R. Schцll, T. Semmler and K. Woth, 2007: Future extreme events in European climate: an exploration of regional climate model projections. *Climatic Change* **81**:S71–S95.

Bennewitz, J., 2009: Climate, entropy and environment. *Environment, Development and Sustainability* **11**:127–136. DOI 10.1007/s10668-007-9118-z.

Berk, M.M., J. Gupta and J.C. Jansen, 2003: Comprehensive approaches to differentiation of future climate commitments – some options compared. In: van Ierland E.C., J. Gupta and M.J. Kok (Eds.): *Issues in international climate policy: theory and policy*, 2003, Edward Elgar, Cheltenham, UK, Northampton, MA, US, pp. 171–200.

Berkhout, F., 2005: Rationales for adaptation in EU climate change policies. *Climate Policy* **5**:377–391.

Berkhout, F, J. Hertin and N. Arnell, 2004: *Business and Climate Change: Measuring and Enhancing Adaptive Capacity*. Tyndall Centre Technical Report No. 11, 40 pp.

Berkhout, F., J. Hertin and D. Gann: 2003: *Learning to adapt: A Conceptual Framework for Organizational Adaptation to Climate Change Impacts*, ADAPT Project Working Paper. Tyndall Centre for Climate Change Research.

Betz, G., 2007: Probabilities in climate policy advice: a critical comment**.** *Climatic Change* **85**:1–9. DOI: 10.1007/s10584-007-9313-9.

Bezanson, K., 2004: Rethinking development: the challenge for international development organizations. *IDS Bulletin* **35**(3):127–134.

Biermann, F., 2008: Earth System Governance, Report on a New IHDP Initiative. *IHDP Update* **1**:23–25.

Biermann, F., 2007: 'Earth system governance' as a crosscutting theme of global change research. *Global Environmental Change* **17**:326–337. DOI:10.1016/j.gloenvcha.2006.11.010.

Biermann, F., 2005: Between the USA and the South: strategic choices for European climate policy. *Climate Policy* **5**:273–290.

Biermann, F. and S. Bauer, 2004: Assessing the effectiveness of intergovernmental organisations in international environmental politics. *Global Environmental Change* **14**:189–193.

Biermann, F. and I. Boas, 2008: Protecting Climate Refugees: The Case for a Global Protocol. *Environment* **50(6)**:8–16.

Biesbroek, G.R., R.J. Swart, and W.G.M. van der Knaap, 2009: The mitigation–adaptation dichotomy and the role of spatial planning. *Habitat International* **33**:230–237. DOI:10.1016/j.habitatint. 2008.10.001.

Bizikova, L., J. Robinson, and S. Cohen, 2007: Linking climate change and sustainable development at the local level. *Climate Policy* **7**:271–277.

Blackman, R., 2003: *Project cycle management.* ROOTS Resources 5, Tearfund , Teddington, UK, 84 pp.

Blanchard, O., 2002: Scenarios for differentiating commitments: a quantitative analysis. In: Baumert, K.A., O. Blanchard, S. Llosa and J.F. Perkaus (eds.): *Building on the Kyoto Protocol: Options for Protecting the Climate.* World Resource Institute, pp. 204–222.

Blennow, K. and J. Persson, 2009: Climate change: Motivation for taking measure to adapt. *Global Environmental Change* **19**:100–104.

Blindenbacher, R. and B. Nashat, 2010: The Black Box of Governmental Learning: The Learning Spiral – A Concept to Organize Learning in Governments. The World Bank, Washington DC, 183 pp.

Bouille, D. and O. Girardin, 2002: Learning from the Argentine voluntary commitment. In: Baumert, K.A., O. Blanchard, S. Llosa and J.F. Perkaus (eds.): *Building on the Kyoto Protocol: Options for Protecting the Climate.* World Resource Institute, pp. 135–156.

Brewer, T.L., 2008: Climate change technology transfer: a new paradigm and policy agenda. *Climate Policy* **8**:516–526.

Briassoulis, H., 2004: The Institutional Complexity of Environmental Policy and Planning Problems: The Example of Mediterranean Desertification. *Journal of Environmental Planning and Management,* **47(1)**:115–135.

Brohan, P., J.J. Kennedy, I. Harris, S.F.B. Tett and P.D. Jones, 2006: Uncertainty estimates in regional and global observed temperature changes: a new dataset from 1850. *J. Geophysical Research* **111**:D12106.

Broman, G., J. Holmberg, and K.-H. Robèrt. 2000: Simplicity Without Reduction – Thinking Upstream Towards the Sustainable Society. *Interfaces: International Journal of the Institute for Operations Research and the Management Sciences* **30(3)**:1–21.

Brown, D., J. Lemons, and N. Tuana, 2006: The importance of expressly integrating ethical analyses into climate change policy formation. *Climate Policy* **5**:549–552.

Brown, A. L. and R. Thérivel, 2000: Principles to guide the development of strategic environmental assessment methodology. *Impact Assessment and Project Appraisal* **18(3)**:183–189.

Brooks, N., 2003: *Vulnerability, Risk and Adaptation: A Conceptual Framework.* Tyndall Centre Working Paper No. 38. Tyndall Centre for Climate Change Research.

Brooks, N., W.N. Adger, and P.M. Kelly, 2005: The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation. *Global Environmental Change* **15**:151–163.

Bruel, R. and J. Hoekstra, 2005: How to stimulate owner-occupiers to save energy? In: Attali, S. & K. Tillerson (eds.): *Energy Savings: What Works & Who Delivers? eceee 2005 Summer Study Proceedings.* eceee secretariat, Stockholm, Sweden, pp. 1197–1204.

Brunn, S.D., and S.R. O'Lear, 1999: Research and communication in the "invisible college" of the Human Dimensions of Global Change. *Global Environmental Change* **9**:285–301.

Buchdahl, J. M. and D. Raper, 1998: Environmental ethics and sustainable development. *Sustainable Development* **6**:92–98.

Buchner, B. and C. Carraro, 2005: Economic and environmental effectiveness of a technology-based climate protocol. *Climate Policy* **4**:229–248.

Bulygina, O.N., V.N. Razuvaev, and N.N. Korshunova, 2009: Changes in snow cover over Northern Eurasia in the last decades. *Environmental Research Letter* **4**:045026. DOI:10.1088/1748-9326/4/4/045026.

Burch, S. and J. Robinson, 2007: A framework for explaining the links between capacity and action in response to global climate change. *Climate Policy* **7**:304–316.

Burdge, R.J., 2002: Why is social impact assessment the orphan of the assessment process? *Impact Assessment and Project Appraisal* **20(1)**:3–9.

Burdge, R., P. Fricke, K. Finsterbusch, W. Freudenberg, R. Gramling, A. Holden, L. Llewellyn, J. Petterson, J. Thompson and G. Williams, 1995: Guidelines and principles for social impact assessment. *Environmental Impact Assessment Review* **15(1)**:11–43.

Burton, J., L. Bizikova, T. Dickinson, Y. Howard, 2007: Integrating adaptation into policy: upscaling evidence from local to global. *Climate Policy* **7**:371–376.

Burton, I., E. Diringer and J. Smith, 2006: *Adaptation to climate change: international policy options*. Pew Center on Global Climate Change, 28 pp.

Burton, I., S. Huq, B. Lim, O. Pilifosova, and E.L. Schipper, 2002: From impacts assessment to adaptation priorities: the shaping of adaptation policy. *Climate Policy* **2**:145–159.

Busch, P-O. and H. Jörgens, 2005: International Patterns of Environmental Policy Change and Convergence. *European Environment* **15**:80–101. **DOI**:10.1002/eet.374.

Cain, J., C. Batchelor, and D. Waughray, 1999: Belief networks: A framework for the participatory development of natural resource management strategies. *Environment, Development and Sustainability* **1**:123–133.

Cairns, J.Jr., 1997: Defining Goals and Conditions for a Sustainable World. *Environmental Health Perspectives* **105(1)**:1164–1170.

Carpenter, S.R., B.H. Walker, J.M. Anderies, and N. Abel, 2001: From metaphor to measurement: resilience of what to what? *Ecosystems* **4**:765–781.

Carraro, C., 2000: Climate policy. An integrated assessment of international and distributional issues. *Integrated Assessment* **1**:105–109.

Carter, T.R., 2004: Regional climate changes associated with key levels of impacts and vulnerability. In: *IPCC Expert Meeting Report on the Science to Address UNFCCC Article 2 including Key Vulnerabilities*. Buenos Aires, Argentina, 18–20 May 2004, pp. 119–121.

Carter, T.R., R.N. Jones, X. Lu, S. Bhadwal, C. Conde, L.O. Mearns, B.C. O'Neill, M.D.A. Rounsevell and M.B. Zurek, 2007: New Assessment Methods and the Characterisation of Future Conditions. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change,* M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 133–171.

Carter, T.R., M. Parry, H. Harasawa, and N. Nishioka, 1994: *IPCC Technical Guidelines for Assessing Climate Change Impacts and Adaptations,* Department of Geography, University College London and Center for Global Environmental Research, National Institute for Environmental Studies, London, UK and Tsukuba, Japan, 54 pp.

Carter, T., M. Hulme, and D. Viner (Eds.), 1999: Representing uncertainty in climate change scenarios and impact studies. In: *Proceedings of the ECLAT-2 Helsinki Workshop*, 14–16 April 1999, Climatic Research Unit, Norwich, UK, 128 pp.

Cash, D.W. and S.C. Moser, 2000: Linking global and local scales: designing dynamic assessment and management processes. *Global Environmental Change* **10**:109–120.

Cash, D.W., W.C. Clark, F. Alcock, N.M. Dickson, N. Eckley, D.H. Guston, J. Jager, and R.B. Mitchell, 2003: Knowledge systems for sustainable development. *Proceedings of the National Academy of Sciences of the United States of America (PNAS)* **100(14)**:8086–8091.

Castelnuovo, E., M. Moretto and S. Vergalli, 2003: Global warming, uncertainty and endogenous technical change. *Environmental Modeling and Assessment* **8**:291–301.

Cebon, P. and J. Risbey, 2000: Four views of "regional" in regional environmental change. *Global Environmental Change* **10**:211–220.

Chadwick, M., K., Begg, G. Hag and T. Jackson, 2001: Environmental and social aspects of Joint Implementation: Methodologies and case studies results. In: *Flexibility in climate policy: making the Kyoto mechanisms work.* Earthscan Publications Ltd., London and Sterling, VA, pp. 78–110.

Charlesworth, M. and C. Okereke, 2010: Policy responses to rapid climate change: An epistemological critique of dominant approaches. *Global Environmental Change* **20**:121–129.

Cherp, A., 2004: *The Promise of Strategic Environmental Management. Final Report of the MiSt Pilot Project 11*. Blekinge Tekniska Högskolan & Central European University, 38 p. Available at: *http://www.ceu.hu/envsci/aleg/research/index.html.*

Cherp, A., 2001: Strategic Environmental Assessment in the Newly Independent States of the Former Soviet Union. In: Dusik J. (ed.): *Proceedings of International Workshop on Public Participation and Health Aspects in Strategic Environmental Assessment* (November 23–24, 2000, Szentendre, Hungary). The Regional Environmental Center for Central and Eastern Europe, Szentendre, Hungary, pp. 57–67.

Cherp, A., nd: *SEA Protocol and the NIS*. Available at: http://www.ceu.hu/envsci/publication/pubAC.htm

Cherp, A. and A. Antypas, 2003: Dealing with continuous reform: Toward adaptive EA policy systems in countries in transition. *Journal of Environmental Assessment Policy and Management* **5(4)**:455–476.

Cherp, A. and S. Golubeva, 2004: Environmental assessment in the Russian Federation: evolution through capacity building. *Impact Assessment and Project Appraisal* **22(2)**:121–130.

Cherp, A. and R. Vrbensky, 2002: Sustainability and Transition: Synergies, Opportunities and Threats (SOT) Analysis. *Development Policy Journal. Special issue: Capacity for sustainable development* **1**:19–48.

Cherp, A., C. George, and C. Kirkpatrick, 2004: A methodology for assessing national sustainable development strategies. *Environment and Planning C: Government and Policy* **22**:913–926. DOI:10.1068/c0310j.

Christensen, J.H. and O.B. Christensen, 2007: A summary of the PRUDENCE model projections of changes in European climate during this century. *Climatic Change*, **81**:S7–S30.

Clark, G.E., 2008: Climate Policy's Quiet Giants. *Environment* **50(4)**:6–7.

Clark ,W.C., 2003a: *Sustainability Science: Challenges for the New Millennium.* Posted to the Initiative on Science and Technology for Sustainability (ISTS) web site 15 September 2003: *http://www.ksg.harvard.edu/sustsci/ists/docs/clark_zicer_opening030904.pdf.*

Clark, W.C., 2003b: *Institutional Needs for Sustainability Science.* Available at: *http://sustainabilityscience.org/ists.*

Clark, W.C. and N.M. Dickson, 2003: Sustainability science: The emerging research program. *Proceedings of the National Academy of Sciences of the United States of America (PNAS)* **100(14)**:8059–8061.

Clark, W.C., P.J. Crutzen and H.J. Schellnhuber. 2005: *Science for Global Sustainability: Toward a New Paradigm*. CID Working Paper No. 120. Cambridge, MA, 28 pp. Available at: *http://www.cid.harvard.edu/cidwp/120.htm.*

Clark, W.C., J. Jäger, and J. van Eijndhoven, 2001: Managing Global Environmental Change: An Introduction to the Volume. Reprinted from the book *Learning to Manage Global Environmental Risks – Volume 1: A Comparative History of Social Responses to Climate Change, Ozone Depletion, and Acid Rain.* MIT Press.

Clement, C., 2005: Environment and Sustainable Regional Development. *European Environment* **15** : 263–265. DOI:10.1002/eet.392.

Clement, K., 2001: Strategic environmental awakening: European progress in regional environmental integration. *European Environment* **11**:75–88. DOI: 10.1002:eet.253.

Clinch, J.P., 2001: Towards a more integrated approach to environmental and health and safety policy. *Eco-Management and Auditing* **8**:12–24. DOI: 10.1002:ema.141.

Clive, G., 2001: Sustainability appraisal for sustainable development: integrating everything from jobs to climate change. *Impact Assessment and Project Appraisal* **19(2)**:95–106.

Cochran, P.L. and A.L. Geller, 2002: The melting ice cellar. *American Journal of Public Health* 92**(9)**:1404–1409.

Cohen, S.J., 1999: Out of the lab and into the frying pan: The need for broader conversation about climate change. *Climatic Change* **41**:265–270.

Cohen, S., D. Demeritt, J. Robinson and D. Rothman, 1998: Climate change and sustainable development: towards dialogue. *Global Environmental Change* **8(4)**:341–371.

Cole, M.A., 1999: Limits to growth, sustainable development and environmental Kuznets Curve: An examination of the environmental impacts of economic development. *Sustainable Development* **7**:87–97.

Confalonieri, U., B. Menne, R. Akhtar, K.L. Ebi, M. Hauengue, R.S. Kovats, B. Revich and A. Woodward, 2007: Human health. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 391–431.

Corfee-Morlot, J. and S. Agrawala, 2004: The benefits of climate policy. *Global Environmental Change* **14**:197–199.

Corobov, R., 2009: Climate change and its challenges for Moldova. In: *Climate change in Moldova: Socio-economic impact and policy options for adaptation.* 2009/2010 National Human Development Report. UNDP Moldova, pp. 38–48.

Corobov, R. and A. Overcenko, 2007: Use of climate modeling outputs for regionalization of global climate projections. In: *Problems of Ecological Monitoring and Ecosystem Modelling,* Vol. XXI, StPetersburg, Gidrometeoizdat, pp. 122–145.

Corobov, R., S. Sheridan, A. Overcenco and N. Terinte, 2010: Air temperature trends and extremes in Chisinau (Moldova) as evidence of climate change. *Climate research* **42(3)**:247–256.

Corobov, R., S. Sheridan, N. Opopol, K. Ebi (Forthcoming): Heat-related mortality in Moldova. Part II: The summer of 2007.

Crutzen, P.J. and W. Steffen, 2003: How long have we been in the anthropocene era? *Climatic Change* **61**:251–257.

Cunningham, J. A. and J.P. Clinch, 2004: An organizing framework for the implementation of environmental voluntary approaches. *European Environment* **14**:30–39. DOI: 10.1002/eet.338.

Curtis, F. and H. Epp, 1999: Role of deductive science in evaluation of alternatives in environmental assessment. *Impact Assessment and Project Appraisal* **17(1)**:3–8.

