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Activities

**OSCE/UNECE Project:
Transboundary Co-operation and Sustainable
Management of the Dniester River**

**TRANSBOUNDARY DIAGNOSTIC
STUDY FOR THE DNIESTER RIVER
BASIN**

November 2005

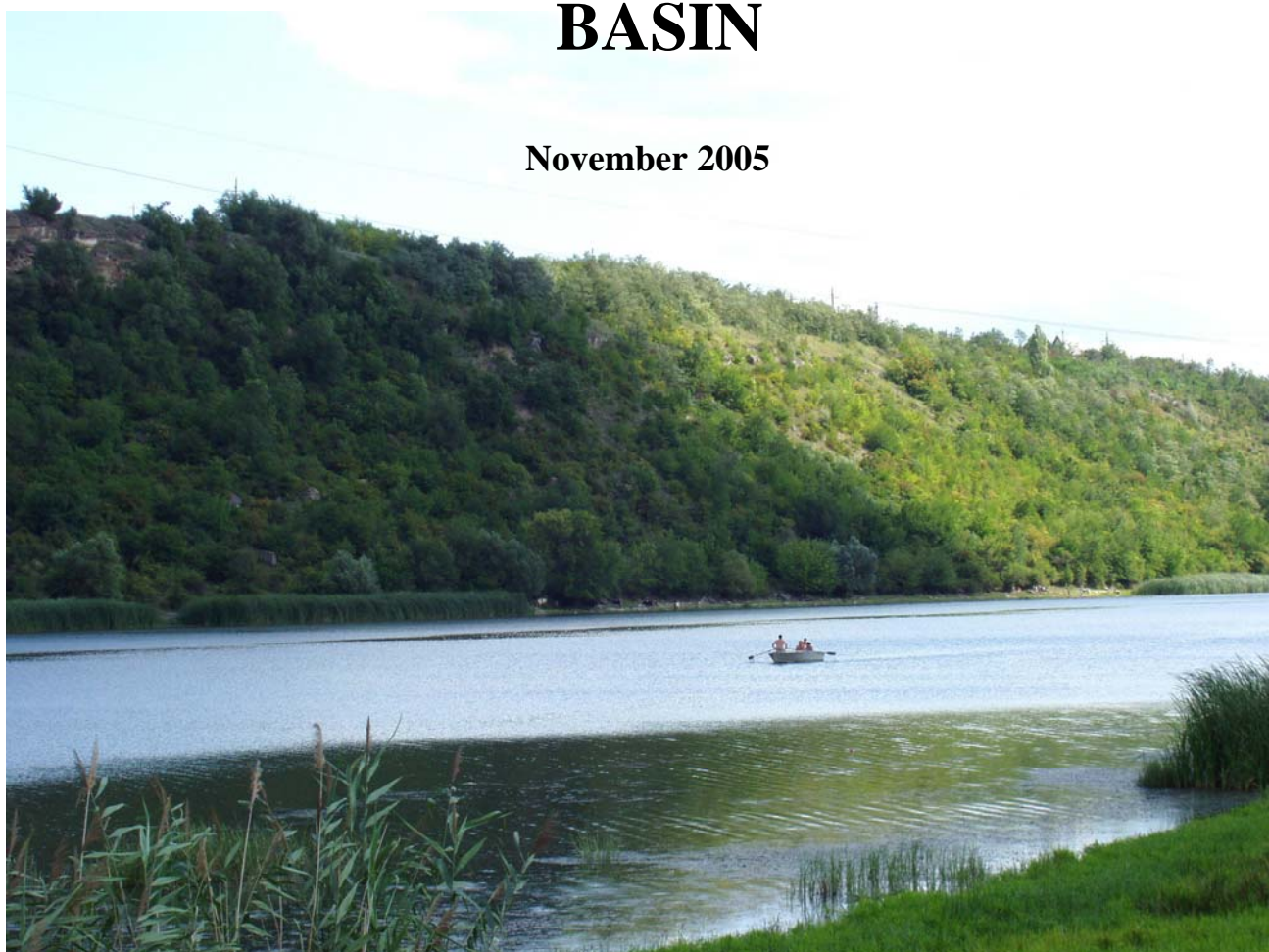


Photo of Valeriu Rusu, NGO "Habitat", Rezina, Moldova

Dear readers,

The Dniester River is facing severe environmental problems due to pollution and impacts associated with the water flow regime. Environmental degradation of the river is made worse by the Trans-Dniestrian conflict, which, amongst others, hinders the use of joint infrastructure for wastewater treatment. The problem is of a transboundary nature, as the water flows from Ukraine to the Republic of Moldova and then back into Ukraine before being discharged into the Black Sea. Given the importance of the Dniester as a source of drinking water for major cities such as Odessa, the current situation threatens not only the environment but also human health.

A Bilateral Agreement between the Government of Ukraine and the Government of the Republic of Moldova on the Joint Use and Protection of Border Waters was signed in 1994, and a Meeting of Plenipotentiaries has been instituted as a cooperation mechanism. Even though this cooperation is working with regard to flood management, the Agreement and its institutional mechanism need to be revised. Important guidelines for future developments include the UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes and (as both Ukraine and the Republic of Moldova aim to become members of the European Union) the EU Water Framework Directive.

In 2004–2006 the project “Transboundary Cooperation and Sustainable Management of the Dniester River” was implemented by UNECE and the Organization for Security and Cooperation in Europe (OSCE) with funding from the Governments of Sweden, Switzerland and the United States. This report is the main result of the project. The report’s main conclusion is that transboundary cooperation between Ukraine and the Republic of Moldova needs to be further developed. Accordingly, Ukrainian and Moldovan authorities signed a Protocol of Understanding within the framework of the project as a basis for future work.

The UNECE/OSCE project was founded on the strong belief that resolving political, economic, environmental and social concerns requires a broad approach taking into account the linkages between environmental and human security. Environmental degradation and mismanagement of scarce natural resources can lead to social tensions and conflicts. Furthermore, continuing conflicts can further harm already fragile natural resources.

During implementation of the project, collaboration not only between states and national organizations but also among international organizations promoted complementarity, with each organization bringing added value to the project. UNECE contributed its expertise in water issues, acquired by hosting the Secretariat of the Water Convention, and OSCE its field presence and security mandate.

Finally, we view this collaboration as a first step in the engagement of our organizations in developing cooperation in the Dniester River basin. We hope that this report will offer readers useful insights into the need for future development of transboundary cooperation between Ukraine and the Republic of Moldova.



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Introduction

This report has been prepared within the framework of the OSCE/UNECE Project “Transboundary Cooperation and Sustainable Management of the Dniester River”. It comprises nine sections that describe the River Basin’s physical and geographical characteristics, its natural resources, past and present human activities, the current ecological status of the Basin and key underlying factors. The report also identifies the priority environmental problems existing in the Basin and its transboundary sections.

The Dniester River (1,380 km) has its source in the Carpathian Mountains in Ukraine, flowing south and east along the territory of Moldova, and re-entering Ukraine near the Black Sea coast. The population of the Dniester Basin is about 8 million people. During the Soviet era, the Dniester Basin was managed as a single system, i.e. on a catchment basis. Since 1991, Moldova and Ukraine have managed those parts of the river basin that lie within their respective territorial jurisdictions. The Dniester is the main source of drinking water in Moldova and is no less important for a significant part of Ukraine, particularly the Odessa Region.

Water pollution and modified river flow regime are major environmental problems in the Dniester Basin. Its poor ecological state is exacerbated by the continuing conflict over the Transdnistrian Region. The transboundary status of existing environmental issues is graphically illustrated by the fact that the river flows into the territory of Moldova from Ukraine, then re-enters Ukraine to drain to the Black Sea south-west of Odessa.

The present Transboundary Diagnostic Study enabled the identification of primary and immediate causes of existing environmental problems. As a result of this study, the Basin country experts have produced an agreed list of recommendations on the joint steps that need to be taken to ensure the environmental rehabilitation of the Dniester Basin.

The joint decision on the formulation and signing the bilateral Dniester Convention was adopted by two joint sessions of the Ukrainian and Moldovan Parliamentary Committees in 1997 and 1999. The draft Convention on the Use and Protection of Biological Resources in the Dniester Basin was sent by the Ministry of Ecology and Natural Resources of Moldova to the Ministry of Environment of Ukraine. The Ukrainian party questioned the need in adopting the Convention and its compatibility with already existing rules governing the management of the Dniester Basin. Since then, the status of the matter remains unchanged.

At this stage, Ukraine’s preference is to use existing legal arrangements as a basis for cooperation with Moldova. The development of the National Programme for Environmental Rehabilitation of the Dniester Basin is underway, and the present project is seen by Ukraine as a significant contribution to this National Programme, which provides a greater focus on the transboundary dimension and application of the modern principles of integrated water resources management.

The present report is a purely technical document, intended to provide an assessment of various water management issues, existing in the Dniester Basin, both at the country level and in the transboundary context. Any mention of or reference to the Transdnistrian Region (Transdnistria) should in no case be interpreted as an attempt to recognize the statehood and/or sovereignty of the Transdnistrian Region on the part of OSCE, UNECE, Republic of Moldova and Ukraine.

1. General Description of the Dniester Basin

The Dniester is the largest river in the Western Ukraine and Moldova, draining to the northern shore of the Black Sea along with the Danube, Dniepro and Southern Buh Rivers. Of its total length of 1,380 km, 925 km (68%) lie within the borders of Ukraine [2, 3], and 652 km in Moldova [4]. The area of the Dniester Basin is 72,100 km² [2-4], with 52,700 km² (or 73.1%) being within Ukraine, and 19,400 km² (26.9%) extending into the territory of Moldova.

1.1. Political and Administrative Setting and Population

The Dniester Basin extends into the territories of 7 Oblasts of Ukraine (Lviv, Ivano-Frankivsk, Chernivtsy, Ternopil, Khmelnytsky, Vinnytsia, and Odessa), covering 13% to 80% of their areas. Within Moldova, the Dniester Basin covers the major part of country's area (59%), with its 19 districts and one territorial unit, located in the left-bank part of the Basin¹, being drained by the Dniester River, fully or partially. There are 62 towns and 95 townships in the Ukrainian part of the Dniester Basin, and 2 municipalities (*Municipias*) and 41 towns within the Moldovan part of the Basin, both on the left and right banks of the river.

The upper and lower reaches of the Dniester River flow within Ukraine over the total length of 629 km, a 225 km river section is shared between Ukraine and Moldova, and 475 km of its length lie within the borders of Moldova [6]. Only a very small upper part of the Strviah River (a left tributary of the Dniester) lies within the territory of Poland.

The total population of the Dniester Basin within Ukraine and Moldova is over 7 million people. Over 5 million people live in Ukraine and 2.74 million people in Moldova. The population density in the Dniester Basin (over 110 people/km²) is higher than the average for the Eastern European countries. The administrative centres of Ukrainian Oblasts (Lviv, Ivano-Frankivsk, Ternopil) and major industrial centres (Drohobych, Boryslav, Stryi, Kalush, Stebnyk) are located in the upper part of the Dniester Basin. Major cities in the middle part of the Dniester Basin include Chisinau, Balti, Soroca, Orhei, Ribnita, Dubossary, Tiraspol, and Bendery. The Dniester is the source of drinking water for an additional 3.5 million people, living outside of the Basin area, i.e. in Chernivtsy and Odessa.

Within the Moldovan part of the Basin, the Dniester River is the source of water for the populations and industries of the following urban centres: Balti, Chisinau, Soroca, Orhei, Ribnita, Dubossary, Tiraspol, Bendery.

1.2. The Economy

Within *Ukraine*, the Dniester River sustains a large multi-sectoral economy, comprising heavily polluting mining activities (potassium salts, sulphur, gas, oil, building materials etc.); chemical industries, oil refineries, machine-building plants, food and textile industries. The most heavily polluting industries are concentrated in the upper part of the Basin (Lviv and Ivano-Frankivsk Oblasts), where the Dniester River collects 70% of its flow.

Four major mining/chemical enterprises, located in the Lviv and Ivano-Frankivsk Oblasts (Sulphur Production Plant "Sera" in Rosdol, Polymineal Plant in Stebnyk, Mining Plant "Podorizhynsky Rudnik", Potassium Plant, and Oriana Plant), significantly impact the environment and water

¹ The territorial unit, lying in the left-bank part of the Dniester Basin, or the Transdnistrian Region, is currently outside the jurisdiction of water and environmental laws of the Republic of Moldova, and is not part of Moldova's water resource management system.

resources in the Dniester Basin, posing a continuous threat of environmental disaster, similar to the one that happened in 1983.

Hydropower is one of the major sectors affecting the ecological status of the Dniester Basin. The Dniester flow in its middle section was dammed to fill a chain of reservoirs, the largest of them being the Dubossary (1954) and Dniestrovsky (1983) reservoirs.

Agriculture in Ukraine and Moldova is dominated by grain farming, sugar beet production, vegetable growing, gardening, and livestock farming, which are considered as the most significant contributors to the deterioration of environment and water resources. Large areas of intensive irrigated agriculture, both in Ukraine and Moldova, and soil erosion contribute significantly to the contamination of water bodies by nutrients and chemical fertilizers.