Dabelko, D., S. Lonergan and R. Matthew, 2000: *State of the Art Review of Environmental Security and Co-operation.* Paris: OECD.

Dalal-Clayton, B. and B. Sadler, 2005: *Strategic environmental assessment: A sourcebook and reference guide to international experience.* Earthscan, London, 470 pp. Available at: *http://www.iied.org/Gov/spa/docs.html#sea*.

de Bruin, K., R.B. Dellink, A. Ruijs, L. Bolwidt, A. van Buuren, J. Graveland, R.S. de Groot, P.J. Kuikman, S. Reinhard, R.P. Roetter, V.C. Tassone, A. Verhagen and E.C. van Ierland, 2009: Adapting to climate change in The Netherlands: an inventory of climate adaptation options and ranking of alternatives. *Climatic Change* **95**:23–45. DOI 10.1007/s10584-009-9576-4.

de Coninck, H., F. Haake and van der Linden N., 2007: Technology transfer in the Clean Development Mechanism, *Climate Policy* **7**:444–456.

Delmas, M. and M.W. Toffel, 2004: Stakeholders and environmental management practices: an institutional framework. *Business Strategy and the Environment* **13**:209–222.

Depledge, D, 2002: Continuing Kyoto: Extending absolute, 2002: In: Baumert, K.A., O. Blanchard, S. Llosa and J.F. Perkaus (eds.), 2002: *Building on the Kyoto Protocol: Options for Protecting the Climate.* World Resource Institute, pp. 31–60.

Dessai, S., K. O'Brien and M. Hulme, 2007: Editorial: On uncertainty and climate change. *Global Environmental Change* **17**:1–3.

Dessai, S. and M. Hulme, 2004: Does climate adaptation policy need probabilities? *Climate Policy* **4**:107–128.

Dessai, S., W.N. Adger, M. Hulme, J. Turnpenny, J. Köhler and R. Warren (Eds.), 2004: Defining and experiencing dangerous climate change—an editorial essay. *Climatic Change* **64(1–2)**:11–25.

Devine-Wright, P., P.D. Fleming and H. Chadwick, 2001: Role of social capital in advancing regional sustainable development. *Impact Assessment and Project Appraisal* **19(2)**:161–167.

Devuyst, D., 2000: Linking impact assessment and sustainable development at the local level: The introduction of sustainability assessment systems. *Sustainable Development* **8**:67–78.

DFID, 2004: *Adaptation to Climate Change: Can insurance reduce the vulnerability of the poor?*" Department for International Development, Fact Sheet 8. United Kingdom, 8 p. Available at: *http://www.dfid.gov.uk/pubs/files/climatechange/8insurance.pdf*.

Dlugolecki, A. and M. Mansley, 2005: *Asset management and climate change*, Tyndall Centre Technical Report 20, 15 pp.

Dlugolecki, A. and E. Hoekstra, 2006: The role of the private market in catastrophe insurance. *Climate Policy* **6**:648–657.

Dobie, P., 2002: Models for National Strategies: Building Capacity for Sustainable Development. In: *Development Policy Journal. Special issue: Capacity for sustainable development.* UNDP, pp. 1–18.

Doelle, M., 2004: Climate Change and the WTO: Opportunities to Motivate State Action on Climate Change through the World Trade Organization. *RECIEL* **13(1)**.

Doelle, M. and A.J. Sinclair, 2006: Time for a new approach to public participation in EA: Promoting cooperation and consensus for sustainability. *Environmental Impact Assessment Review* **26**:185–205.

Donnelly, A., M. Jones, T. O'Mahony and G. Byrne, 2007: Selecting environmental indicator for use in strategic environmental assessment. *Environmental Impact Assessment Review* **27**:161–175.

Donnelly, A., M. Jones, T. O'Mahony and G. Byrne, 2006: Decision-support framework for establishing objectives, targets and indicators for use in strategic environmental assessment. *Impact Assessment and Project Appraisal* **24(2)**:151–157.

Doulton, H. and K. Brown, 2009: Ten years to prevent catastrophe? Discourses of climate change and international development in the UK press. *Global Environmental Change* **19**:191–202.

Dowlatabadi, H., 2007): On integration of policies for climate and global change. *Mitigation and Adaptation Strategies for Global Change* **12(5)**:651–663.

Dronin, N. and A. Kirilenko, 2008: Climate change and food stress in Russia: what if the market transforms as it did during the past century? *Climatic Change* **86**:123–150. DOI:10.1007/s10584-007-9282-z .

Dupuy, J.-P. and A. Grinbaum, 2004: Living with Uncertainty: From the Precautionary Principle to the Methodology of Ongoing Normative Assessment. In: Manning M., M. Petit, D. Easterling, J. Murphy, A. Patwardhan, H.-H. Rogner, R. Swart and G. Yohe (eds.), 2004: *IPCC Workshop on Describing Scientific Uncertainties in Climate Change to Support Analysis of Risk and of Options.* Workshop report, pp. 63–64.

Dusik, J. and B. Sadler, 2004: Reforming strategic environmental assessment systems: lessons from Central and Eastern Europe. *Impact Assessment and Project Appraisal* **22(2)**:89–97.

Dusik, J., B. Sadler and N. Mikulic, 2001: Developments in Strategic Environmental Assessment in Central and Eastern Europe. In: Dusik J. (ed.): *Proceedings of International Workshop on Public Participation and Health Aspects in Strategic Environmental Assessment* (November 23–24, 2000, Szentendre, Hungary). The Regional Environmental Center for Central and Eastern Europe, Szentendre, Hungary, pp. 49–56.

Dyson, T., 2005: On Development, Demography and Climate Change: The End of the World as We Know it? *Population and Environment* **27(2)**:117-149. DOI: 10.1007/s11111-006-0017-2.

Eakin, H.C. and M.B. Wehbe, 2009: Linking local vulnerability to system sustainability in a resilience frame-work: two cases from Latin America. *Climatic Change* **93**:355–377. DOI:10.1007/s10584-008-9514-x.

Ebi, K., R.S. Kovats and B. Menne, 2006: An approach for assessing human health vulnerability and public health interventions to adapt to climate change. *Environmental Health Perspectives* **114**:1930–1934.

ECA (Economics of adaptation), 2009: *Shaping climate-resilient development: a framework for decision-making,* 164 p.

EEA (European Environment Agency), 2006: *Vulnerability and adaptation to climate change in Europe.* EEA Technical report No 7/2005, 79 pp.

EEA (European Environment Agency), 2005: *EEA core set of indicators – Guide*. EEA Technical report No. 1/2005, Luxembourg, 38 pp.

EEA (European Environment Agency), 2004: Impacts of Europe's changing climate: An indicator-based assessment. EEA report No 2/2004, EEA, Copenhagen, 101 pp.

Eggenberger, M. and M.R. Partidário, 2000: Development of a framework to assist the integration of environmental, social and economic issues in spatial planning. *Impact Assessment and Project Appraisal* **18(3)**:201–207.

Egmond, C. and K. Lulofs, 2005: One size fits all? Policy instruments should fit the segments of target groups. In: Attali, S. & K. Tillerson (eds.): *Energy Savings: What Works & Who Delivers? eceee 2005 Summer Study Proceedings.* eceee secretariat, Stockholm, Sweden, pp. 735–743.

Egmond, C., R. Jonkers, and G. Kok, 2005: A strategy to encourage housing associations to invest in energy conservation. *Energy Policy* **33(18)**: 2374-2384. doi:10.1016/j.enpol.2004.05.007.

Elsner, W., 2005: Regional Industries and Environmental Impacts. Long-run Regional Economic Effects of Climate Change: The Case of the Coastal and Estuary Zone of the German Northwest. *Journal of Environmental Planning and Management* **48(5)**:665–690.

Emmelin, L., 1998: Evaluating environmental impact assessment systems. Part 1: Theoretical and methodological considerations. *Scandinavian Housing and Planning Research* **15**:129–148.

Emrealp, S., 200?: Localizing Sustainable Development in Central and Eastern Europe. In*: Development Policy Journal. Special issue: Capacity for sustainable development.* UNDP, pp. 109–133.

Engels, A., 2005: The Science-Policy Interface. *The Integrated Assessment Journal: Bridging Sciences & Policy* **5(1)**:7–26.

Enserink, B., 2000: A quick scan for infrastructure planning: screening alternatives through interactive stakeholder analysis. *Impact Assessment and Project Appraisal* **18(1)**:15–22.

ENVSEC, 2007: *Environment and Security: Transforming risks into cooperation. The case of Eastern Europe.* The Environment and Security initiative (ENVSEC) publications*,* 97 pp.

Eriksen, S.H. and P.M. Kelly, 2007: Developing credible vulnerability indicators for climate adaptation policy assessment. *Mitigation and Adaptation Strategies for Global Change* **12**:495–524. DOI: 10.1007/s11027-006-3460-6.

European Commission (EC), 2007: *Limiting Global Climate Change to 2 degrees Celsius. The way ahead for 2020 and beyond.* COM(2007) 2 final.

European Commission (EC), 2002: *Project Cycle Management Handbook*, Version 2.0. EuropeAid Co-operation Office, General Affairs Evaluation. Helsinki, Finland, 105 pp.

European Commision (EC), nd: *Communication from the Commission to the Council and the European Parliament: Climate change in the context of development cooperation.* Available at: http://europa.eu/scadplus/leg/en/lvb/r12542.htm

European Commission, 1997: European Commission Council directive 97/11/EC of 3 March 1997 amending directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment. *Official journal of the European communities* **L73**:5–15.

Evans, B., M. Joas, S. Sundback and K. Theobald, 2006: Governing Local Sustainability. *Journal of Environmental Planning and Management* **49(6)**:849–867.

Eyckmans, J. and M. Finus, 2007: Measures to enhance the success of global climate treaties. *Int Environ Agreements* **7**:73–97. DOI 10.1007/s10784-006-9030-2.

Fankhauser, S., F. Sehlleier, and N. Stern, 2008: Climate change, innovation and jobs. *Climate Policy* **8**:421–429. doi:10.3763/cpol.2008.0513.

Few, R., K. Brown and E. Tompkins, 2007: Public participation and climate change adaptation: avoiding the illusion of inclusion. *Climate policy* **7**:46–59.

Figge, F. & T. Hahn, 2004: Value-oriented Impact Assessment: The Economics of a New Approach to Impact Assessment *Journal of Environmental Planning and Management* **47(6)**:921–941.

Fischer, C., 2003: Beyond households: discovering the collective consumer. In: Attali, S., E. Métreau, M. Prône, K. Tillerson (eds.), *Time to turn down energy demands. eceee 2003 Summer Study Proceedings,* eceee Secretariat, Stockholm*,* pp. 1135–1146.

Folke, C., 2006: Resilience: The emergence of a perspective for social–ecological systems analyses. *Global Environmental Change* **16**:253–267.

Ford, J.D., B. Smit and J. Wandel, 2006: Vulnerability to climate change in the Arctic: A case study from Arctic Bay, Canada. *Global Environmental Change* **16**:145–160.

Froyn, C.B., 2005: Decision criteria, scientific uncertainty, and the global warming controversy. *Mitigation and Adaptation Strategies for Global Change* **10**:183–211.

Füssel, H.-M., 2009: Ranking of national-level adaptation options. An editorial comment. *Climatic Change* **95**:47–51. DOI 10.1007/s10584-009-9609-z.

Füssel, H.-M., 2007: Vulnerability: A generally applicable conceptual framework for climate change research. *Global Environmental Change* **17**:155–167. DOI:10.1016/j.gloenvcha.2006.05.002.

Füssel, H.-M. and R.J.T. Klein, 2006: Climate change vulnerability assessments: an evolution of conceptual thinking. *Climatic Change* **75**:301–329.

Gaffin, S.R., C. Rosenzweig, X. Xing, G. Yetman, 2004: Downscaling and geo-spatial griding of socio-economic projections from the IPCC Special Report on Emissions Scenarios (SRES). *Global Environmental Change* **14**:105–123.

Gallopín, G.C., 2006: Linkages between vulnerability, resilience, and adaptive capacity. *Global Environmental Change* **16**:293–303.

George, C., 2007: Sustainable Development and Global Governance. *The Journal of Environment & Development* **16(1)**:102–125.

George, C., 2001: Sustainability appraisal for sustainable development: integrating everything from jobs to climate change. *Impact Assessment and Project Appraisal* **19(2)**:95–106.

George, C., R. Nafti and J. Curran, 2001: Capacity building for trade impact assessment: lessons from the development of environmental impact assessment. *Impact Assessment and Project Appraisal* **19(4)**:311–319.

Giampietro, M., 2002: Complexity and Scales: The Challenge for Integrated Assessment. *Integrated Assessment* **3(2–3)**:247–265.

Gibson, R., 2006a: Sustainability assessment: basic components of a practical approach. *Impact Assessment and Project Appraisal* **24**(3):170–182.

Gibson, R., 2006b: Beyond the pillars: Sustainability assessment as a framework for effective integration of social, economic and ecological considerations in significant decision-making. *Journal of Environmental Assessment Policy and Management* **8(3)**:259–280. DOI:10.1142/S1464333206002517.

Giddings, B., B. Hopwood and G. O'Brien, 2002: Environment, economy and society: Fitting them together into sustainable development. *Sustainable Development* **10**:187–196. DOI: 10.1002/sd.199.

Gil-Alana, L.A., 2008: Time trend estimation with breaks in temperature time series. *Climate Change* **89**:325–337.

Giorgi, F., X. Bi and J. Pal, 2004: Mean interannual and trends in a regional climate change experiment over Europe. II: Climate Change scenarios (2071–2100). *Climate Dynamic* **23**:839–858.

Glantz, M. and Z. Adeel, 2000: Climate Affairs as a next-generation environmental science. *Global Environmental Change* **10**:81–85.

Goklany, I.M., 2007: Integrated strategies to reduce vulnerability and advance adaptation, mitigation, and sustainable development. *Mitigation and Adaptation Strategies for Global Change* **12(5)**:755–786.

Good, P., L. Bärring, C. Giannakopoulos, T. Holt, J. Palutikof, 2006: Non-linear regional relationships between climate extremes and annual mean temperatures in model projections for 1961–2099 over Europe. *Climate Research* **31**:19–34.

Gössling, S. and C.M. Hall, 2006: Uncertainties in predicting tourist flows under scenarios of climate change. *Climatic Change* **79**:163–173. DOI: 10.1007/s10584-006-9081-y.

Green, A.O. and Hunton-Clarke L., 2003: A typology of stakeholder participation for company environmental decision-making. *Business Strategy and the Environment* **12**:292–299. DOI: 10.1002/bse.371.

Groisman P. and A.J. Soja, 2009: Ongoing climatic change in Northern Eurasia: justification for expedient research. *Environmental Research Letters* **4**:045002. DOI:10.1088/1748-9326/4/4/045002.

Groisman, P.Ya. and S.V. Ivanov (Eds.), 2008: *Regional aspects of climate-terrestrial-hydrologic interactions in non-boreal Eastern Europe.* Selected Papers Presented at the Joint Northern Eurasia Earth Science Partnership Initiative (NEESPI) and NATO Advanced Research Workshop, Odessa, Ukraine, 23–28 August 2008.

Grothmann, T. and A. Patt, 2005: Adaptive capacity and human cognition: The process of individual adaptation to climate change. *Global Environmental Change* **15**:199–213.

Gupta, J., 2007: Legal Steps Outside the Climate Convention: Litigation as a Tool to Address Climate Change. *RECIEL* **16(1)**:76–86.

Gupta, J. and M. Grubb (Eds.), 2000: *Climate Change and European Leadership: A Sustainable Role for Europe?* Kluwer Academic Publishers, Dordrecht/Boston/London, 344 pp.

Gupta, J. and R.S.J. Tol, 2003: Why reduce greenhouse gas emissions? Reasons, issue-linkages and dilemmas. In: van Ierland E.C., J. Gupta and M.J. Kok (Eds.): *Issues in international climate policy: theory and policy*, Edward Elgar, Cheltenham, UK, Northampton, MA, US, pp. 17–38.

Gutman, G., 2007: Contribution of the NASA Land-Cover/Land-Use Change Program to the Northern Eurasia Earth Science Partnership Initiative: An overview. *Global and Planetary Change* **56**:235–247.

Gurkov, I., 2002: Innovations and Legacies in Russian Human Resource Management Practices: Surveys of 700 Chief Executive. Post-Communist Economies **14(1)**:137–144.

Hacking, T. and P. Guthrie, 2008: A framework for clarifying the meaning of Triple Bottom-Line, Integrated, and Sustainability Assessment. *Environmental Impact Assessment Review* **28(2–3)**:73–89. DOI:10.1016/j.eiar.2007.03.002.10.1177/1070496504268699.