Moldova's economy is export-oriented and dependent on imported energy resources. The Dniester River sustains about 54% of the national economy of the Republic of Moldova.

In 1990-1999, the Moldovan and Ukrainian economies were hard hit by the dramatic decline in production outputs, financial inflows and capital investments, and the Dniester Basin was no exception. In Moldova, certain signs of growth have started to manifest themselves since 1999.

The Basin's industry comprises the following sectors: sugar production, fruit and vegetable processing, wine industry, meat and milk production/processing, fat-and-oil industry, baking industry, tobacco industry; machine-building, metal fabrication, electric engineering, building material production, chemical industry, textile industry, carpet-making, clothing industry, footwear industry, wood processing and furniture manufacturing.

The transport sector includes motor, railway and river transport.

Key exported products are wine and spirits, fruit and vegetable products, tobacco, sugar, livestock and related products, and textiles and garments.

Key imports are fuel resources, raw materials for machine-building and textile industries, machinery and equipment, and certain food products.

Energy and industry sectors are major contributors to the chemical pollution load in the Basin (combined heat and power plant in Kuchurgan, metallurgical plant in Rybnitsa, cement plants in Ribnita and Rezina, etc. The main sources of organic pollution, particularly in smaller catchments, are intensive surface runoff from agricultural land and livestock farming.

1.3. The Hydrographic Network

The Dniester Basin extends over a length of about 700 km, with the average width of about 100 km and slope of 56 cm/km [7]. It is surrounded by the Carpathian Mountains from the west. From the north-west, north, south-east and west, the Basin is limited by the Sano-Dniester, Rostochie, Dniester-Buh, Dniester-Prut and Dniester-Black Sea water divides.

The Basin's hydrographic network is dominated by over 14,000 small rivers, which are up to 10 km long. The lack of large tributaries and presence of numerous small streams is a characteristic hydrographic feature of the Dniester Basin. The river network densities vary significantly across the Basin, from 1-1.5 km/km² in the upper (Carpathian) part of the Dniester Basin to 0.5-0.7 km/km² and 0.2 km/km² in the left-bank (Podol) and lower parts of the Dniester Basin, respectively. Within Moldova, the river network density is 0.46 km/km².

There are 65 water reservoirs (with a total water surface area of 24,350 hectares and net storage capacity of 2,156 million m³) and 3,447 ponds (with water surface area of 20,800 hectares and capacity of 244.4 million m³). Of that, 49 reservoirs (with a water surface area of 7,960 ha and net storage capacity of 119.83 million m³) and 1,935 ponds (with a water surface area of 20,800 ha and capacity of 12.89 million m³) are located within the catchments of medium to smaller rivers [6].



Dniester's Middle Reach, Rezina District, Moldova.
Photo: Valeriu Rusu, "Habitat"

Based on its flow collection pattern, water regime and physical/geographical characteristics, the Dniester is generally divided into three reaches² :

- Upper Carpathian Dniester, from the river source to the Nizhny Village and the Tlumach River inflow (2 km downstream of the Zolota Lypa River mouth, 296 km);
- Middle Podol Dniester (from the Nizhny Village to Dubossary (715 km);
- Lower Dniester, from the Dubossary Hydropower Dam to the estuary (351 km) [8].

This division is illustrated in Figure 1.1.

It is, however, obvious that the construction of the Dniestrovsky Hydropower Station and Pumped Storage Facility has significantly altered the ecological status of the Basin, and this hydropower complex can be considered as a new boundary in the division of the Dniester river system into reaches.

The *Carpathian Dniester* area comprises a number of medium-height mountain ranges lying parallel to each other, with rather gentle slopes. This section of the Dniester River is characterized by significant variations in riverbed levels and numerous waterfalls that occur every 2-3 km. The river flow velocity in this section is 1 m/s. The river is about 100 m wide and 2.5-3 m deep, flowing between relatively high, 100-150 m, banks [6]. The thickness of sediment deposits is generally very

² The orographic and climatic division of the Dniester Basin also features **three sections**: Carpathian (limited by the Bystritsa River inflow), Volyn/Podol (to the Camenca Village) and Southern sections [8]. There are certain differences between these two approaches.

small, up to 1 metre. Mountain cliffs and slide rocks are mainly represented by grey Sarmatian limestone and sandy/chalk marl with siliceous inclusions. In some areas, pebble blankets extend along the river banks [9].

The Carpathian part of the Dniester Basin has a well-developed and dense (up to 1-1.5 km/km²) hydrographic network [10], which provides about 70% of the total river flow.

The **Podol Dniester** (Middle Dniester) drains the Volyn/Podol part of the Dniester Basin. This part of the Basin is bounded by the Podilsk Upland, which consists of extensive areas of hills on the north. Several left-bank Dniester tributaries are rising in these areas, known as Rostochie and Holohory.

The Dniester River and its tributaries have narrow, canyon-like valleys with steep slopes, rising to 150-180 m above the Dniester's channel level [11]. This river section features a number of pronounced meanders.

The most prominent feature of the Basin's topography within the territory of Moldova is a strip of scenic hills, known as Codru, where some right-bank Dniester tributaries have their sources. The river network density in the Middle Dniester Basin is 0.5-0.7 km/km², with the average river flow velocities ranging between 0.2 m/s to 0.7 m/s. Further downstream, as the Dniester leaves the territory of Moldova, its course runs very close to a water divide, with little or no tributary inflows present along its right bank.

Two major reservoirs, the **Dniestrovsky** and **Dubossary**, have been constructed in the middle reach of the Dniester River. The Dniestrovsky reservoir is one of the largest hydropower reservoirs constructed in Ukraine in the 1980s to regulate the Dniester flow, first on a yearly basis, with subsequent transition to a multi-year flow regulation pattern. The Dniestrovsky hydropower dam is located 678 km from the river mouth, on the border between the Chernivtsy and Vinnytsia Oblasts. The drainage basin area upstream of the reservoir dam is 40,500 km², with a mean annual flow discharge rate of 274 m³/s. The reservoir has a length of 204 km, extending along the narrow, canyon-shape valley with steep banks. The reservoir shape mirrors the contours of the Dniester valley, with a relatively small width (730 m) and area (142 km²) of water surface. The reservoir has a full storage capacity of 3 km³ and effective storage capacity of 2 km³. Its average depth is 21.0 m, with a maximum depth of 55 m [12].

The river valley grows wider as one moves downstream, particularly where the Dniester runs along the Moldovan/Ukrainian border. In this section, the river channel is 100-120 m wide and up to 3-4 m deep. The middle reach of the Dniester is limited by the Dubossary reservoir dam.

The 128 km long Dubossary reservoir is located within the borders of Moldova, between the Camenca Village and Dubossary Town [12]. It has an area of 67.5 km², with a full storage capacity of 0.486 km³ and effective storage capacity of 0.214 km³. Within the reservoir, river flow velocities are in the range of 0.05 m/s to 0.15 m/s, with the average velocity being as low as 0.1 m/s.

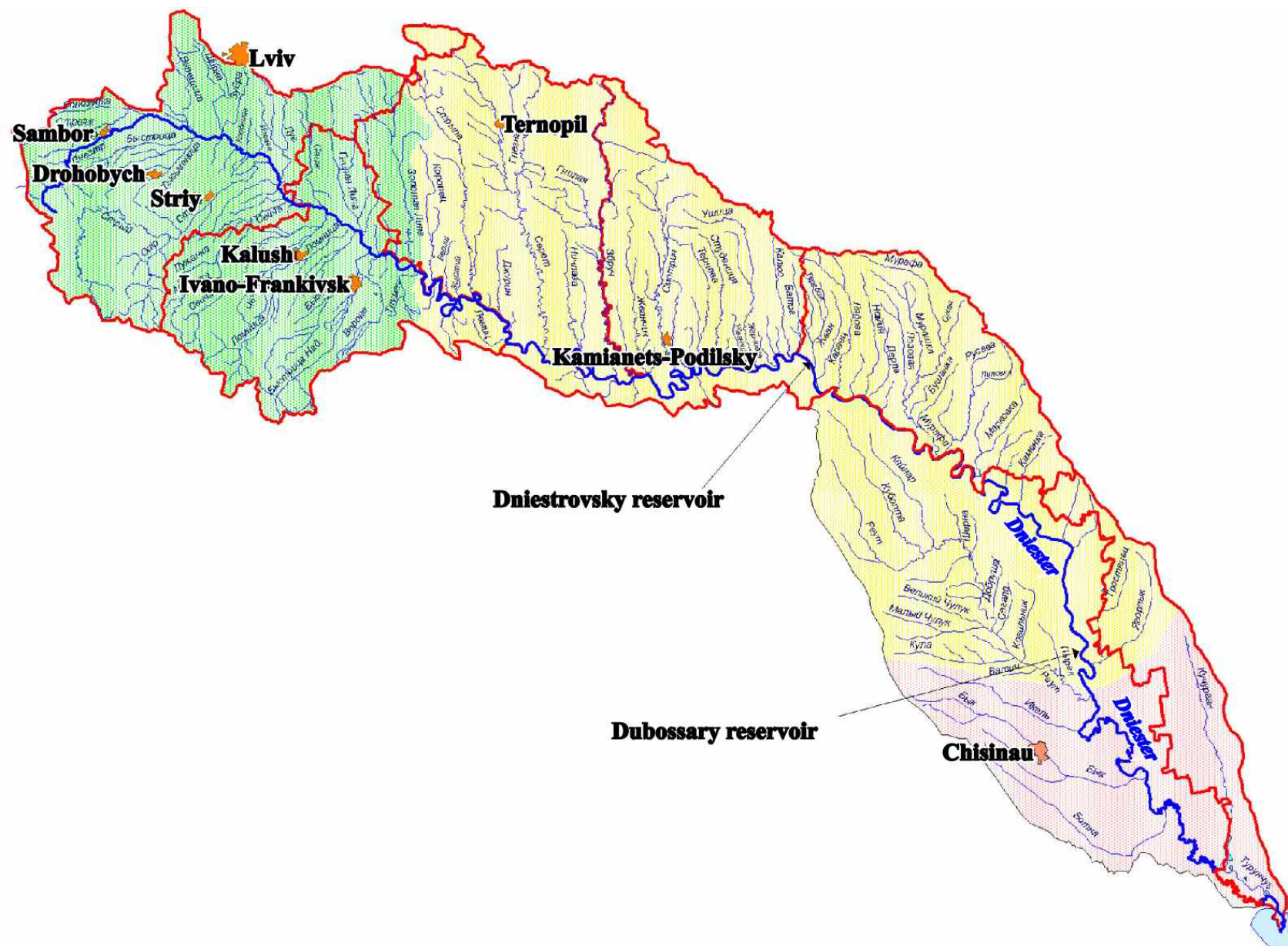


Figure 1.1. The Division of the Dniester Basin into Three Sections: Upper (Carpathian), Middle (Podol) and Lower Dniester

The ***Lower Dniester Basin*** is located within the Black Sea Lowland, consisting of steppe plains. Unlike other sections of the Basin, the topography of this area is one of a gently dipping plain, which has promoted the development of extensive wetland area in the river floodplain, dissected by branches, ancient river beds that are frequently flooded. On the other hand, this character of area topography is considered to be conducive to sedimentation [13].

The hydrographic network of the Lower Dniester Basin is weak (0.2 km/km^2). Flow velocities show an increase, from 0.2-0.4 m/s in the deeper sections to 0.5-0.9 m/s in the sandbar sections. The river depths range from 1.6-2.5 m in the bar sections to 4.8 m in the deeper sections, reaching from 10 m to 16 m in some locations. The width of this section of the Dniester River is in the range 100 m to 200 m. The river valley slopes are asymmetrical: the altitudes of the right slope decrease from 150 m to 50 m, whereas the left slope altitudes fall from 70 m to 30 m in the downstream direction.

Near the Ciobrucci Village in Moldova (148 km from the mouth), the navigable channel of the Dniester River bifurcates to form the Turunchuk, or Novy (New) Dniester, which joins the main Dniester River channel further downstream, near the Belyaevka Village (21 km from the mouth) [14]. The Turunchuk Branch has been separated from the Beloe Lake by a naturally developed sand levee, to flow directly into the Dniester River. The Turunchuk Branch receives about 60% of the total Dniester's flow. It has precipitous banks with clayey soil, covered with pussy-willow woods, willow bushes and wild grass. This area has an extensive system of lakes, which are located along the Dniester and Turunchuk channels, enveloping the Turunchuk Island. The largest of them include the Kuchurgan Liman, Beloe Lake, Putrino Lake, and Tudorovo Lake. These lakes, along with the remaining ancient riverbed, occupy a total area of 39.4 km^2 , and their total volume is 35.2 million m^3 [6]. This area is considered to be very significant for the protection and conservation of wetlands and their biodiversity.

The Hlyboki (Deep) Turunchuk splits from the main Dniester channel downstream of the Mayaki Village, featuring an artificial channel, about 100 m wide and 9-10 m deep. The Dniester drains to the Dniester Estuary via its two branches, the Dniester and Hlyboki Turunchuk.