Ha-Duong, M., R. Swart, L. Bernstein and A. Petersen, 2007: Uncertainty management in the IPCC: Agreeing to disagree. *Global Environmental Change* **17**:8–11.

Haddad, B.M., 2005: Ranking the adaptive capacity of nations to climate change when socio-political goals are explicit. *Global Environmental Change* **15**:165–176.

Hale, T.N. and D.L. Mauzerall, 2004: Thinking Globally and Acting Locally: Can the Johannesburg Partnerships Coordinate Action on Sustainable Development? *Journal of Environment & Development* **13(3)**:220–239. DOI: 10.1177/1070496504268699.

Hall, J., G. Fu, and J. Lawry, 2007: Imprecise probabilities of climate change: aggregation of fuzzy scenarios and model uncertainties. *Climatic Change* **81**:265–281. DOI: 10.1007/s10584-006-9175-6.

Hallegatte, S., 2009: Strategies to adapt to an uncertain climate change. *Global Environmental Change* **19**:240–247.

Halsnæes, K., 2002: A review of the literature on climate change and sustainable development. In: Markandya A. and K. Halsnaes (eds.), 2002: *Climate change and sustainable development: prospects for developing countries.* Earthscan Publications Limited, London-Sterling, VA, pp. 49–72.

Halsnæs, K. and P. Shukla, 2008: Sustainable development as a framework for developing country participation in international climate change policies. *Mitigation Adaptation Strategies for Global Change* **13(2)**:105–130. DOI:10.1007/s11027-006-9079-9.

Halsnæs, K., P. Shukla and A. Gaeg, 2008: Sustainable development and climate change: lessons from country studies. *Climate Policy* **8**:202–219. DOI:10.3763/cpol.2007.0475.

Halsnæes, K. and A. Markandya, 2002: Analytical approaches for decision-making, sustainable development and greenhouse gas emission-reduction policies. In: Markandya A. and K. Halsnaes (eds.), 2002: *Climate change and sustainable development: prospects for developing countries.* Earthscan Publications Limited, London-Sterling, VA, pp. 129–162.

Hamblin, P., 1999: Environmental integration through strategic environmental assessment: Prospects in Europe. *European Environment* **9**:1–9.

Hammitt, J.K., 1999: Evaluation endpoints and climate policy: Atmospheric stabilization, benefit-cost analysis, and near-term greenhouse-gas emissions. *Climatic Change* **41**:447–468.

Hanemann, W.M., 2000: Adaptation and its measurement. *Climatic Change* **45**:571–581.

Hansen, J., M. Sato, R. Ruedy, K. Lo, D.W. Lea and M. Medina-Elizade, 2006: Global temperature change. *PNAS,* **103(39)**:14288–14293. DOI:10.1073/pnas.0606291103.

Hanson, C.E., J.P. Palutikof, A. Dlugolecki and C. Giannakopoulos, 2006: Bridging the gap between science and the stakeholder: the case of climate change research. *Climate Research* **31**:121–133.

Hardi, P. and T. Zdan, 1997: *Assessing Sustainable Development: Principles in Practice*. Winnipeg: International Institute for Sustainable Development.

Hardin, G., 1968: The tragedy of the commons. *Science* **162(3859)**:1243–1248.

Hare, B. and M. Meinshausen, 2006: How much warming are we committed to and how much can be avoided? *Climatic Change* **75**:111–149. DOI:10.1007/s10584-005-9027-9.

Harmelink, M., E. Kanaalweg and S. Joosen, 2005: The theory-based policy evaluation method applied to the ex-post evaluation of climate change policies in the built environment in the Netherlands. In: Attali, S. & K. Tillerson (eds.): *Energy Savings: What Works & Who Delivers? eceee 2005 Summer Study Proceedings.* eceee secretariat, Stockholm, Sweden, pp. 947–956.

Harrison, D. and G. Easton, 2002: Collective action in the face of international environmental regulation. *Business Strategy and the Environment* **11**:143–153. DOI:10.1002/bse.325.

Harvey, L.D.D., 2007: Dangerous anthropogenic interference, dangerous climatic change, and harmful climatic change: non-trivial distinctions with significant policy implications. *Climatic Change* **82**:1–25. DOI:10.1007/s10584-006-9183-6.

Hasselmann, K., 1999: Intertemporal accounting of climate change – harmonizing economic efficiency and climate stewardship. *Climatic Change* **41**:333–350.

Havrylyshyn, O. and T. Wolf, 1999: Determinants of Growth in Transition Countries*. Finance & development* **36(2)**.

Hay, J., R. Warrick, C. Cheatham, T. Manarangi-Trott, J. Konno, and P. Hartley, 2004: *Climate Proofing: A risk-based approach to adaptation.* Manila, ADB.

Heller, P.S. and M**.** Mani**,** 2002: Adapting to Climate Change. *Finance & Development* **39(1).** Accessed 18 January 2010 at *http://www.imf.org/external/pubs/ft/fandd/2002/03/heller.htm*.

Henderson-Sellers, A., 1998: Climate whispers: Media communication about climate change. *Climatic Change* **40**:421–456.

Herring H., 2003: Reducing consumption through communal living. In: Attali, S., E. Métreau, M. Prône, K. Tillerson (eds.), *Time to turn down energy demands. eceee 2003 Summer Study Proceedings,* eceee Secretariat, Stockholm*,* pp. 1073–1078.

Heugens P.P.M.A.R., 2006: Environmental Issue Management: Towards a Multi-Level Theory of Environmental Management Competence, *Business Strategy and the Environment* **15**:363–376. DOI: 10.1002/bse.438.

Hisschemöller, M., R.S.J. Tol and P.Vellinga, 2001: The relevance of participatory approaches in integrated environmental assessment. *Integrated Assessment* **2**:57–72.

Hoeppe, P., and E.N. Gurenko, 2006: Scientific and economic rationales for innovative climate insurance solutions. *Climate Policy* **6**:607–620.

Holz, L., G. Kuczera, and J. Kalma, 2006: Multiple Criteria Decision Making: Facilitating a Learning Environment. *Journal of Environmental Planning and Management* **49(3)**:455–470.

Huber, J., 2008: Pioneer countries and the global diffusion of environmental innovations: Theses from the viewpoint of ecological modernization theory. *Global Environmental Change* **18**:360–367.

Hug, S. and H. Reid, 2004: Mainstreaming adaptation in development. *IDS Bulletin* **35**(3):15–21.

Hulme, M., 2008a: The conquering of climate: discourses of fear and their dissolution. *The Geographical Journal* **174(1)**:5–16.

Hulme, M., 2008b: Climate Refugees: Cause for a New Agreement? *Environment* **50(6)**:50–52.

Hunt, A. and P. Watkiss, 2009: Identification and analysis of options. *In:* Watkiss P., H. Hunt and L. Horrocks, 2009: *Scoping Study for a National Climate Change Risk Assessment and Cost-Benefit Analysis*. Final Report. Metroeconomica, AEA group, and Paul Watkiss Associates, published by UK Defra. pp: 57–72. Accessed at: *http://randd.defra.gov.uk/Document.aspx?Document=GA0208_7996_SCO.pdf*>.

Holman, I.P. and J. Harman, 2008: Preliminary evaluation of the benefits of a participatory regional integrated assessment software. *Climatic Change* **90**:169–187. DOI 10.1007/s10584-008-9455-4.

Ibarrarán, M.E., M. Ruth, S. Ahmad, and M. London, 2009: Climate change and natural disasters: macroeconomic performance and distributional impacts. *Environment, Development and Sustainability* **11**:549–569. DOI:10.1007/s10668-007-9129-9.

IEG (Independent Evaluation Group), 2009: Institutionalizing impact evaluation within the framework of a monitoring and evaluation system. The World Bank Group, Washington, 50 pp.

Inglis, K., 2004: Enlargement and the Environment *Acquis*. *RECIEL* **13(2)**.

IPCC, 2001a: *Climate Change 2001: Synthesis Report. A contribution of Working Groups I, II, and III to the Third Assessment Report of Intergovernmental Panel on Climate Change* [Watson, R.T. and the Core Writing Team (eds.)]. Cambridge University Press, Cambridge, United Kingdom, and New York, NY, USA, 398 pp.

IPCC, 2001b: *Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change*, J.T. Houghton, Y. Ding, D.J. Griggs, M. Noguer, P.J. van der Linden, X.Dai, K.Maskell and C.A. Johnson, Eds., Cambridge University Press, Cambridge, 881 pp.

IPCC, 2001c: *Climate Change 2001: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change*, J.J. McCarthy, O.F. Canziani, N.A. Leary, D.J.Dokken and K.S.White, Eds., Cambridge University Press, Cambridge, 1032 pp.

IPCC, 2004: *16 Years of Scientific Assessment in Support of the Climate Convention.* IPCC Secretariat, Geneva, 13 pp.

IPCC, 2007a: *Climate Change 2007: Synthesis Report*. *Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change,* Core Writing Team, R.K Pachauri and A. Reisinger, Eds., IPCC, Geneva, 102 pp.

IPCC, 2007b: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, ambridge, United Kingdom and New York, NY, USA, 996 pp.

IPCC, 2007c: Summary for Policymakers. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

IPCC, 2007d: *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change,* M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 976 pp.

Izrael, Y.A., 2004: On the concept of dangerous anthropogenic interference with the climate system and capacities of the biosphere. *Meteorology and Hydrology* **4**:30–37 (in Russian).

Izrael, Yu., 1983: *Ecology and Control of the Natural Environment*. Kluwer Ac. Publ., Dordrecht-Boston-London, 420 pp.

Jacques, P., 2006: Downscaling Climate Models and Environmental Policy: From Global to Regional Politics. *Journal of Environmental Planning and Management* **49(2)**:301–307.

Jackson, T., K. Begg and S. Parkinson (eds.), 2001: *Flexibility in climate policy: making the Kyoto mechanisms work.* Earthscan Publications Ltd., London and Sterling, VA, 242 pp.

Jackson, T., K. Begg and S. Parkinson, 2001: Objective of joint implementation: towards a multicriteria evaluation framework. In: Jackson, T., K. Begg and S. Parkinson (Eds.): *Flexibility in climate policy: making the Kyoto mechanisms work.* Earthscan Publications Ltd., London and Sterling, VA, pp. 29–43.

Jacoby, H.D., 2004: Informing climate policy given incommensurable benefits estimates. *Global Environmental Change* **14**:287–297.

Jaeger, C. and P. Shi, 2008: Core science initiative on integrated risk governance. *IHDP Update* **1**:27–28.

Jaeger, C.C., B. Kasemir, S. Stoll-Kleemann, D. Schibli and U. Dahinden, 2000: Climate change and the voice of the public. *Integrated Assessment* **1**:339–349.

Jänicke, M., 2005: Trend-Setters in Environmental Policy: the Character and Role of Pioneer Countries. *European Environment* **15**:129–142. DOI: 10.1002/eet.375.

Janssen, M.A. and E. Ostrom, 2006: Resilience, vulnerability, and adaptation: A cross-cutting theme of the International Human Dimensions Programme on Global Environmental Change. *Global Environmental Change* **16**:237–239.

Janssen, M.A., M.L. Schoon, W. Kee, and K. Börnere, 2006: Scholarly networks on resilience, vulnerability and adaptation within the human dimensions of global environmental change. *Global Environmental Change* **16**:240–252.

Jasináski, P. and C. Ross, 1999: The Use of Policies for Competition in the Promotion of Structural Change in Transforming Economies. *Post-Communist Economies* **11(2)**:193–217.

Jay, S, C. Jones, P. Slinn and C. Wood, 2007: Environmental impact assessment: Retrospect and prospect. *Environmental Impact Assessment Review* **27**:287–300.

Jepma, C.J. and J. Bandsma, 2003: Policies and measures in international climate policy: price vs. quantity. In: van Ierland E.C., J. Gupta and M.J. Kok (Eds.): *Issues in international climate policy: theory and policy*, 2003, Edward Elgar, Cheltenham, UK, Northampton, MA, US, pp. 97–114.

Jerneck, A., Olsson, L., 2008: Adaptation and the poor: development, resilience and transition. *Climate Policy* **8**:170–182. DOI:10.3763/cpol.2007.0434.

Jiliberto, R., 2002: Decisional environment values as the object of analysis for strategic environmental assessment. *Impact Assessment and Project Appraisal* **20(1)**:61–70.

João, E., 2007: A research agenda for data and scale issues in Strategic Environmental Assessment (SEA). *Environmental Impact Assessment Review* **27**:479–491.

Joáo, E, 2002: How scale affects environmental impact assessment. *Environmental Impact Assessment Review* **22**:289–310.

Johansson, B., 2005: Are "efficient" climate policy instruments efficient? In: Attali, S. & K. Tillerson (eds.): *Energy Savings: What Works & Who Delivers? eceee 2005 Summer Study Proceedings*. eceee secretariat, Stockholm, Sweden, pp. 1455–1462.

Johnston, A., J. Hutchison and A. Smith, 2000: Significant environmental impact evaluation: A proposed methodology. *Eco-Management and Auditing* **7**:186–195.

Jones, D. (ed.), 1995: *Environmental Standard Certification Kit*: *How To Achieve BS*7750 *Registration*. GEE: London.

Jones, R.N.: 2000: Managing Uncertainties in Climate Change Projections: Issues for Impact Assessment, *Climatic Change* **45**:403–419.

Jones, S.A., B. Fischhoff and D. Lach, 1999: Evaluating the science-policy interface for climate change research. *Climatic Change* **43**:581–599.

Jörgens, H., 2005: Diffusion and Convergence of Environmental Policies in Europe. *European Environment* **15**:61–62. DOI:10.1002/eet.379.

Jost, G.F. and K. Jacob, 2004: The climate change policy network in Germany, *European Environment* **14**:1–15. DOI:10.1002/eet.337.

Karamanos, P., 2001: Voluntary Environmental Agreements: Evolution and Definition of a New Environmental Policy Approach. *Journal of Environmental Planning and Management* **44(1)**:67–84.

Kasemir, B., U. Dahinden, A.G. Swartling, R. Schüle, D. Tabara and C.C. Jaeger, 2000: Citizens' perspectives on climate change and energy use*. Global Environmental Change* **10**:169–184.

Karstens, S.A.M., P.W.G. Bots and J.H. Slinger, 2007: Spatial boundary choice and the views of different actors. *Environmental Impact Assessment Review* **27**:386–407.

Kates, R.W., 2000: Cautionary tales: Adaptation and the global pure. *Climatic Change* **45**:5–17.

Kates, R.W., T.M. Parris, and A.A. Leiserowitz, 2005: What is sustainable development?: Goals, indicators, values and practice. *Environment: Science and Policy for Sustainable Development* **47(3)**:8–21.

Kates, R.W., W.C. Clark, R. Corell *et al.,* 2001: Sustainability Science. *Science* **27(292)**:641–642.

Kautto, P., 2006: New Instruments – Old Practices? The Implications of Environmental Management Systems and Extended Producer Responsibility for Design for the Environment. *Business Strategy and the Environment* **15**:377–388. DOI:10.1002/bse.454.

Keller, K., G. Yohe and M. Schlesinger, 2008: Managing the risks of climate thresholds: uncertainties and information needs. *Climatic Change* **91**:5–10. DOI:10.1007/s10584-006-9114-6.

Keller, K., M., Hall, S.-R. Kim, D.F. Bradford and M. Oppenheimer, 2005: Avoiding dangerous anthropogenic interference with the climate system. *Climatic Change* **73**:227–238. DOI: 10.1007/s10584-005-0426-8.

Kelly, P.M. and W.N. Adger, 2000: Theory and practice in assessing vulnerability to climate change and facilitating adaptation. *Climatic Change* **47**:325–352.

Kasperson, J.X., R.E. Kasperson, B.L. Turner II, A. Schiller and W.H. Hsiel, 2005: Vulnerability to global environmental change. In: Kasperson, J.X., Kasperson, R.E. (Eds.), *Social Contours of Risk*, vol. II. Earthscan, London, pp. 245–285.

Kasemir, B., U. Dahinden, A.G. Swartling, R. Schüle, D. Tabara and C.C. Jaeger, 2000: Citizens' perspectives on climate change and energy use*. Global Environmental Change* **10**:169–184.

Khagram, S., W.C. Clark, and D.F. Raad. 2003: From the Environment and Human Security to Sustainable Security and Development. *Journal of Human Development* **4(2)**:289–313.