Dniester Wetlands. The Dniester's mouth section, extending from the northwest towards the southeast, is 57 km long and 4-6 km wide. This area consists of the aquatic/wetland/deltaic and floodplain sectors, and the most valuable wetland systems are extending along the Dniester Estuary [15] (Figure 1.2).

Wetland lakes represent a very important feature in the local landscape. There are about 100 of them, with 10-15 major lakes. Most of wetland lakes are in hydraulic continuity with the Dniester, being connected to its branches via small streams, cutting through the natural levee and running in the reed thickets. The largest of them are 15-20 m wide and up to 1.5 m deep. These streams are major suppliers of flow to the lakes, especially from the Turunchuk Branch, which provides flow to the upper part of the Dniester Wetlands, characterized by the significant variability of water levels, resulting in elevated discharge rates and velocities of incoming flow.

The lakes (and wetlands as a whole) are also fed by water overflowing the natural riparian levee during significant flooding events. The whole wetland area floods in these periods.

Of the whole Dniester Wetland area (240 km^2), the most valuable and undisturbed part, occupying 100 km^2 , is located within the confines of the river branches.

The value of the Dniester Wetland lakes as unique features of local natural landscape cannot be overestimated, though their water surfaces are gradually shrinking due to intensive sediment deposition and overgrowth of aquatic and riparian plants.

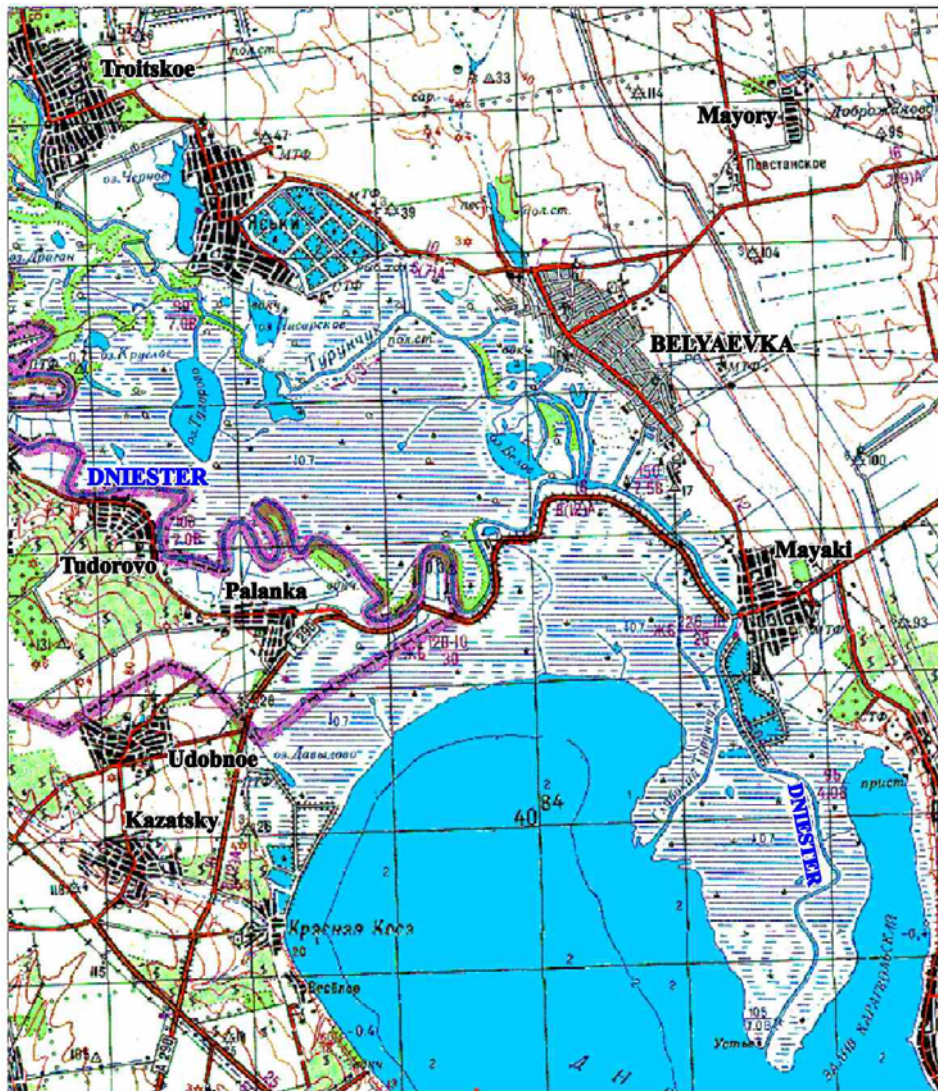


Figure 1.2. Dniester Wetlands

The largest lakes in the Dniester Wetland area are the Putrino, Tudorovo, and Beloe Lakes, occupying 2.2 km², 2.8 km², and 1.3 km², respectively. Available literature sources indicate that their depths used to be rather significant. Currently, the largest water depths of about 2.8 m only remain in the Kryve Lake, which has developed in the ancient river bed [16].

The *Dniester Estuary* is a shallow basin formed in the wider part of the Lower Dniester River valley, extending over 42 km. It has a water surface area of 360 km² (or 408 km² if wetland area is taken into account) [3] and capacity of 0.54 km³ [10]. The Dniester Estuary is the largest freshwater estuary in Ukraine.

The geology and water chemistry of the Dniester Estuary are the reflection of complicated interactions between the Dniester water inflow (70%) and upward intrusion of marine waters (30%). Based on the level of influence, associated with these water inflows, the water area of the Dniester Estuary can be divided into four sections: outer and southern sections, containing saline water (with the salinity level at 9%), with the freshwater being predominant in the central transitional (0.03-5%) and northern sections (0.02-1.2%) [17]. There is a man-made channel, providing a connection between the Tsarehradsky arm (which is a link between the sea and the Dniester Estuary), and the Belhorod-Dniestrovsky, with depths in the range 1.8 to 2.0 m. Salinity levels within the canal can be as high as 17‰, especially during inflows from the sea.

1.4. Climate

There are obvious differences in local climatic characteristics across the Dniester Basin, which reflects the fact that the Dniester drains a long basin, rising in the Carpathian Mountains and draining to the Dniester Estuary on the Black Sea shore.

The climate of Upper and Middle Dniester Basin has been largely shaped by local topography, with the Carpathian Mountains and Volyn Upland playing a significant role in terms of air circulation, mountain-induced frontogenesis, and air mass transformation over the plain areas. The climate of the Basin's mountainous part is characterized by lower temperatures and higher humidity.

The southern areas of the Basin lie within the Black Sea Climatic Sub-Zone, which is part of the Atlantic/Continental Steppe Climatic Region. Winters are usually mild and unstable, with frequent thaws. In springs, the moderately continental air masses gradually transform to tropical ones, with warm and sunny weather settling in May.

Annual air humidity pattern is fully synchronized with the temperature pattern, with maximum humidity levels/temperatures recorded in July, and respective minimums in January.

Annual precipitation also varies significantly across the Basin, from 1,200 mm or more in the Carpathians to 500 mm in the Lower Dniester Basin [18, 19, 20].

Likewise, the snow cover depths are significant in the Carpathians (with the maximum depth of 80 cm typically recorded in early February, and even reaching 1.5 m in some years), decreasing twofold in the Carpathian foothills. In the mouth section, the snow cover is very unstable, being at only about 5 cm [12, 20].

1.5. Geology and Mineral Resources

The Dniester Basin has a very complicated and varied geology, comprising mountain ranges, uplands, lowlands, karst formations, etc. In some areas, the river channel cuts into the rocks of various ages and origins. The lithological composition of river banks is no less diverse, showing outcrops of crystalline basement rocks in various locations, loess deposits, clay and limestone strata.

The geology of the *Carpathian Region* largely comprises sandstone, marl, argillic strata and limestone, with relatively weak Quaternary deposits. The Middle Dniester Basin is founded upon limestone, sandstone and clay deposits. The geological structure of the Lower Dniester Basin is dominated by clays and limestone strata, covered with loess deposits. The downstream section of the river valley consists of alluvial sediments.

The mountainous section of the Dniester Basin is rich in various mineral resources: fossil fuel (oil, gas, condensate, brown coal, peat), chemical minerals (magnesium salt, rock salt, native sulphur), ore minerals (ozocerite; rhodonite, building materials). The most important mineral resources are oil, gas, potassium salt, building materials, raw materials for cement production, limestone, fresh and mineralised groundwater (its sources are located in the Carpathian mountainous/foothill areas). The locations of major mineral resource fields are shown in Figure 1.3.

Production is now declining in the majority of oil and gas fields, being greatly affected by complicated geology and difficult operational conditions.

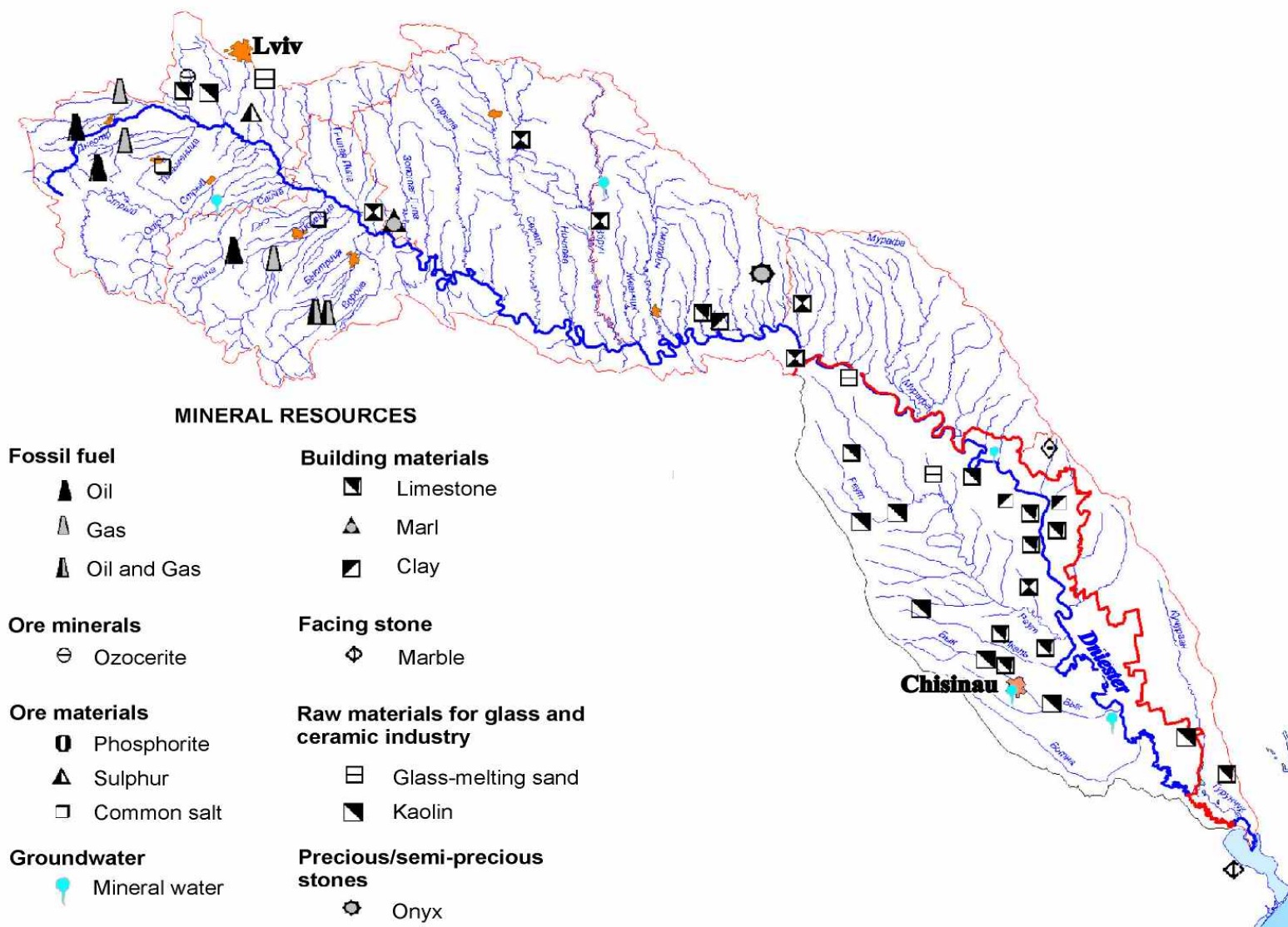


Figure 1.3. Locations of Mineral Resource Deposits in the Dniester Basin

Most of mineral resource deposits, concentrated in the Carpathian Province, are of national significance, particularly the Stary Sambor and Boryslav oil deposits; Zaluzhansky gas deposit; Rasdelsky native sulphur deposit; Boryslav ozocerite deposit; Stebnik and Kalush-Holyn potassium salt deposit; and Morshinsky artesian water source (Figure 1.3).

The ***Trans-Carpathian Area within the Dniester Basin*** (Lviv, Ivano-Frankivsk and, partially, Chernivtsy Oblasts) has a varied base of explored mineral resources, including agro-chemical minerals (potassium salt and phosphorites), carbonate materials for sugar industry and soil treatment, building materials, artesian water (both fresh and mineralised).