Khandekar, M.L., T.S. Murty and P. Chittibabu. 2005: The Global Warming Debate: A Review of the State of Science. *Pure and Applied Geophysics* **162**:1557–1586. DOI 10.1007/s00024-005-2683-x.

Kim, Y.-G. and K.A. Baumert, 2002: Reducing uncertainty through dual-intensity targets. In: Baumert, K.A., O. Blanchard, S. Llosa and J.F. Perkaus (eds.): *Building on the Kyoto Protocol: Options for Protecting the Climate,* World Resource Institute, pp.109–133.

Kirby, A., 2008: *A UN guide to climate neutrality: Kick to habit.* UNEP, Nairobi, Kenya, 200 pp.

Kirilenko, A.P., J. Alcamo, G.N. Golubev, N.M. Dronin, and M. Endejan, 2004: Modeling the impact of climate changes on agriculture in Russia. *Doklady Academii Nauk Geografia* (Reports of Russian Academy of Sciences, Geography) **396(6)**:819–822.

Kjellén, B., 2004: Pathways to the future: The new diplomacy for sustainable development. *IDS Bulletin* **35(3)**:107–113.

Klees, R., A. Capcelea and A. Barannik , 2002: *Environmental Impact Assessment (EIA) Systems in Europe and Central Asia Countries*, The World Bank, Washington DC.

Klein, R.J.T., S. Huq, F. Denton, T.E. Downing, R.G. Richels, J.B. Robinson, and F.L. Toth, 2007: Inter-relationships between adaptation and mitigation. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 745–777.

Klein, R.J.T., S.E.H. Eriksen, L.O.Næss, A. Hammill, T.M. Tanner, C. Robledo and K.L. O'Brien, 2007a: Portfolio screening to support the mainstreaming of adaptation to climate change into development assistance. *Climatic Change* **84**:23–44.DOI 10.1007/s10584-007-9268-x.

Klein, R.J.T., R.J. Nicholls, and N. Mimura. 1999: Coastal adaptation to climate change: Can the IPCC Technical Guidelines be applied. *Mitigation Adaptation Strategies for Global Change* **4(3–4)**:239–252.

Klein, R.J.T., E.L.F. Schipper and S. Dessai, 2005: Integrating mitigation and adaptation into climate and development policy: three research questions. *Environmental Science and Policy* **8**:579–588.

Kloprogge, P. and J.P. van Der Sluijs, 2006: The inclusion of stakeholder knowledge and perspectives in integrated assessment of climate change. *Climatic Change* **75**:359–389. DOI: 10.1007/s10584-006-0362-2.

Knill, C. and A. Lenschow, 2005: Compliance, Communication and Competition: Patterns of EU Environmental Policy Making and Their Impact on Policy Convergence. *European Environment* **15**:114–128. DOI:10.1002/eet.376.

Knutti, R., G. Abramowitz, M. Collins, V. Eyring, P.J. Gleckler, B. Hewitson, and L. Mearns, 2010: Good Practice Guidance Paper on Assessing and Combining Multi Model Climate Projections. In: *Meeting Report of the Intergovernmental Panel on Climate Change Expert Meeting on Assessing and Combining Multi Model Climate Projections* [Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, and P.M. Midgley (eds.)]. IPCC Working Group I Technical Support Unit, University of Bern, Bern, Switzerland.

Koellner, T., O. Weber, M. Fenche and R. Scholz, 2005: Principles for Sustainability Rating of Investment Funds. *Business Strategy and the Environment* **14**:54–70. DOI: 10.1002/bse.423.

Kok, M., B. Metz, J. Vernagen and S. van Rooijen, 2008: Integrating development and climate policies: national and international benefits. *Climate Policy* **8**:103–118. DOI:10.3763/cpol.2007.0436.

Kolstad, C. and A. Ulph, 2008: Learning and international environmental agreements. *Climatic Change* **89**:125–141. DOI: 10.1007/s10584-008-9399-8.

Kørnøv, L. and W.A.H. Thissen, 2000: Rationality in decision- and policy-making: implications for strategic environmental assessment. *Impact Assessment and Project Appraisal* **18(3)**:191–200.

Kotchen, M.J. and O.R. Young, 2007: Meeting the challenges of the anthropocene: Towards a science of coupled human–biophysical systems. *Global Environmental Change* **17**:149–151.

Kousky, C. and S.H. Schneider, 2003: Global climate policy: will cities lead the way? *Climate Policy* **3**:359–372.

Krayer von Krauss, M.P., W.E. Walker, J.P. van der Sluijs, P. Janssen, M.B.A. van Asselt and J. Rotmans, 2006: Response to "To what extent, and how, might uncertainty be defined" by Norton, Brown, and Mysiak. *The Integrated Assessment Journal (IAJ) Bridging Sciences & Policy* **6(1)**:89–94.

Kværner, J., G. Swensen and L. Erikstad, 2006: Assessing environmental vulnerability in EIA – The content and context of the vulnerability concept in an alternative approach to standard EIA procedure. *Environmental Impact Assessment Review* **26**:511–527.

Kuik, O., R.S.J. Tol and D.J.-E. Grimeaud, 2003: Linkages between the climate change regime and the international trade regime. In: van Ierland E.C., J. Gupta and M.J. Kok (Eds.): *Issues in international climate policy: theory and policy*, 2003, Edward Elgar, Cheltenham, UK, Northampton, MA, US, pp. 201–222.

Kulessa, M.E., S. Bode, S. Oberthür, J. Anderson, R. Walz, W. Schade and C. Doll, 2007: The climate policy of the European Union. *Intereconomics* **42(2)**:64–95.

Lachapelle, P.R. and S.F. McCool, 2005: Exploring the Concept of ''Ownership'' in Natural Resource Planning. *Society and Natural Resources* **18**:279–285. DOI: 10.1080/08941920590908141.

Lahusen, C., 2000: The good government: Cooperative environmental regulation in a comparative perspective. *European Environment* **10**:253–264.

Lamb, P.J., 2002: The climate revolution: A perspective. *Climatic Change* **54**:1–9.

Lamin, M., 2004: Climate change and development: The role of EU development cooperation. *IDS Bulletin* **35**(3):62–65.

Lapin, M. and K. Hlavcova, 2003: *Changes in Summer Type of Flash Floods in the Slovak Carpathians due to Changing Climate*. Proceedings of the International Conference on Alpine Meteorology and MPA2003 meeting, **66**:105–108, Brig, Switzerland, Meteoswiss.

Leary, N., K.B. Averyt, B. Hewitson, J. Marengo and R. Moss, 2007: Crossing Thresholds in Regional Climate Research: Synthesis of the IPCC Expert Meeting on Regional Impacts, Adaptation, Vulnerability, and Mitigation. In: IPCC-TGICA, 2007: *Integrating Analysis of Regional Climate Change and Response Options*. IPCC TGICA Expert Meeting, Denarau Island Nadi, Fiji, 20–22 June 2007, pp. 1–7.

Lee, N., 2006: Bridging the gap between theory and practice in integrated assessment. *Environmental Impact Assessment Review* **26**:57–78.

Leiserowitz, A., 2006: Climate change risk perception and policy preferences: The role of affect, imagery, and values. *Climatic Change* **77**: 45–72. DOI:10.1007/s10584-006-9059-9.

Leiserowitz, A.A., R.W. Kates and T.M. Parris, 2004: Sustainability Values, Attitudes, and Behaviors: A Review of Multi-national and Global Trends. *CID Working Paper No. 113*. Cambridge, MA: Science, Environment and Development Group, Center for International Development, Harvard University.

Lemos, M.C. and B.J. Morehouse, 2005: The co-production of science and policy in integrated climate assessments. *Global Environmental Change* **15**:57–68.

Lemos, M.C., T.J. Finan, R.W. Fox, D.R. Nelson and J. Tucker, 2002: The use of seasonal climate forecasting in policymaking: Lessons from Northeast Brasil. *Climatic Change* **55**:479–507.

Lempert, R., N. Nakicenovic, D. Sarewitz, and M. Schlesinger, 2004: characterizing climate-change uncertainties for decision-makers. *Climatic Change* **65**:1–9.

Lenschow, A., 2002: ‘‘Greening’’ the European Union – are there lessons to be learned for international environmental policy? *Global Environmental Change* **12**:241–245.

Lemos, M.C and B.J. Morehouse, 2005: The co-production of science and policy in integrated climate Assessments. *Global Environmental Change* **15**:57–68.

Lemos, M.C., T.J. Finan, R.W. Fox, D.R. Nelson and J. Tucker, 2002: The use of seasonal climate forecasting in policymaking: Lessons from Northeast Brasil. *Climatic Change* **55**:479–507.

Lemke, P., J. Ren, R.B. Alley, *et al.,* 2007: *Observations: Changes in Snow, Ice and Frozen Ground.* In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen *et al.,* (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Lempert, R. J. and M.E, Schlesinger, 2000: Robust strategies for abating climate change. *Climatic Change* **45**:387–401.

Lempert, R.J., M.E. Schlesinger, S.C. Bankes and N.G. Andronova, 2000: The impact of climate variability on near-term policy choices and the value of information. *Climatic Change* **45**:129–161.

Liefferink, D. and A. Jordan, 2005: An ‘Ever Closer Union’ of National Policy? The Convergence of National Environmental Policy in the European Union. *European Environment* **15**:102–113. DOI:10.1002/eet.377.

Ligeti, E., J. Penney and I. Wieditz, 2007: *Cities Preparing for Climate Change: A Study of Six Urban Regions*, Clean Air Partnership, Toronto, 90 p.

Lim, B. and E. Spanger-Siegfried (Eds.), 2004: *Adaptation Policy Frameworks for Climate Change: Developing Strategies, Policies and Measures.* UNDP, Cambridge University Press, 258 pp.

Lindzen, R.S., 2005: *Is There a Basis for Global Warming Alarm?* Accessed 10/21/2010 at: *http://www.independent.org/publications/publist.asp?pid=3.*

Linnér, B.-O., 2006: Authority Through Synergism: the Roles of Climate Change Linkages. *European Environment* **16**: 278–289. DOI:10.1002/eet.423.

Linnerooth-Bayer, J. and R. Mechler, 2006: Insurance for assisting adaptation to climate change in developing countries: a proposed strategy. *Climate Policy* **6**:621–636.

Litre, G. and S. Mekjian, 2008: *Science-Policy Interaction. IHDPUpdate* **1**:22.

Livny, E., A. Mehendale and A. Vanags, 2006: *Bridging the research policy gaps in developing and transition countries: Analytical lessons and proposal for action.* Global Development Network, 60 pp.

Llewellyn, J., 2007: *The Business of Climate Change: Challenges and Opportunities.* Lehman Brothers, 143 p.

Lockie, S., 2001: SIA in review: setting the agenda for impact assessment in the 21st century. *Impact Assessment and Project Appraisal* **19(4)**:277–287.

Lorenzoni, I. and N.F. Pidgeon, 2006: Public views on climate change: European and USA perspectives. *Climatic Change* **77**: 73–95. DOI: 10.1007/s10584-006-9072-z.

Lorenzoni, I., Lowe T. and N. Pidgeon, 2005: *A strategic assessment of scientific and behavioral perspectives on 'dangerous' climate change.* Tyndall Centre Technical Report No. 28, 80 pp.

Lorenzoni, I., A. Jordan, T. O'Riordan, R. K. Turner and M. Hulme, 2000a: A co-evolutionary approach to climate change impact assessment: Part I. Integrating socio-economic and climate change scenarios. *Global Environmental Change* **10**:57–68.

Lorenzoni, I., A. Jordan, T. O'Riordan, R.K. Turner and M. Hulme, 2000b: A co-evolutionary approach to climate change impact assessment: Part II. A scenario-based case study in East Anglia (UK). *Global Environmental Change* **10**:145–155.

Lövbrand, E., 2004: Climate impacts, vulnerability and resilience – exploring trends in adaptation research. *The ESS Bulletin* **2(2)**:27–32.

Lövbrand, E., J. Stripple and B. Wiman, 2009: Earth System governmentality. Reflections on science in the Anthropocene. *Global Environmental Change* **19**:7–13.

Lowe, T.D. and I. Lorenzoni, 2007: Danger is all around: Eliciting expert perceptions for managing climate change through a mental models approach. *Global Environmental Change* **17**:131–146.

Lubell, M, S. Zahran and A. Vedlitz, 2007: Collective Action and Citizen Responses to Global Warming. *Political Behavior* **29(3)**:391–413. DOI:10.1007/s11109-006-9025-2.

Luers, A.L., 2005. The surface of vulnerability: an analytical framework for examining environmental change. *Global Environmental Change* **15**:214–223.

Luterbacher, J., D. Dietrich, E. Xoplaki, M. Grosjean and H. Wanner, 2004: European Seasonal and Annual Temperature Variability, Trends, and Extremes since 1500. *SCIENCE* **303**:1499–1503.

Lutz, W., 2004: Uncertain Demographic Futures, Human Capital Formation and Their Possible Effects on Vulnerability. In: *IPCC Expert Meeting Report on the Science to Address UNFCCC Article 2 including Key Vulnerabilities*. 8–20 May 2004, pp. 158–163.

Mace, M.J., 2005: Funding for Adaptation to Climate Change: UNFCCC and GEF Developments since COP-7. *RECIEL* **14 (3)**:225–246.

Mackay, K., 2007: How to Build M&E Systems to Support Better Government. The World Bank, Washington, D.C., 157 pp.

Madsen, H., and J.P. Ulhøi, 2001: Integrating environmental and stakeholder management. *Business Strategy and the Environment* **10**:77–88. DOI: 10.1002:bse.279.

Magalhies, A.R., 1998: Planning for sustainable development in the context of global change. *Global Environmental Change* **8(1)**:1–10.

Makhmadaliev, B.U., Novikov, V.V. and Kayumov, A.K. (Eds), 2003: The First National Communication of the Republic of Tajikistan on the UN Framework Convention on Climate Change. Phase 2: Capacity Building in Priority Areas, Dushanbe, Tajik Met Service, 120 pp.

Maltais, A., K. Dow and Å. Persson, 2003: *Integrating Perspectives on Environmental Security.* SEI Risk and Vulnerability Programme Report 2003-01. Stockholm Environmental Institute, Stockholm, Sweden, 30 p. Accessed 25.04.2008 at *http://www.sei.se/risk/integratingperspectives.pdf.*

Manning, M. and M. Petit, 2004: A Concept Paper for the AR4 Cross Cutting Theme: Uncertainties and Risk. In: Manning M., M. Petit, D. Easterling, J. Murphy, A. Patwardhan, H.-H. Rogner, R. Swart, G. Yohe (eds.), 2004: *IPCC Workshop on Describing Scientific Uncertainties in Climate Change to Support Analysis of Risk and of Options.* Workshop report, pp. 119–133.

Manning, M., M. Petit, D. Easterling, J. Murphy, A. Patwardhan, H.-H. Rogner, R. Swart and G. Yohe (eds.), 2004: *IPCC Workshop on Describing Scientific Uncertainties in Climate Change to Support Analysis of Risk and of Options*. Workshop report, 138 pp.

Matkins, J.J. and R.L. Bell, 2007: Awakening the Scientist Inside: Global Climate Change and the Nature of Science in an Elementary Science Methods Course. *Journal of Science Teacher Education* **18**:137–163. DOI:10.1007/s10972-006-9033-4 _c.

Markandya, A. and K. Halsnaes (eds.), 2002: *Climate change and sustainable development: prospects for developing countries.* Earthscan Publications Limited, London-Sterling, VA, 291 pp.

Markandya, A., K. Halsnaes, P. Mason, and A. Olboff, 2002: A conceptual framework for analyzing climate change in the context of sustainable development. In: Markandya A. and K. Halsnaes (eds.), 2002: *Climate change and sustainable development: prospects for developing countries.* Earthscan Publications Limited, London-Sterling, VA, pp.15–48.

Marsden, S. and J. De Mulder, 2005: Strategic Environmental Assessment and Sustainability in Europe – How Bright is the Future? *RECIEL* **14(1)**:50–62.

Marx, S.M., E.U. Weber, B.S. Orlove, A. Leiserowitz, D.H. Krantz, C. Roncoli and J. Phillips, 2007: Communication and mental processes: Experiential and analytic processing of uncertain climate information. *Global Environmental Change* **17**:47–58.

McCarthy, J.J., O.F. Canziani, N.A. Leary, D.J. Dokken and K.S. White, Eds., 2001: *Climate Change 2001: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change.* Cambridge University Press, Cambridge, UK, 1032 pp.

McCormick, J., 2001: *Environmental Policy in the European Union. The European Series*. Palgrave, 347 pp.

McDaniels, T., S. Chang, D. Cole, J. Mikawoz, and H. Longstaff, 2008: Fostering resilience to extreme events within infrastructure systems: Characterizing decision contexts for mitigation and adaptation. *Global Environmental Change* **18**:310–318.

McLeman, R. and B. Smit, 2006: Migration as an adaptation to climate change. *Climatic Change* **76**:31–53. DOI:10.1007/s10584-005-9000-7.

Mee L.D., H.T. Dublin and A.A. Eberhard, 2008: Evaluating the Global Environment Facility: A good will gesture or a serious attempt to deliver global benefits? *Global Environmental Change* **18**:800–810.

Meehl, G.A., T. Karl, D.R. Easterling, S. Changnon, R. Pielke, D. Changnon, J. Evans, P.Y. Groisman, T.T. Knutson, K.E. Kunkel, L.O. Mearns, C. Parmesan, R. Pulwarty, T. Root, R.T. Sylves, P. Whetton and F. Zwiers, 2000a: An introduction to trends in extreme weather and climate projections: observations, socioeconomic impacts and model projections. *Bull Am Meteorol Soc* **81**(3):413–416.

Meehl, G.A., F. Zwiers, J. Evans, T. Knutson, L. Mearns and P. Whetton, 2000b: Trends in extreme weather and climate events: Issues related to modeling extremes in projection of future climate change projections. *Bull Am Meteorol Soc* **81(3)**:427–436

Megdal, L., V. Engle, L. Pakenas, S. Albert, J. Peters and G. Jordan, 2005: Using program logic model analysis to evaluate & better deliver what works. In: Attali, S. & K. Tillerson (eds.): *Energy Savings: What Works & Who Delivers? eceee 2005 Summer Study Proceedings.* eceee secretariat, Stockholm, Sweden, pp. 1045–1054.

Meinke, H., R. Nelson, P. Kokic, R. Stone, R. Selvaraju and W. Baethgen, 2006: Actionable climate knowledge: from analysis to synthesis. *Climate Research* **33**:101–110.

Mendelsonn, R., 2006: The role of markets and governments in helping society adapt to a changing climate. *Climatic Change* **78**:203–215. DOI: 10.1007/s10584-006-9088-4.

Mendelsonn, R., 2000: Efficient adaptation to climate change. *Climatic Change* **45**:583–600.

Menne, B. and F. Matthies, 2009: *Improving public health responses to extreme weather/heat-waves – EuroHEAT. Technical summary.* WHO Regional Office for Europe, 60 pp.

Menne, B., F. Apfel, S. Kovats and F. Racioppi (Eds.), 2008: *Protecting health in Europe from climate change.* WHO, Regional Office for Europe, 52 pp.

Mertensson, A., A. Bjurklund, J. Johansson and J.S. Nilsson, 2005: Energy planning using strategic environmental assessment – exploring new tools in a Swedish municipality. In: Attali, S. & K. Tillerson (eds.): *Energy Savings: What Works & Who Delivers? eceee 2005 Summer Study Proceedings.* eceee secretariat, Stockholm, Sweden, pp. 75–80.

Metz, B., 2000: International equity in climate change policy. *Integrated Assessment* **1**:111–126.

Metz, B. and M. Kok, 2008: Integrating development and climate policies. *Climate Policy* **8**:99–102. DOI:10.3763/cpol.2008.0523.

Metz, B., A. Mol, M. Andersson, M.M. Berk, J.G. van Minnen and W. Tuinstra, 2003: Climate options for long term: possible strategies. In: van Ierland E.C., J. Gupta and M.J. Kok (Eds.): *Issues in international climate policy: theory and policy*, 2003, Edward Elgar, Cheltenham, UK, Northampton, MA, US, pp. 263–284.

Metz, B., M. Berk, M. den Elzen, B. de Vries and D. van Vuuren, 2002: Towards an equitable global climate change regime: compatibility with Article 2 of the Climate Change Convention and the link with sustainable development. *Climate Policy* **2**:211–230.

Metz, B., O. Davidson, J.-W. Martens, S.N.M. van Rooijen and L.V.W. McGrory (eds), 2000: *Methodological and Technological Issues in Technology Transfer*. Cambridge University Press, Cambridge, UK and New York, 466 pp.

Metzger, M.J. and D. Schröter, 2006: Towards a spatially explicit and quantitative vulnerability assessment of environmental change in Europe. *Reg Environ Change,* **6**:201–216 DOI:10.1007/ s10113-006-0020-2.

Meze-Hausken, E., 2008: On the (im-)possibilities of defining human climate thresholds. *Climatic Change* **89**:299–324. DOI:10.1007/s10584-007-9392-7.

Michaelis, L., 2003: Sustainable consumption and greenhouse gas mitigation. *Climate Policy* **3S1**:S135–S146.

Michaelowa, A., 2006: Can insurance deal with negative effects arising from climate policy measures? *Climate Policy* **6**:672–682.

Michaelowa, A. and K. Michaelowa, 2007: Does climate policy promote development? *Climatic Change* **84**:1–4. DOI:10.1007/s10584-007-9266-z.

Michaelowa, A. and K. Michaelowa, 2007a: Climate or development: is ODA diverted from its original purpose? *Climatic Change* **84**:5–21. DOI 10.1007/s10584-007-9270-3.

Millennium Ecosystem Assessment, 2005: *Ecosystems and Human Well-being—Synthesis*. Island Press, Washington, DC. Available at: *http://www.millenniumassessment.org/documents/document.356.aspx.pdf.*

Mills, E., 2004: *Insurance as an Adaptation Strategy for Extreme Weather Events in Developing Countries and Economies in Transition: New Opportunities for Public-Private Partnerships.* Lawrence Berkeley National Laboratory Report No. LBNL-52220. Available at: *http://eetd.lbl.gov/ emills/PUBS/Insurance_Emerging_Markets.html*.

Mintzer, I. and M. Trexler, nd: *Best Practices Guide: Global Climate Change & Development.* USAID/Office of Energy, Environment and Technology, p. 34. Available at: *http://www.iie.org/programs/energy/pdfs/Climate%20Change%20and%20Dev.pdf.*

Mitchell, R.B., W.C. Clark, and D.W. Cash, 2006: Information and influence. In: Mitchell R.B., W.C. Clark, D.W. Cash and N.M. Dickson (eds.). *Global Environmental Assessments: Information and Influence.* Cambridge, MIT Press, pp. 307–339.

Morgan, M.G., M. Kandlikar, J. Risbey and H. Dowlatabadi, 1999: Why conventional tools for policy analysis are often inadequate for problems of global change. *Climatic Change* **41**:271–281.

Morgera, E. and G.M. Durán, 2004: Enlargement and EU Development Policy: An Environmental Perspective. *RECIEL* **13(2)**.

Moser, C., 2008: A new charge: Engaging at the science-practice interface. *IHDP* **1**:18–22.

Moser, S.C., 2006: Talk of the city: engaging urbanites on climate change. *Environmental Research. Letters* **1**, 10 pp. DOI:10.1088/1748-9326/1/1/014006. Online at: *stacks.iop.org/ERL/1/014006*.

Moss, R.H., 2007: Improving information for managing an uncertain future climate. *Global Environmental Change* **17**:4–7.

Moss, R.H., A.L. Brenkert and E.L. Malone, 2001: *Vulnerability to climate change: A Quantitative Approach*. Pacific Northwest National Laboratory (PNNL-SA-33642), Battelle Institute, Washington, DC, 70 pp.

Moxnes, E. and A.K. Saysel, 2009: Misperceptions of global climate change: information policies. *Climatic Change* **93**:15–37. DOI:10.1007/s10584-008-9465-2.

Muir-Leresche, K., 2002: Education, Sustainability and Change Management. In: *Development Policy Journal. Special issue: Capacity for sustainable development.* UNDP, pp. 83–107.

Munasinghe, M., 2003: Climate change and sustainable development linkages: Points of departure from the IPCC TAR. In: Munasinghe M., O. Canziani, O. Davidson, B. Metz, M. Parry, M. Harrison (eds.), 2003: *Integrating Sustainable Development and Climate Change in the IPCC Fourth Assessment Report*. Proceedings of the IPCC Expert Meeting held in Colombo, Sri Lanka, 5–7 March 2003, pp. 44–120.

Mustin, K., W.J. Sutherland and J.A. Gill, 2007: The complexity of predicting climate-induced ecological impacts. *Climate Research* **35**:165–175.

Najam, A., A.A. Rahman, S. Huq and Y. Sokona, 2003: Integrating sustainable development into the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. *Climate Policy* **3S1**:S9–S17.

Nakicenovic, N. and R. Swart (eds.), 2000: *Special Report on Emission Scenarios,* Cambridge University Press, UK, 612 pp.

Naylor, R.L., A.J. Liska, M.B. Burke, W.P. Falcon, J.C. Gaskell, S.D. Rozelle and K.G. Cassman, 2007: Biofuels, food security, and the environment. *Environment* **49(9)**:30–43.

Næss, L.O., I.T. Norland, WM. Lafferty, and C. Aall, 2006: Data and processes linking vulnerability assessment to adaptation decision-making on climate change in Norway. *Global Environmental Change* **16**: 221–233.

NCSP (National Communication Support Programme), 2006: *NCSP Workshop on vulnerability and adaptation to climate change for Europe and the Commonwealth of Independent States*, Tashkent, Uzbekistan, 17–19 October 2006. NCSP, New-York, 28 pp.

Neij, L. and K. Åstrand, 2005: Evaluating energy policy instruments using outcome indicators. In: Attali, S. & K. Tillerson (eds.): *Energy Savings: What Works & Who Delivers? eceee 2005 Summer Study Proceedings.* eceee secretariat, Stockholm, Sweden, pp. 1151–1155.

Newell, P., 2004: Climate change and development: A tale of two crises. *IDS Bulletin* **35(3)**:120–126.

Nicholls, N. and T. Kestin, 1998: Communicating climate. *Climatic Change* **40**:417–420.

Nijkamp, P. and H. Verbruggen, 2003: Global trend and climate change policies. In: van Ierland E.C., J. Gupta and M.J. Kok (Eds.): *Issues in international climate policy: theory and policy*, 2003, Edward Elgar, Cheltenham, UK, Northampton, MA, US, pp. 59–74.

Nisbet, M.C., 2009: Communicating climate change: Why frames matter for public engagement. *Environment* **51(2)**:12–23.

Noorbakhsh, F. and S. Ranjan, 1999: A model for sustainable development: integrating environmental impact assessment and project planning. *Impact Assessment and Project Appraisal* **17(4)**:283–293.

Nooteboom, S., 2000: Environmental assessments of strategic decisions and project decisions: interactions and benefits. *Impact Assessment and Project Appraisal:* **18(2)**:151–160.

Norgard, J.S., 2005: Under-use of body energy and over-use of external energy. In: Attali, S. & K. Tillerson (eds.): *Energy Savings: What Works & Who Delivers? eceee 2005 Summer Study Proceedings.* eceee secretariat, Stockholm, Sweden, pp. 243–252

Norton, J., J. Brown and J. Mysiak, 2006: To what extent, and how, might uncertainty be defined? Comments engendered by "Defining uncertainty: A conceptual basis for uncertainty management in model-based decision support": Walker et al., Integrated Assessment 4:1, 2003, *Integrated Assessment* **6(1)**:83–88.

NRC (National Research Council), 1999: *Our Common Journey: A Transition Toward Sustainability*, Board on Sustainable Development, Eds., National Academy Press, Washington, DC, pp. 21–58.

O'Brien, G., P. O'Keefe, H. Meena, J. Rose and L. Wilson, 2008: Climate adaptation from a poverty perspective. *Climate Policy* **8**:194–201.

O'Brien, K., S. Eriksen, L.P. Nygaard and A. Schjolden, 2007: Why different interpretations of vulnerability matter in climate change discourses. *Climate Policy* **7**:73–88.

O'Brien, K., S. Eriksen, A. Schjolden and L.P. Nygaard, 2004: *What's in a word? Conflicting interpretations of vulnerability in climate change research*. Working Paper 2004:04. CICERO, Oslo, Norway. 16 pp. Available at: *http://www.cicero.uio.no/employees/homepage.aspx?person_id=30&lang=en#RPRTWP.*

O'Brien, K.L. and R.M. Leichenko, 2002: Double exposure: assessing the impacts of climate change within the context of economic globalization. *Global Environmental Change* **10**:221–232.

OECD, 2004: *OECD key environmental indicators*. OECD Publications, Paris, 38 pp.

OECD, 2001: *Strategies for Sustainable Development: Practical Guidance for Development Co-operation.* OECD, Paris, 60 pp.

O'Neill, B.C., 2008: Learning and climate change: an introduction and overview. *Climatic Change* **89**:1–6. DOI: 10.1007/s10584-008-9443-8.

O'Neill, B.C. and W. Sanderson, 2008: Population, uncertainty, and learning in climate change decision analysis. *Climatic Change* **89**:87–123. DOI: 10.1007/s10584-008-9419-8.

O'Neill, B.C., P. Crutzen, A. Grübler, M.H. Duong, K. Keller, C. Kolstad, J. Koomey, A. Lange, M. Obersteiner, M. Oppenheimer, W. Pepper, W. Sanderson, M. Schlesinger, N. Treich, A. Ulph, M. Webster and C. Wilson, 2006: Learning and climate change. *Climate Policy* **6**:585–589.

Oppenheimer, M. and A.Todorov, 2006: Global warming: the psychology of long-term risk. *Climatic Change* **77**:1–6.

Oppenheimer, M. and A. Petsonk, 2005: Article 2 of the UNFCCC: Historical origins, recent interpretations. *Climatic Change* **73**:195–226. DOI: 10.1007/s10584-005-0434-8.

O'Riordan, T. and A. Jordan, 1999: Institutions, climate change and cultural theory: towards a common analytical framework. *Global Environmental Change* **9**:81–93.

Orlove, B., 2009: Glacier retreat: Reviewing the Limits of Human Adaptation to Climate Change. *Environment* **51(3)**:21–34.

Ostrom, E., 2008: Frameworks and theories of environmental change. *Global Environmental Change* **18**:249–252. DOI:10.1016/j.gloenvcha.2008.01.001.

Ovin, R., 2001: The Nature of Institutional Change in Transition. *Post-Communist Economies* **13(2)**:132–146. DOI: 10.1080/14631370120052636.

Pacala, S. and R. Socolow, 2004: Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies. *SCIENCE* **305**:968–972.

Parkinson, S., P. Bailey, K. Begg and T. Jackson, 2001: Accounting for emission reductions and costs: Methodology and case study results. In: *Flexibility in climate policy: making the Kyoto mechanisms work.* Earthscan Publications Ltd., London and Sterling, VA, pp. 111–136.

Parkinson, S., P. Bailey, K. Begg and T. Jackson, 2001: Uncertainty and sensitivity analysis: Methodology and case study results. In: *Flexibility in climate policy: making the Kyoto mechanisms work.* Earthscan Publications Ltd., London and Sterling, VA, pp. 137–161.

Parks, B.C. and J.T. Roberts, 2006: Globalization, Vulnerability to Climate Change, and Perceived Injustice. *Society and Natural Resources* **19**:337–355. DOI: 10.1080/08941920500519255.

Parry, M.L., J.A. Lowe, and C.E. Hanson, 2009: Overshoot, adapt and recover. *Nature* **458**:1102–1103.

Parry, M., J. Lowe and C. Hanson, 2008a: *The consequences of delayed action on climate change*. A discussion paper from the 14th Conference of the Parties in Poznan, Poland, December 2008. Available at: *http://www3.imperial.ac.uk/climatechange.*

Parry, M., J. Palutikof, C. Hanson and J. Lowe, 2008b: Squaring up to reality. *Nature reports climate change* **2**:68–70. DOI:10.1038/climate.2008.50.

Parry, M.L., O.F. Canziani, J.P. Palutikof and Co-authors, 2007b: Technical Summary. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change,* M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 23–78.

Parry, M.L., O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson (Eds.), 2007c: Cross-chapter case study. In: *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge, UK, 843–868.

Parson, E.A., R.W. Corell, E.J. Barron, V. Burkett, A. Janetos, L. Joyce, T.R. Karl, M.C. Maccracken, J. Melillo, M.G. Morgan, D. S. Schimel and T. Wilbanks, 2003: Understanding climatic impacts, vulnerabilities, and adaptation in the United States: Building a capacity for assessment. *Climatic Change* **57**:9–42.

Partidário, M.R., 2007: Scales and associated data – What is enough for SEA needs? *Environmental Impact Assessment Review* **27**:460–478.