The ***Dniester Basin within the Republic of Moldova*** is located in the south-western part of the Russian Platform, which dominates the regional geology. The only exception is a small area to the south, which retains the signs of the ancient buried mountain rock formation of Dobruja, especially its northern slope.

The crystalline basement of platform comprises Archaean and Proterozoic rocks, arranged in blocks due to numerous fractures. Palaeozoic deposits comprise the whole variety of their system elements. Cretaceous deposits are present in the whole area of the Dniester Basin within Moldova, the south-westernmost part being the only exception.

The Republic of Moldova has a number of mineral resource deposits coinciding with the above mentioned formations, most of which contain non-metallic minerals. The Neogene limestone strata are exploited to extract various building materials (wall stone, rough stone and crushed stone, raw materials for cement production).

The varied mineral resource base of the ***Lower Dniester Basin*** comprises non-ore minerals of local significance (sand, silty clay, gravel, limestone, pebble, granite), used in building industry. Other extracted mineral resources include raw materials for production of cement, expanded clay, brick, roof tile, etc. The marble deposit in Belhorod-Dniestrovsky has strategic importance for the national economy.

1.6. Land Uses, Soils and Forest Cover

In the Carpathian Province, soil structure is dominated by the mountain forest rubbly soil, with the soddy podzolic soil covering the Carpathian foothills. The soil pattern of the Podol Upland is different, being dominated by grey forest soil in the upper part of the Basin, with an increasingly wider occurrence of black podzolised soil in the lower parts. Black soils are predominant in the Moldovan part of the Dniester Basin, with the maximum thickness reaching 1 m in the plain areas. In the arid area of the Lower Dniester Basin, soil structure comprises southern black soil and chestnut soil exhibiting signs of elevated salinity levels [21].

About 67% of the ***Dniester Basin area within Ukraine*** is occupied by agriculture, the majority of which is arable farmland (78% vs. Ukraine's average of 66%).

Within the Ukrainian part of the Dniester Basin, average forest coverage is relatively low (14%), and only in the Chernivtsy Oblast do forests occupy about 30% of the total area. (It should be noted that the optimal proportion of forests is at least 30% of the total area.) The Vinnytsa Oblast has the highest proportion of cultivated agricultural land within the whole Dniester Basin.

The total area of forest cover within the Ukrainian part of the Dniester Basin is over 1.2 million ha. Additional 23,400 ha and 21,000 ha are occupied by wind breaks, surrounding agricultural fields, and protective forest plantations, respectively.

It should be noted, however, that the existing forest cover is insufficient and unevenly distributed. In the upper mountainous part of the Dniester Basin, the forest has been severely affected by unsustainable cutting operations and large-scale transformation of forest areas into pasture. The area covered by forests has been halved in the past century as a result of human activities. The conversion of forest land to agricultural land has led to an increased risk of soil erosion and changes in the landscape which in turn have resulted in unstable agrosystems that are not capable of self-regulation. Other major consequences include increased levels of soil contamination and consequent deterioration of surface water quality.

Within the *Moldovan part of the Dniester Basin*, 76% of land is used for agriculture, with only 9% being occupied by forests. Such a high level of land usage for arable agriculture is neither scientifically justified nor environmentally sustainable, and this can be graphically illustrated by the progressive degradation of soil cover, alteration of natural landscapes, intensive sedimentation/siltation processes in the Dniester River and its tributaries, triggered by surface runoff from agricultural land, which also contributes significantly to total pollution load carried with river flow. Available data indicate that the Dniester's ecosystem within Moldova has been overused and overstressed due to intensive agricultural activities.

Table 1.1. Land Use Pattern in the Moldovan Part of the Dniester basin, % (*)

River Catchments	Total Area	Area of Agricultural Land	Arable Land	Perennial Plantations, Including Gardens, Vineyards etc.	Gardens	Vineyards	Pastures	Grassland	Fallows	Forests	Rivers, Lakes, Ponds, Marshes	Other
Dniester	100.0	75.6	59.2	9.1	6.2	2.5	7.0	0.1	0.2	11.1	3.1	10.2
Reut	100.0	78.7	56.9	7.8	5.2	2.3	13.6	0.1	0.3	9.8	2.5	9.0
Byk	100.0	61.6	37.1	14.8	6.1	8.5	9.5	0.1	0.1	21.9	2.1	14.4
Botna	100.0	73.4	50.5	11.6	4.7	6.5	10.6	0.1	0.6	14.8	3.8	8.0
Ikkel	100.0	64.8	37.1	17.0	6.2	10.6	10.5	0.1	0.1	22.1	1.8	11.3
Moldova's Average	100.0	75.0	54.4	9.0	4.2	4.5	11.3	0.1	0.2	12.5	2.9	9.6

(*) Data provided by O. Kasantseva, Institute of Geography, Moldovan Academy of Sciences

Various estimates put Moldova's forest coverage between 9.6% and 12.5%. It is a conservative assumption that forests covered about 40% of the land in the Middle Ages. The largest areas of forests are concentrated around Kodry, where the forest coverage is over 24%. Forests are particularly scarce in the upper section of the Reut River catchment (Balti Steppe) and southern areas of the left-bank part of the Dniester Basin within Moldova, where the proportion of forests is below 6% [23].

The state of existing forest resources has been greatly affected by the illegal tree-cutting and grazing activities, and unauthorized dumping of household, construction and other wastes. In 1992-1999, about 1,400 ha of state-owned forests (or about 174,000 m³ of wood) were lost due to illegal cutting operations. In other words, the forest resources managed by the state forestry authorities, had shrunk by about 1%. An additional 13% of forests, managed/owned by other forest holders, were lost over the same period [24].

The scale of illegal grazing, which is considered to be responsible for about 6% of the total loss of forest resources, has increased dramatically since 1990 as a result of a progressive increase in number of privately owned livestock.

The lack of adequate and effective arrangements for the development and maintenance of water protection zones and protective strips surrounding the Basin's water bodies is a common issue, both for Ukraine and Moldova.

1.7. Biological Resources and Biodiversity

The Dniester Basin's biological diversity has been shaped by various natural factors, though its current state is largely a reflection of increasing human pressures in the Basin.

The biogeographical setting of Dniester is unique, with its upper section lying near the Vistula River. For many centuries Dniester has been known as the Amber Route, connecting the Black Sea with the Baltic Sea. The Dniester/Prut water divide is the area where the sources of the left-bank Prut tributaries are located in the immediate proximity to the Dniester River bank, thereby providing a hydraulic continuity between the Dniester and Danube Basins. The inter-basin links have promoted the migration of aquatic species and mutual enhancement of flora and fauna in these Basins. Another factor contributing to the Basin's biodiversity is a characteristic vertical zonation of its ecosystem that comprises species groups from mountain, sub-mountain and lowland water bodies [25].