Partidário, M.R. and R. Clark, 2000: Introduction. In: M.R. Partidario and R. Clark (Eds.), 2000: *Perspectives on Strategic Environmental Assessment.* CRC-Lewis.

Patrinos, A. and Bamzai, A., 2005: Policy needs robust climate science. *Nature* **438**:285.

Patt, A., 2007: Assessing model-based and conflict-based uncertainty. *Global Environmental Change* **17**:37–46.

Patwardhan, A., S. H. Schneider and S. M. Semenov**,** 2004: Assessing the science to address UNFCCC Article 2. In: *IPCC Expert Meeting Report on the Science to Address UNFCCC Article 2 including Key Vulnerabilities*. Buenos Aires, Argentina, 18–20 May 2004, p. 211–220. Available at: *http://www.ipcc.ch/ipccreports/supporting-material.htm.*

Pejovich, S., 1997: Law, Tradition and the Transition in Eastern Europe. *The Independent Review* **2(2)**:243–254.

Pellegrini, L. and R. Gerlagh, 2006: Corruption, Democracy, and Environmental Policy: An Empirical Contribution to the Debate. *The Journal of Environment & Development* **15(3)**:332–354.

Pelling, M. and C. High, 2005: Understanding adaptation: What can social capital offer assessments of adaptive capacity? *Global Environmental Change* **15**:308–319.

Perch-Nielsen, S.L., M.B. Bättig and D. Imboden, 2008: Exploring the link between climate change and migration. *Climatic Change* **91**:375–393. DOI 10.1007/s10584-008-9416-y.

Pérez, A.A., H.B. Fernandez and R.C. Gatti (eds.), 2010: *Building Resilience to Climate Change: Ecosystem-based adaptation and lessons from the field.* Gland, Switzerland: IUCN, 164 pp.

Peterson, K., 2004: The role and value of strategic environmental assessment in Estonia: stakeholders' perspectives. *Impact Assessment and Project Appraisal* **22** (2):159–165.

Pew Global Attitudes Project, 2007: *Rising Environmental Concern in 47-Nation Survey—Global Unease with Major World Powers.* 47-Nation Pew Global Attitudes Survey, Pew Research Center, Washington, DC, 133 pp.

Pew Center on Global Climate Change, 2006a: *Agenda for climate action.* Pew Center on Global Climate Change, Arlington, VA, 14 pp.

Pew Center on Global climate Change, 2006b: *Climate Change 101: Understanding and Responding to Global Climate Change*. Pew Center, US, 58 pp. Available at: *http://www.pewclimate.org/global-warming-basics/climate_change_101/.*

Pew Center on Global Climate Change, 2005: International climate efforts beyond 2012: Report of the climate dialogue at Pocantico. Pew Center on Global Climate Change, Arlington, VA, 25 pp. Available at: *http://www.pewclimate.org/docUploads/PEW%5FPocantico%5FReport05%2Epdf.*

Philibert, C., 2005: The role of technological development and policies in a post-Kyoto climate regime. *Climate Policy* **5**: 291–308.

Philibert, C. and J. Pershing, 2001: Considering the options: climate targets for all countries. *Climate Policy* **1**:211–227.

Pickvance, C., 2002: Settlement type and local government environmental policy in Hungary: the role of local economic structure and local government resources. *European Environment* **12**:90–104. DOI: 10.1002/eet.285.

Pischke, F. and M. Cashmore, 2006: Decision-oriented environmental assessment: An empirical study of its theory and methods. *Environmental Impact Assessment Review* **26**:643–662.

Pittock, B., 2003: *Climate Change: An Australian Guide to the Science and Potential Impacts.* Australian Greenhouse Office, Commonwealth of Australia, 239 pp.

Pittock, A.B., R.N. Jones and C.D. Mitchell, 2001: Probabilities will help us plan for climate change. *NATURE,* **413(20)**:249.

Polsky, C., R. Neff and B. Yarnal, 2007: Building comparable global change vulnerability assessments: The vulnerability scoping diagram. *Global Environmental Change* **17(3–4)**:472–485. DOI:10.1016/j.gloenvcha.2007.01.005.

Pope, V., F. Carroll, D. Britton and J. Lowe, 2008: *Avoiding dangerous climate change.* UK Met Office Hadley Centre, 22 pp.

Radunsky, K., 2003: Comparison of basic concepts in air quality and climate change management. Presentation at the IPCC Expert Meeting "*Levels of greenhouse gases in the atmosphere preventing* *dangerous anthropogenic interference with climate system*". Discussant Paper. Geneva, 21–22 January 2003, 19 pp.

Raes, F., 2006: Climate Change and Air Pollution – Research and Policy. *Global Change News Letter* **65**:19–21.

REC, 2008: *Handbook on the Implementation of EC Environmental Legislation. Introduction.* Regional Environmental Center for CEE (REC), Budapest, 27 pp.

Redclift, M., 1998: Dances with wolves? Interdisciplinary research on the global environment. *Global Environmental Change* **8(3)**:177–182.

Resilience Alliance, 2010: *Key concept.* Accessed on September 28, 2010 from at: *http://www.resalliance.org/564.php.*

Reilly, J. and D. Schimmelpfennig, 2000: Irreversibility, uncertainty, and learning: portraits of adaptation to long-term climate change. *Climatic Change* **45**:253–278.

Rial, J.A., R.A. Pielke Sr., M. Beniston, M. Claussen, J. Canadell, P. Cox, H. Held, N. de Noblet-Ducoudre, R. Prinn, J.F. Reynolds and J.D. Salas, 2004: Nonlinearities, feedbacks and critical thresholds within the earth's climate system. *Climatic Change* **65**:11–38.

Risbey, J.S., 2008: The new climate discourse: Alarmist or alarming? *Global Environmental Change* **18**:26–37.

Risbey J.S., 2007: Subjective elements in climate policy advice. *Climatic Change* **85**:11–17. DOI: 10.1007/s10584-007-9314-8.

Risbey, J.S., 2006: Some dangers of 'dangerous' climate change. *Climate Policy* **6**:527–536.

Risbey, J.S. and M. Kandlikar, 2007: Expressions of likelihood and confidence in the IPCC uncertainty assessment process. *Climatic Change* **85**:19–31. DOI:10.1007/s10584-007-9315-7.

Risbey, J., M. Kandlikar, H. Dowlatabadi and D. Graetz, 1999: Scale, context and decision-making in agricultural adaptation to climate variability and change. *Mitigation and Adaptation Strategies for Global Change* **4 (2)**:137–165.

Rive, N., A. Torvanger and J.S. Fuglestvedt, 2006: Climate agreements based on responsibility for global warming: Periodic updating, policy choices, and regional costs. *Global Environmental Change* **16**:182–194.

Rivera-Camino, J., 2001: What motivates European firms to adopt environmental management systems? *Eco-Management and Auditing* **8**:134–143. DOI:10.1002/ema.154.

Roberts, J.T., 2008: Commentary: Challenges and opportunities for global environmental governance in the 21st century. *Global Environmental Change* **18**:375–379. DOI:10.1016/j.gloenvcha.2008.07.001.

Robinson P.J., 2001: On the definition of a heat wave. *Journal of Applied Meteorology* **40**:762–775.

Romsdahl, R.J. and C.R. Pyke, 2009: What does decision support mean to the climate change research community? *Climatic Change* **95**:1–10. DOI:10.1007/s10584-008-9538-2.

Rosa, E.A., 2001: Global Climate Change: Background and Sociological Contributions. *Society and Natural Resources,* **14**:491–499.

Rotmans, J., 2006: Tools for Integrated Sustainability Assessment: A two-track approach. *The Integrated Assessment Journal (IAJ)* **6(4)**:35–57.

Runhaar, H. and P.P.J. Driessen, 2007: What makes strategic environmental assessment successful environmental assessment? The role of context in the contribution of SEA to decision-making. *Impact Assessment and Project Appraisal* **25(1)**:2–14. DOI:10.3152/146155107X190613.

Runnalls, D., 2008: Our common inaction: The call for institutional change. *Environment* **50(6)**:8–28.

Ruosteenoja, K., H. Tuomenvirta and K. Jylh, 2007: GCM-based regional temperature and precipitation change estimates for Europe under four SRES scenarios applying a super-ensemble pattern-scaling method. *Climatic Change* **81(1)**:193–208. DOI:10.1007/s10584-006-9222-3.

Sabonis-Helf, T., 2003: Catching air? Climate change policy in Russia, Ukraine and Kazakhstan. *Climate Policy* **3**:159–170.

Sadler, B., 2001a: A Framework Approach to Strategic Environmental Assessment: Aims, Principles and Elements of Good Practice. In: Dusik J. (ed.): *Proceedings of International Workshop on Public Participation and Health Aspects in Strategic Environmental Assessment* (November 23–24, 2000, Szentendre, Hungary). The Regional Environmental Center for CEE, Szentendre, Hungary, pp. 11–24.

Sadler, B., 2001b: Strategic Environmental Assessment: An *Aide Memoire* to Drafting a SEA Protocol to the Espoo Convention. *Ibid,* pp. 25–34.

Samaniego, J. and C. Figueres, 2002: Evolving to a sector-based Clean Development Mechanism, 2002. In: Baumert, K.A., O. Blanchard, S. Llosa and J.F. Perkaus (eds.): *Building on the Kyoto Protocol: Options for Protecting the Climate.* World Resource Institute, pp. 89–108.

Sánchez, L.E. and T. Hacking, 2002: An approach to linking environmental impact assessment and environmental management systems. *Impact Assessment and Project Appraisal* **20(1)**:25–*38.*

Sanden, B.A. and C. Azar, 2005: Near-term technology policies for long-term climate targets—economy wide versus technology specific approaches. *Energy Policy* **33**:1557–1576.

Sandvik, H., 2008: Public concern over global warming correlates negatively with national wealth. *Climatic Change* **90**:333–341. DOI 10.1007/s10584-008-9429-6.

Schaltegger, S., and F. Figge, 2000: Environmental shareholder value: economic success with corporate environmental management. *Eco-Management and Auditing* **7**:29–42.

Schipper, E.L.F., 2006: Conceptual History of Adaptation in the UNFCCC Process *RECIEL* **15(1)**:82–92.

Schlumpf, C., C. Pahl-Wostl, A. Schönborn, C.C. Jaeger and D. Imboden, 2001: *IMPACTS: An Information Tool for Citizens to Assess Impacts of Climate Change from a Regional Perspective. Climatic Change* **51**:199–241.

Schneider, S.H., 2004: Abrupt non-linear climate change, irreversibility and surprise. *Global Environmental Change* **14**: 245–258.

Schneider, S.H., 2004a: UNFCCC Article 2 including key vulnerabilities. In: *IPCC Expert Meeting Report on the Science to Address UNFCCC Article 2 including Key Vulnerabilities*. Buenos Aires, Argentina, 18–20 May 2004, pp. 21–24.

Schneider, S.H., 2002: Can we estimate the likelihood of climatic changes at 2100? *Climatic Change* **52**:441–451.

Schneider, S.H., W.E. Easterling and L.0. Mearns, 2000: Adaptation: sensitivity to natural variability, agent assumption and dynamic climate changes. *Climatic Change* **45**:203–221.

Schneider, S.H., K. Kuntz-Duriseti, and C. Azar, 2000: Costing Nonlinearities, Surprises, and Irreversible Events. *Pacific and Asian Journal of Energy* **10(1)**:81–106.

Schneider, S.H., S. Semenov, A. Patwardhan, I. Burton, C.H.D. Magadza, M. Oppenheimer, A.B. Pittock, A. Rahman, J.B. Smith, A. Suarez and F. Yamin, 2007: Assessing key vulnerabilities and the risk from climate change. *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 779–810.

Schouw, J., 2005: Climate Landscapes® – local and regional policy making for sustainability. In: Attali, S. & K. Tillerson (eds.): *Energy Savings: What Works & Who Delivers? eceee 2005 Summer Study Proceedings.* eceee secretariat, Stockholm, Sweden, pp. 177–181.

Schröter, D., C. Polsky and A.G. Patt, 2005: Assessing vulnerabilities to the effects of global change: an eight step approach. *Mitigation and Adaptation Strategies for Global Change* **10**:573–596.

SEG (Scientific Expert Group on Climate Change), 2007: Confronting Climate Change: Avoiding the Unmanageable and Managing the Unavoidable [Rosina M. Bierbaum, John P. Holdren, Michael C. MacCracken, Richard H. Moss, and Peter H. Raven (eds.)]. Report prepared for the UN Commission on Sustainable Development. Sigma Xi, Research Triangle Park, NC, and the United Nations Foundation, Washington, DC, 144 pp.

Selin, H. and B.-O. Linnér, 2005: *The Quest for Global Sustainability: International Efforts on Linking Environment and Development*. CID Graduate Student and Postdoctoral Fellow Working Paper No. 5. Cambridge, MA: Science, Environment and Development Group, Center for International Development, Harvard University. Available at: *http://www.cid.harvard.edu/cidwp/grad/005.htm.*

Semenov, S.M., 2004: *Greenhouse gases and present climate of the Earth*. Moscow, Publishing Center "Meteorology and Hydrology", 175 pp (in Russian).

Sen, A., 2007: Climate policy as human development. In: *Human Development Report 2007/2008. Fighting climate change: Human solidarity in a divided world* (Special contribution). Palgrave Macmillan, New York, NY, pp. 28–29.

Settle, C., J.F. Shogren and S. Kane, 2007: Assessing mitigation-adaptation scenarios for reducing catastrophic climate risk. *Climatic Change* **83**:443–456. DOI 10.1007/s10584-007-9260-5.

Shabanova, G. and T. Izverscaia, 2004: Sensitivity of Moldova's natural plant communities to climate change, In: *Moldova's climate in XXI century: the projections of changes, impacts, and responses.* Chisinau, Elan Poligraf, pp. 99–151 (In Russian).

Shackley, S. and R. Deanwood, 2003: Constructing social futures for climate-change impacts and response studies: building qualitative and quantitative scenarios with the participation of stakeholders. *Climate Research* **24**:71–90.

Shackley, S. and R. Deanwood, 2002: Stakeholder Perceptions of Climate Change Impacts at the Regional Scale: Implications for the Effectiveness of Regional and Local Responses. *Journal of Environmental Planning and Management* **45(3)**:381–402.

Shalizi, Z. and F. Lecocq, 2009: To Mitigate or to Adapt: Is that the Question? Observations on an Appropriate Response to the Climate Change Challenge to Development Strategies. Accessed 7/12/2009 at: *http://wbro.oxfordjournals.org/cgi/reprint/lkp012v1*.

Sharma, S. and A. Ruud, 2003: On the path t sustainability: Integrating social dimensions into the research and practice of environmental management. *Business Strategy and the Environment* **12**:205–214. DOI:10.1002/bse.366.

Shaw, D. and S. Kidd, 2001: Sustainable development and environmental partnership at the regional scale: the case of sustainability North West. *European Environment* **11**:112–123. DOI:10.1002:eet.255.

Shearlock, C., P. James2 and J. Phillips, 2000: Regional sustainable development: Are the new regional development agencies armed with the information they require? *Sustainable Development* **8**:79–88.

Sheate, W.R., S. Dagg, J. Richardson, R. Aschemann, J. Palerm, and U. Steen, 2003: Integrating the environment into strategic decision-making: conceptualizing policy sea. *European Environment* **13**:1–18. DOI:10.1002/eet.305.

Sheehan, P., 2008: The new global growth path: implications for climate change analysis and policy. *Climatic Change* **91**:211–231. DOI:10.1007/s10584-008-9415-z .

Sheehan, P., R.N. Jones, A. Jolley, B.L. Preston, M. Clarke, P.J. Durack, S.M.N. Islam and P.H. Whetton, 2008: Climate change and the new world economy: Implications for the nature and timing of policy responses. *Global Environmental Change* **18**:380–396. DOI:10.1016/j.gloenvcha.2008.04.008.

Shipworth, D., 2005: Synergies and conflicts on the landscape of domestic energy consumption: beyond metaphor. In: Attali, S. & K. Tillerson (eds.): *Energy Savings: What Works & Who Delivers? eceee 2005 Summer Study Proceedings*. eceee secretariat, Stockholm, Sweden, pp. 1381–1391.

Shwom, R., A. Dan and T. Dietz, 2008: The effects of information and state of residence on climate change policy preferences. *Climatic Change* **90**:343–358. DOI:10.1007/s10584-008-9428-7.

Siebenhüner, B., 2003: The changing role of nation states in international environmental assessments—the case of the IPCC. *Global Environmental Change* **13**:113–123.

Simóes, S., G. Huppes and J. Seixas, 2005: A tangled web: assessing overlaps between energy and environmental policy instruments in place along electricity systems. In: Attali, S. & K. Tillerson (eds.): *Energy Savings: What Works & Who Delivers? eceee 2005 Summer Study Proceedings*. eceee secretariat, Stockholm, Sweden, pp. 125–136.

Slootweg, R., F. Vanclay and M. van Schooten, 2001: Function evaluation as a framework for the integration of social and environmental impact assessment. *Impact Assessment and Project Appraisal* **19(1)**:19–28.

Smit, B. and J. Wandel, 2006: Adaptation, adaptive capacity and vulnerability. *Global Environmental Change* **16**:282–292.

Smit, B., O. Pilifosova, I. Burton, B. Challenger, S. Huq, R.J.T. Klein and G.Yohe, 2001: Adaptation to climate change in the context of sustainable development and equity. *Climate Change 2001: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change*, J.J. McCarthy, O.F. Canziani, N.A. Leary, D.J.Dokken andK.S.White, Eds., CambridgeUniversity Press, Cambridge, 877–912.

Smit, B., I. Burton, R.J.T. Klein and J. Wandel, 2000: An anatomy of adaptation to climate change and variability. *Climatic Change* **45**:223–251.

Smith, J.B., J.M. Vogel and J.E. Cromwell III, 2009: An architecture for government action on adaptation to climate change. An editorial comment. *Climatic Change* **95**:53–61. DOI: 10.1007/s10584-009-9623-1.

Smith, W. and J. Pett, 2005: Energy efficiency refurbishment programmes help, but are the end-users doing their bit? In: Attali, S. & K. Tillerson (eds.): *Energy Savings: What Works & Who Delivers? eceee 2005 Summer Study Proceedings.* eceee secretariat, Stockholm, Sweden, pp. 957–968.

Sokona, Y., 2007: Sustainable Development and Resilience to Climate Stress. In: IPCC-TGICA, 2007: *Integrating Analysis of Regional Climate Change and Response Options*. IPCC TGICA Expert Meeting, Denarau Island Nadi, Fiji, 20–22 June 2007, pp. 209–212.

Solomon, S., D. Qin, M. Manning, R.B. Alley, T. Berntsen, N.L. Bindoff, Z. Chen, A. Chidthaisong, J.M. Gregory, G.C. Hegerl, M. Heimann, B. Hewitson, B.J. Hoskins, F. Joos, J. Jouzel, V. Kattsov, U. Lohmann, T. Matsuno, M. Molina, N. Nicholls, J. Overpeck, G. Raga, V. Ramaswamy, J. Ren, M. Rusticucci, R. Somerville, T.F. Stocker, P. Whetton, R.A. Wood and D. Wratt, 2007: Technical Summary. In: *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Soveroski, M., 2004: EC Enlargement and the Development of European Environmental Policy: Parallel Histories, Divergent Paths? *RECIEL* **13(2).**

Spaargaren, G., 2003: Sustainable Consumption: A Theoretical and Environmental Policy Perspective. *Society and Natural Resources* **16**:687–701. DOI:10.1080/08941920390217429.

Spaargaren, G. and A.P.J. Mol, 2008: Greening global consumption: Redefining politics and authority. *Global Environmental Change* **18**:350–359.

Spangenberg, J.H., 2002: Institutional sustainability indicators: An analysis of the institutions in Agenda 21 and a draft set of indicators for monitoring their effectivity. *Sustainable Development* **10**:103–115. DOI:10.1002/sd.184.

Spanger-Siegfried, E. and B. Dougherty, 2004: *User's Guidebook.* In: Lim B. and E. Spanger-Siegfried E. (Eds.): *Adaptation Policy Frameworks for Climate Change: Developing Strategies, Policies and Measures.* UNDP, Cambridge University Press, pp. 5–28.

Springett, D. and K. Kearins, 2005: Educating for Sustainability: an Imperative for Action. *Business Strategy and the Environment* **14**:143–145. DOI: 10.1002/bse.449.

Steffen, W., 2006: The Anthropocene, global change and sleeping giants: where on Earth are we going? *Carbon Balance and Management* **1**:3. DOI:10.1186/1750-0680-1-3.

Stehr, N. and H. Storch, 2005: Introduction to papers on mitigation and adaptation strategies for climate change: protecting nature from society or protecting society from nature? *Environmental Science & Policy* **8(6)**: 537–540.

Stern Review, 2007: *The Economics of Climate Change: The Stern Review.* Cambridge University Press, Cambridge, 692 pp.

Stern, P.C., 2000: Toward a coherent theory of environmentally significant behavior. *Journal of Social Issues* **56(3)**:407–424.

Stewart, A.E., 2007: Linguistic dimensions of weather and climate perception. *International Journal of Biometeorology* **52**:57–67. DOI 10.1007/s00484-007-0101-z .

Stott, P.A. & J.A. Kettleborough, 2002: Origins and estimates of uncertainty in predictions of twenty-first century temperature rise. *NATURE* **416(18)**:723–726.

Srinivasan, A. *(Ed.),* 2006: *Asian Aspirations for Climate Regime Beyond 2012.* Institute for Global Environmental Strategies, Hayama, Japan.

Srivastava, L. and T. Heller, 2003: *Integrating Sustainable Development and Climate Change in AR4.* Available at: *http://www.ipcc.ch/activity/cct4.pdf.*

Synnestvedt, T., 2001: Debates over environmental information to stakeholders as a policy instrument. *Eco-Management and Auditing* **8**:165–178. DOI:10.1002/ema.155.

Swart, R., L. Bernstein, M. Ha-Duong and A. Petersen, 2009: Agreeing to disagree: uncertainty management in assessing climate change, impacts and responses by the IPCC. *Climatic Change* **92**:1–29. DOI:10.1007/s10584-008-9444-7.

Swart, R. and F. Raes, 2007: Making integration of adaptation and mitigation work: mainstreaming into sustainable development policies? *Climate policy* **7**:288–303.

Swart, R., M. Amann, F. Raers and W. Tuinstra, 2004a: A good climate for clean air: linkages between climate change and air pollutants. *Climatic Change* **66**:263–269.

Swart, R.J, P. Raskin and J. Robinson, 2004: The problem of the future: sustainability science and scenario analysis. *Global Environmental Change* **14**:137–146.
Swart, R., J. Robinson and S. Cohen, 2003: Climate change and sustainable development: expanding the options. *Climate Policy* **3S1**:S19–S40.
Szarka, J., 2006: From inadvertent to reluctant pioneer? Climate strategies and policy style in France. *Climate Policy* **5**:627–638.
Tapiador, F.J. and E. Sánchez, 2008: Changes in the European Precipitation Climatologies as Derived by an Ensemble of Regional Models. *Journal of Climate* **21**:2540–2557. DOI:10.1175/2007JCLI1867.1.
Taylor, T., 2002: Sustainability in climate mitigation: Integrating equity into project analysis. In: van Ierland E.C., J. Gupta and M.J. Kok (Eds.): *Issues in international climate policy: theory and policy*, Edward Elgar, Cheltenham, UK, Northampton, MA, US, pp. 163–201.
Tews, K., 2005: The Diffusion of Environmental Policy Innovations: Cornerstones of an Analytical Framework. *European Environment* **15**:63–79. DOI: 10.1002/eet.378.
The Johannesburg Declaration on Sustainable Development, 4 September 2002. Available at: *http://www.un.org/esa/sustdev/documents/WSSD_POI_PD/English/POI_PD.htm*
The World Bank, 1996: *From Plan to Market. World Development Report* 1996. New York, Oxford University Press, 241 pp.
Thérivel, R. and B. Ross, 2007: Cumulative effects assessment: Does scale matter? *Environmental Impact Assessment Review* **27**:365–385.
Thérivel, R. and P. Minas, 2002: Ensuring effective sustainability appraisal. *Impact Assessment and Project Appraisal* **20 (2)**:81–91.
Thompson, A., P. Robbins, B. Sohngen, J. Arvai and T. Koontz, 2006: Economy, politics and institutions: from adaptation to adaptive management in climate change. *Climatic Change* **78**:1–5.
Tol, R.S.J., 1999: Safe policies in an uncertain climate: an application of *FUND. Global Environmental Change* **9**:221–232.
Tol, R.S.J., 2005: Adaptation and mitigation: trade-offs in substance and methods. *Environmental Science & Policy* **8(6)**:572–578.
Tol, R.S.J. and G.W. Yohe, 2007: The weakest link hypothesis for adaptive capacity: An empirical test. *Global Environmental Change* **17**:218–227.
Tol, R.S.J. and G.W. Yohe, 2007a: Infinite uncertainty, forgotten feedbacks, and cost-benefit analysis of climate policy. *Climatic Change* **83**:429–442. DOI 10.1007/s10584-007-9258-z.
Tol, R.S.J. and R. Verheyend, 2004: State responsibility and compensation for climate change damages—a legal and economic assessment. *Energy Policy* **32**:1109–1130.
Tol, R.S.J., T.E. Downing, O.J. Kuik and J.B. Smith, 2004: Distributional aspects of climate change impacts. *Global Environmental Change* **14**:259–272.
Tomassini, L., R. Knutti, G.-K. Plattner, D. P. van Vuuren, T.F. Stocker, R.B. Howarth, and M.E. Borsuk, 2010: Uncertainty and risk in climate projections for the 21st century: comparing mitigation to non-intervention scenarios. *Climatic Change* **103**:399–422. DOI 10.1007/s10584-009-9763-3.
Tong, S., R. Gerber, R. Wolff, and K. Verrall, 2002: Population health, environment and economic development. *Global change & human health* **3(1)**:36–41.
Tonn, B., M. Ehglish and C. Travis, 2000: A Framework for Understanding and Improving Environmental Decision Making. *Journal of Environmental Planning and Management,* **43(2)**:163–183.
Toth, F.L., 2003a: Integrated assessment of climate protection strategies. *Climatic Change* **56**:1–5.
Toth, F.L., 2003b: Climate policy in light of climate science: The ICLIPS project. *Climatic Change* **56**:7–36.
Toth, F.L., 2003c: State of the Art and Future Challenges for Integrated Environmental Assessment. *Integrated Assessment* **4(4)**:250–264.
Toth, F.L. and E. Hizsnyik, 2008: Managing the inconceivable: participatory assessments of impacts and responses to extreme climate change. *Climatic Change* **91**:81–101. DOI 10.1007/s10584-008-9425-x.
Tschakert, P. and L. Olsson, 2005: Post-20l2 climate action in the broad framework of sustainable development policies: the role of the ED. *Climate Policy* **5**:329–348.

Tuinstra, W., L. Hordijkc and C. Kroezea, 2006: Moving boundaries in transboundary air pollution co-production of science and policy under the convention on long range transboundary air pollution. *Global Environmental Change* **16**:349–363.

Turner, G.M., 2008: A comparison of The Limits to Growth with 30 years of reality. *Global Environmental Change* **18**:397–411.

Turner II, B. L., R.E. Kasperson, P.A. Matson, J. J. McCarthy, R.W. Corell, L. Christensen, N. Eckleyg, J.X. Kasperson, Amy Luerse, M.L. Martello, C Polsky, A. Pulsipher, and A. Schiller, 2003: A framework for vulnerability analysis in sustainability science, *PNAS* **100(14)**:8074–8079.

UN, 1987: *Report of the World Commission on Environment and Development: Our common Future*. General Assembly Resolution 42/187, 11 December 1987. Available at: *http://www.un-documents.net/wced-ocf.htm*

UN, 2002: Report of the World Summit on Sustainable Development (Johannesburg, 26 August – 4 September 2002) A/CONF.199/20 (United Nations, New York).

UNCED (United Nations Conference on Environment and Development), 1992: Available at: *http:// www.un.org/geninfo/bp/enviro.html*

UNCTAD (UN Conference on trade and development), 2004: *Development and Globalization: Facts and Figures*. UN, New York and Geneva, 108 pp.

UNDP, 2007a: *Human Development Report 2007/2008. Fighting climate change: Human solidarity in a divided world.* Palgrave Macmillan, New York, NY, 384 pp.

UNDP, 2007b: *Annual Report 2007: Making Globalization Work for All.* The Office of Communications UNDP, New York, NY, 44 pp.

UNDP, 2002: *Development Policy Journal. Special issue: Capacity for sustainable development.* UNDP, 159 pp.

UNDP, 1998: *Human Development Report 1998: Consumption for Human Development.* Available at: *http://hdr.undp.org/reports/global/1998/en/.*

UNDP, 1997: *Global Environment Outlook*. UNDP, New York-Oxford, Oxford University Press, 264 pp.

UNDP, 1994: *Human Development Report: New Dimensions of Human Security*. UNDP, Oxford University Press, New York.

UNDP, nd: *Capacity 2015: Developing capacities for sustainable development.* UNDP, 11 pp.

UNDSD (UN Division for Sustainable Development), 2001: *Indicators of sustainable development: Guidelines and methodologies*. Available at: *http://www.un.org/esa/sustdev/publications/indisd-mg2001.pdf.*

UNEP, 2009: *Environmental Governance.* UNEP, Nairobi, Kenya, 8 pp.

UNEP, 2005: *Environment and Security: Transforming risks into cooperation. Central Asia – Ferghana / Osh / Khujand area,* 56 pp.

UNEP, 2004: *Environment and Security: Transforming risks into cooperation. The Case of the Southern Caucasus,* 34 pp.

UNFCCC, 2009: Potential costs and benefits of adaptation options: A review of existing literature. Technical paper FCCC/TP/2009/2, 80 p. Available at: *http://unfccc.int/resource/docs/2009/tp/02.pdf.*

UNFCCC, 2008: *Investment and Financial Flows to Address Climate Change: An update.* Technical paper FCCC/TP/2008/7.

UNFCCC, 2007a: *Synthesis report on the implementation of the framework for capacity-building in countries with economies in transition*. FCCC/SBI/2007/18. Available at: *http://unfccc.int/resource/ docs/2007/sbi/eng/18.pdf.*

UNFCCC, 2007b: *Information relating to the comprehensive review of the implementation of the framework for capacity-building in countries with economies in transition.* FCCC/SBI/2007/MISC.9. Available at*: http://unfccc.int/resource/docs/2007/sbi/eng/misc09.pdf.*

UNFCCC, 2007c: *Climate change: Impacts, vulnerabilities and adaptation in developing countries*. The Information Services of the UNFCCC secretariat, 64 pp.

UNFCCC, 2005: *Caring for Climate. A guide to the Climate Change Convention and the Kyoto Protocol* (revised 2005 edition). The UNFCCC Climate Change Secretariat, Bonn, Germany, 40 pp.

UNFCCC, 2006: *Technologies for adaptation to climate change*. The UNFCCC Climate Change Secretariat, Bonn, Germany, 39 pp.

UNFCCC**,** 2002: Decision 3/CP.7: Capacity building in countries with economies in transition. In: *FCCC/CP/2001/13/Add.1,* pp. 15–21.

UNFCCC, 2003: *Reporting on climate change: User manual for the guidelines on national communications from non-Annex I Parties*, 38 pp.

United Nations Framework Convention on Climate Change. UNFCCC, New York, 9 May 1992.

Urwin, K. and A. Jordan, 2008: Does public policy support or undermine climate change adaptation? Exploring policy interplay across different scales of governance. *Global Environmental Change* **18**:180–191.

van Aalst, M.K., T. Cannon and I. Burton, 2008: Community level adaptation to climate change: The potential role of participatory community risk assessment *Global Environmental Change* **18**:165–179.

van Asselt, M.B.A. and N. Rijkens-Klomp, 2002: A look in the mirror: reflection on participation in Integrated Assessment from a methodological perspective. *Global Environmental Change* **12**:167–184.

van Asselt, M.B.A. and J. Rotmans, 2002: Uncertainty in integrated modeling : From positivism to pluralism. *Climatic Change* **54**:75–105.

van de Kerkhof, M., 2006: A dialogue approach to enhance learning for sustainability—A Dutch experiment with two participatory methods in the field of climate change. *The Integrated Assessment Journal (IAJ): Bridging Sciences & Policy* **6(4)**:7–34.

van der Lagt, J., 2003: Elaborating an international compliance regime under the Kyoto Protocol. In: van Ierland E.C., J. Gupta and M.J. Kok (Eds.): *Issues in international climate policy: theory and policy*, 2003, Edward Elgar, Cheltenham, UK, Northampton, MA, US, pp. 223–241.

van der Leeuw, S.E., 2008: A new initiative on vulnerability, resilience and adaptation. *IHDP Update* **1**:29–31.

van Elburg, H., 2005: Energy efficiency is EASY: new knowledge to change human behaviour. In: Attali, S. & K. Tillerson (eds.): *Energy Savings: What Works & Who Delivers? eceee 2005 Summer Study Proceedings.* eceee secretariat, Stockholm, Sweden, pp. 1231–1235.

van Ierland, E.C., J. Gupta and M.T.J. Kok, 2003: Options for international climate policies: towards an effective regime. In: van Ierland E.C., J. Gupta and M.J. Kok (Eds.): *Issues in international climate policy: theory and policy*, 2003, Edward Elgar, Cheltenham, UK, Northampton, MA, US, pp. 1–11.

van Minnen, J.G., C. E.C. van Ierland and G.-J. Nabuurs, 2003: Terrestrial carbon sinks and biomass in international climate policies. In: van Ierland E.C., J. Gupta and M.J. Kok (Eds.): *Issues in international climate policy: theory and policy*, 2003, Edward Elgar, Cheltenham, UK, Northampton, MA, US, pp. 137–168.

van Oldenborgh, G.J., 2006: Extraordinarily mild European autumn 2006 due to global warming? *Global Change NewsLetter* **67**:18–20.

van Vuuren, D.P., P.L. Lucas and H. Hilderink, 2007: Downscaling drivers of global environmental change: Enabling use of global SRES scenarios at the national and grid levels. *Global Environmental Change* **17**:114–130.

van Woerkum, C., 2002: Orality in environmental planning. *European Environment* **12**:160–172. DOI: 10.1002/eet.290.

Varone, F., E. Reynard, I. Kissling-Náf and C. Mauch, 2002: Institutional Resource Regimes: The Case of Water Management in Switzerland. *Integrated Assessment* **3(1)**:78–94.

Verheem, R.A.A. and J.A.M.N. Tonk, 2000: Strategic environmental assessment: one concept, multiple forms. *Impact Assessment and Project Appraisal* **18(3)**:177–182.

Vescovi, L., A. Bourque, G. Simonet and A. Musy, 2009: Transfer of climate knowledge via a regional climate-change management body to support vulnerability, impact assessments and adaptation measures. *Climate Research* **40**:163–173. DOI: 10.3354/cr00787.

Vincent, K., 2007: Uncertainty in adaptive capacity and the importance of scale. *Global Environmental Change* **17**:12–24.

Vlachou, A., 2004: Capitalism and ecological sustainability: the shaping of environmental policies. *Review of International Political Economy* **11(5)**:926–952.

Vogel, C. and K. O'Brien, 2006: Who can eat information? Examining the effectiveness of seasonal climate forecasts and regional climate-risk management strategies. *Climate Research* **33**:111–122.

Vogel, C., S.C. Moser, R.E. Kasperson, and G.D. Dabelko, 2007: Linking vulnerability, adaptation, and resilience science to practice: Pathways, players, and partnerships. *Global Environmental Change* **17**:349–364.

von Geibler, J., C. Liedtke, H. Wallbaum and S. Schaller, 2006: Accounting for the Social Dimension of Sustainability: Experiences from the Biotechnology Industry. *Business Strategy and the Environment* **15**:334–346. DOI:10.1002/bse.540.

von Ritter, K. and V. Tsirkunov, 2002: *How well is Environmental Assessment Working in Russia.* World Bank, Washington DC, 85 pp.

Vrolijk, C., 2002: *Climate Change and Power: Economic Instruments for European Electricity*. Earthscan Publications Ltd, London, 310 pp.

Walker, B.: 2006: A Resilience Approach to Integrated Assessment. *The Integrated Assessment Journal (IAJ), Bridging Sciences & Policy* **5(**1):77–97.

Walker, W.E. and V.A.W.J. Marchau, 2003: Dealing With Uncertainty in Policy Analysis and Policymaking. *Integrated Assessment* **4(1)**:1–4.

Walker, W.E., P. Harremoës, J. Rotmans, J.P. van der Sluijs, M.B.A. van Asselt, P. Janssen and M.P.K von Krauss, 2003: Defining Uncertainty: A Conceptual Basis for Uncertainty Management in Model-Based Decision Support. *Integrated Assessment* **4(1)**:5–17.

Walker, W.E., J. Cave and S.A. Rahman, 2001: Adaptive Policies, Policy Analysis, and Policymaking. *European Journal of Operational Research* **128(2)**:282–289.

WCED (World Commission on Environment and Development), 1987: *Our Common Future*. Oxford University Press, Oxford, 398 pp.

Webster, M., 2003: Communicating climate change uncertainty to policy makers and the public. *Climatic Change* **61**:1–8.

Welp, M., A. de la Vega-Leinert, S. Stoll-Kleemann and C.C. Jaeger, 2006: Science-based stakeholder dialogues: Theories and tools. *Global Environmental Change* **16**:170–181.

Weston, R.F., 1995: Sustainable development: To better understand the concept. Roy F. Weston, Inc. "*Sustainable Development"* WESTON WAY. Available at: *http://ces.iisc.ernet.in/hpg/envis/susdoc1106.html*.

Wilbanks, T.J., 2007: Scale and sustainability. *Climate policy* **7**:278–287.

Wilbanks, T.J., 2004: Considering the mix of mitigation and adaptation and approaches to avoid key impacts. In: *IPCC Expert Meeting Report on the Science to Address UNFCCC Article 2 including Key Vulnerabilities*. Buenos Aires, Argentina, 18–20 May 2004, pp. 179–180.

Wilbanks, T.J., 2003: Integrating climate change and sustainable development in a place-based context. *Climate Policy* **3S1**:S147–S154.

Wilbanks, T.J. and R.W. Kates, 1999: Global changes in local places: How scale matters. *Climatic Change* **43**:601–628.

Wilbanks, T.J., P. Leiby, R. Perlack, J.T. Ensminger and S.B. Wright, 2007: Toward an integrated analysis of mitigation and adaptation: some preliminary findings. *Mitigation and Adaptation Strategies for Global Change,* **12(5)**:713–725.

Wilenius, M. and J. Tirkkonen, 1998*:* Building a regime for climate protection: Finland and international climate policy. *Global Environmental Change* **8(4)**:291–708.

Wilkinson, D, 1998: Steps towards integrating the environment into other EU policy sectors. In: O'Riordan T. and H. Voisey (eds): *The Transition to Sustainability: The Politics of Agenda 21 in Europe,* Earthscan, London.

Wilmshurst, T.D. and G.R. Frost, 2001: The role of accounting and the accountant in the environmental management system. *Business Strategy and Environmental Responsibility* **10**:135–147. DOI:10.1002/bse.283.

Wilson, C. and T. McDaniels, 2007: Structured decision-making to link climate change and sustainable development. *Climate Policy* **7**:353–370.

Winkler, H., N. Höhne and M.D. Elzen, 2008: Methods for quantifying the benefits of sustainable develop-ment policies and measures (SD-PAMs). *Climate Policy* **8**:119–134. DOI:10.3763/cpol.2007.0433.

Winkler, H., R. Spalding-Fecher, S. Mwakasonda and O. Davidson, 2002: Sustainable development policies and measure: Starting from development to tackle climate change. In: Baumert, K.A., O.

Blanchard, S. Llosa and J.F. Perkaus (eds.), 2002: *Building on the Kyoto Protocol: Options for Protecting the Climate.* World Resource Institute, pp. 61–87.

Winne, S., A. Haxeltine, W. Kersten and M. Berk, 2005: Towards a long-term European strategy on climate change policy. *Climate Policy* **5**:244–250.

Winslow, M., 2005: Is Democracy Good for the Environment? *Journal of Environmental Planning and Management* **48(5)**:771–783.

Wisner, B., M. Fordham, I. Kelman, B.R. Johnston, D. Simon, A. Lavell, H.G. Brauch, U.O. Spring, G. Wilches-Chaux, M. Moench and D. Weiner, 2007: Climate Change and Human Security. Available at: *http://www.afes-press.de/pdf/ClimateChange_and_HumanSecurity.pdf.*

Wood, G., 2008: Thresholds and criteria for evaluating and communicating impact significance in environmental statements: 'See no evil, hear no evil, speak no evil'? *Environmental Impact Assessment Review* **28(1)**:22–38. DOI:10.1016/j.eiar.2007.03.003. Available online 25.04.2007.

Wood, G. and J. Becker, 2005: Discretionary Judgment in Local Planning Authority Decision Making: Screening Development Proposals for Environmental Impact Assessment. *Journal of Environmental Planning and Management* **48(3)**:349–371.

Word Bank, 2010: *World Development Report 2010: Development and Climate Change.* Word Bank, Washington, DC, 398 pp.

Word Bank Report, 2009: Adapting to climate change in Europe and Central Asia. The World Bank, 133 pp. Accessed 9/9/2010 at: *http://siteresources.worldbank.org/ECAEXT/Resources/258598-1243892418318/ECA_CCA_Full_Report.pdf.*

Yamin, F., 2004: Overview. *IDS Bulletin* **35**(3):1–10.

Yamin, F., 2005: The European Union and future climate policy: is main streaming adaptation a distraction or part of the solution? *Climate Policy* **5**:349–361.

Yang, C.-J. and M. Oppenheimer, 2007: A "Manhattan Project" for climate change? *Climatic Change* **80**:199–204. DOI 10.1007/s10584-006-9202-7.

Yin, Y., S. Cohen and G.H. Huang, 2000: Global climate change and regional sustainable development: the case of Mackenzie Basin in Canada. *Integrated Assessment* **1**:21–36.

Yohe, G., 2004: Some thoughts on perspective. *Global Environmental Change* **14**:283–286.

Yohe, G., 2000: Assessing the role of adaptation in evaluating vulnerability to climate change. *Climatic Change* **46**:371–390.

Yohe, G.W., 1999: The tolerable windows approach: lessons and limitations. *Climatic Change* **41**:283–295.

Yohe, G. and R.S.J. Tol, 2002: Indicators for social and economic coping capacity—moving toward a working definition of adaptive capacity. *Global Environmental Change* **12**:25–40.

Yohe, G.W., R.D. Lasco, Q.K. Ahmad, N.W. Arnell, S.J. Cohen, C. Hope, A.C. Janetos and R.T. Perez, 2007: Perspectives on climate change and sustainability. *Climate Change 2007: Impacts, Adaptation and Vulnerability*. *Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 811–841.

Yohe, G., E.Malone,A. Brenkert,M.E. Schlesinger, H.Meij and X. Xing, 2006: Global distributions of vulnerability to climate change. *Integrated Assessment Journal* **6**:35–44.

Yohe, G., N. Andronova and M. Schlesinger, 2004: To hedge or not against an uncertain climate. *Science* **306**:416–417.

Yohe, G., M. Jacobsen and T. Gapotchenko, 1999: Spanning `not-implausiblea futures to assess relative vulnerability to climate change and climate variability. *Global Environmental Change* **9**:233–249.

Young, O.R., 2002: *The Institutional Dimensions of Environmental Change: Fit, Interplay and Scale*. The MIT Press, Cambridge, MA.

Young, O.R., 2005: Science plan – Institutional dimensions of global environmental change. IHDP Report No. 16 (revised edition), UNDP, Bonn, Germany, 158 pp. Available at: *http://www.ihdp.uni-bonn.de/.*

Young, O.R., F. Berkhout, G.C. Gallopinc, M.A. Janssen, E. Ostrom and S. van der Leeuw: 2006: The globalization of socio-ecological systems: An agenda for scientific research. *Global Environmental Change* **16**:304–316.

Youngman R., J. Schmidt, J. Lee and H. de Coninck, 2007: Evaluating technology transfer in the Clean Development Mechanism and Joint Implementation, *Climate Policy* **7**:488–499.

Zahran, S., E. Kim, X. Chen, M. Lubell, 2007: Ecological Development and Global Climate Change: A Cross-National Study of Kyoto Protocol Ratification. *Society and Natural Resources* **20**:37–55. DOI:10.1080/08941920600981355.

Zahran, S., S.D. Brody, H. Grover, A.Vedlitz, 2006: Climate Change Vulnerability and Policy Support. *Society and Natural Resources* **19**:771–789. DOI:10.1080/08941920600835528.

Zhang, Z.-X., 2007: A report on the international conference on climate policy after Marrakech: Towards global participation. *Mitigation and Adaptation Strategies for Global Change* **12**:203–217. DOI:10.1007/s11027-005-2323-x.

Zhang, Z.-X., 2004: The challenging economic and social issues of climate change: introduction. *Energy Policy* **32**:443–446.

Ziervogel, G., 2007: Adaptation and development futures: looking ahead. In: IPCC-TGICA, 2007: *Integrating Analysis of Regional Climate Change and Response Options*. IPCC TGICA Expert Meeting, Denarau Island Nadi, Fiji, 20–22 June 2007, pp. 255–259.

Zoï Environment Network, 2009: *Climate Change in Central Asia: A visual synthesis.* Geneva, 80 pp.

УДК 502/504(094)

С 71

Коробов Р.М.

Стратегии адаптации к изменению климата в рамках устойчивого менеджмента окружающей среды. – Кишинэу: Eco-TIRAS, 2011 (Типогр. “Elan Poligraf” SRL). – 664 с. – на английском.

ISBN 978-9975-66-233-8

Глобальное потепление является типичным примером системных проблем окружающей среды, которые становятся все более актуальными. Все более осознается также взаимосвязь между изменением климата и устойчивым развитием. Окружающая среда и развитие являются главными «линзами», сквозь которые адаптация к изменению климата обсуждается в этой книге, увязывая три темы в единое целое. Такой подход к проблеме неизбежно ведет к сдвигу от монодисциплинарного подхода с акцентом на естественные науки к междисциплинарным исследованиям с более сильным фокусом на совместное производство знания представителями естественных и социальных наук, политики и общества. Книга представляет всесторонний обзор современный литературы по обсуждаемым проблемам. Некоторые самостоятельные исследования автора и его коллег главным образом используются для иллюстрации различных научных и политических рекомендаций, выраженных в цитируемых источниках. Структура книги следует ее принципиальной идее и целевой аудитории, прежде всего тех, кто работает в области изменения климата в странах с переходной экономикой, и предназначена для специалистов, достаточно знакомых с проблемой противостояния этому явлению.

Рис. – 117, табл. – 78, библ. – 706.

Printing House “Elan Poligraf”
MD-2069, Republica Moldova, Chişinău, str. Mesager, 7
Tel: (+37322) 745800, Fax: (+37322) 746500, www.elan.md

This publication was made possible in part by the Senior Visiting Research Fellowships Program at Central European University

www.ceu.hu

Central European University (CEU) is a graduate institution in the social sciences, the humanities, law and management. It is accredited in both the United States and Hungary, and offers English-language Master's and doctoral programs. Located in the heart of Central Europe Budapest, Hungary CEU has developed a distinct academic and intellectual focus, combining the comparative study of the region's historical, cultural, and social diversity with a global perspective on good governance, sustainable development and social transformation. As part of its educational, research, and civic engagement activities, CEU attaches particular importance to scholarship relevant to public policy. "CEU is a new model for international education, a center for regional and global studies, and a source of intellectual support for building open and democratic societies that respect human rights" (John Shattuck, the CEU president and rector).

Prepress and publishing of the book was financed by the Rosa Luxemburg Foundation

www.rosalux.de

The Rosa Luxemburg Foundation is one of the political foundations in the Federal Republic of Germany and is registered as a non-profit organization. The Foundation's main task is to provide political education, and since 1990 it has been active in keeping with its eponym, representing the main current of democratic socialism with a deliberate international focus. The Foundation considers itself committed to a radical perspective of social processes and developments, and works within the tradition of workers and women's movements as well as anti-fascism and anti-racism. Its work is supported by the dedication and commitment of many volunteers nationwide.

With its work the Foundation promotes a critical analysis of society and fosters networks of emancipatory activists and progressive cultural approaches. It is active internationally in the field of development co-operation and equal dialogue. Just as the other political foundations, the Rosa Luxemburg Foundation seeks to further develop the classical concept of political education. The Foundation has set itself the goal of developing alternative concepts and approaches for processes of transformation which enable a more united and just society. Education and training in politics, analysis, information and policy advice are thereby basic tasks of the national and also international framework of the Foundation's work.

Prepress and publishing of the book was accomplished with the Eco-Tiras extensive support

Eco-TIRAS is an international transboundary environmental association of Dniester River keepers incorporating, as of 1 January 2011, _ NGOs from Ukraine and Moldova with the mission to implement Integrated River Basin Management, using a scientific approach and including wide public participation and stakeholder involvement.

www.eco-tiras.org