The lowland mouth section of the Dniester Basin is a unique and highly productive ecosystem, sustaining a wide range of plant and animal life.

The *Dniester Wetlands* are home to many endangered species, both plant and animal, which are included into the Red Data Books of Ukraine and Moldova, and the Red List of Threatened Species maintained by the World Conservation Union (IUCN). Especially valuable is the bird community, nesting in the wetlands, including the glossy ibis (*Plegadis falcinellus*), the most endangered species. The Dniester Estuary area harbours a number of rare and endangered fish species, including European mud minnow (*Umbra krameri*), great sturgeon (*Huso huso*), and sterlet (*Acipenser ruthenus*). Examples of mammals are the wild cat (*Felis sylvestris*), the European mink (*Mustela lutreola*), and the Eurasian otter (*Lutra lutra*) [25].

Prior to the construction of dams, the distribution and settlement of species along the river channel were unrestricted, being only governed by species activity and specific natural conditions in various parts of the Basin. Today, the natural process of changes in biodiversity is greatly affected by technogenic pressures, the most significant being associated with the presence and operation of three in-channel reservoirs and related hydropower plants, water pollution, introduction of new fish species and aquatic life [25].

Terrestrial and Aquatic Plants. The greatest variety of terrestrial plant species remains in the Carpathian part of the Dniester Basin. Its tree species pattern is dominated by spruce, with the presence of silver fir and beech. These types of forests are mainly concentrated at higher altitudes (between 1,000-1,400 m to 1,500 m). Lower mountain slopes are occupied by mixed forests, followed by deciduous forests towards the foothills. These forests mainly consist of oak, beech, hornbeam, and lime-tree. Nut trees occur in the underwood. Ash trees and elms are present in the damp gully beds [12, 26, 27].

Beyond the Carpathian Province, the number of natural local woodland communities has shrunk. The hornbeam and oak woods still occur within the Podol area and Moldova. River valleys are

covered with shrub thickets. In the plain steppe areas of the Basin, the woodlands only remain in the gully beds and near the mouth section of the Dniester River. The woodlands on the gully slopes and beds mainly consist of oak, whereas the Dniester Wetland forests are dominated by white poplar and pussy willow. The plant community of the Dniester Wetlands is dominated by herbaceous species, both aerial and aquatic.

There is great concern in Moldova over the significant level of fragmentation of forests and other remaining areas of natural vegetation (meadows, marshes and steppes). The Red Data Book of Moldova includes 96 vascular plant species, 10 moss species, 16 lichen species, and 8 mushroom species. The majority of these species occur in the Dniester Basin.

Prior to the construction of the hydropower dam in Novodniestrovsk, excessive growth of semi-submerged and submerged aquatic plants was found in the central and downstream sections of the Dubossary reservoir, in the Dniester's mouth section and estuary. Algal growth has increased in the recent years, and is now a basinwide issue.

About 919 species of algae have been recorded in the Dniester. The phytoplankton community comprises 79 species, dominating the biota of the Middle Dniester, and 39 species present in the Lower Dniester, with the domination of diatomic, green and blue-green algal species. The phytoplankton development pattern in the Dniester Basin features two seasonal peaks, one in spring and one in autumn [28].

The Middle Dniester's plant world comprises 131 rare and endangered species. Of that, 35 species are included into the Red Data Book of the Republic of Moldova, and 82 species enjoy a special protection status.

Ichthyofauna. Overall, 94 fish species have been recorded and described in the Dniester Basin. The Dniester Estuary still sustains a rich diversity of highly-productive fish species. However, intensive human activities have led to significant changes in the commercial fishing pattern, where some species have virtually disappeared from commercial catches, being substituted by less valuable, often invasive, species [25].

The record of fish species occurring in the Dniester River within Moldova, prepared by V.N. Dolgy [29], comprises 79 fish species and sub-species that represent 17 fish families. Of these, 70 species and sub-species representing 14 families dwell downstream of the Dubossary Hydropower Plant dam, and 51 species inhabit the Middle Dniester section between the two hydropower dams and the Dubossary reservoir itself.

The Dubossary reservoir is home to 40 fish species and sub-species belonging to 9 families, including 12 commercial species (such as the pike, the common bream, the silver and bighead carp, the grass carp, the pikeperch, and the common carp).

Amphibia and ***Reptile*** communities inhabiting the Dniester Basin comprise the following typical species: the grass frog, the pool frog and the lake frog; the fire-bellied toad; the common tree frog; the green toad; the green lizard and the sand lizard; the slow worm; and the common grass-snake. Other, less numerous reptile populations include the racerunner, the steppe lizard, the green whip snake, the four-lined ratsnake, and the common and steppe vipers, among others.

Bird Fauna. One of the major transboundary migratory routes lies along the Dniester Basin. It is used by many bird species, including rare and endangered birds. The importance of the Lower Dniester Basin and Dniester Estuary habitats, used by waterfowl communities for breeding,

migration and wintering is illustrated by the fact that the Dniester Wetland area within Ukraine was included into the List of Important Bird Areas in Europe in 1989.

By the Resolution of the Cabinet of Ministers of Ukraine No. 935 of 23 February 1995, the Ukrainian part of the Dniester Estuary was included into the list of internationally recognized wetlands. In 2003, the Lower Dniester Basin section with an area of about 600 km², lying along either side of the river between the Copanca and Palanca Villages in Moldova, also received the status of an internationally recognized wetland area.

The assessment study, undertaken by the BIOTICA Ecological Society, suggests that the area lying between the Otaci and Holosnita Villages downstream of the Novodniestrovsky Pumped Storage Facility is a very important and valuable habitat for waterfowl communities. About 205 bird species have been recorded in this area, including 113 nesting species. Of these, 9 bird species are included in the IUCN Red List, 24 species included in the Red Data Book of Ukraine, and 25 species included in the Red Data Book of Moldova [30]. There are periods when the total number of bird individuals recorded in this area is over 20,000, i.e. this area meets the Criteria 5 of the Ramsar Convention. This area provides a habitat for 57 bird species listed under the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention). In 2005 this area is also recognized as Ramsar site.

The bird life in the Dniester Wetlands is especially spectacular in autumn, during the post-nesting and migration periods, when numerous shallows, islets and feeding bases are occupied by various birds.

Mammals. The Dniester Basin's forests are inhabited by mammal species that are typical to the broad-leaved forests of the Western Europe. Native mammal species include wild boars, deer, grey hares, European ground squirrels and speckled ground squirrels, forest shrews and white-toothed shrews, Leisler's bats, squirrels, and hedgehogs, among others. The representatives of acclimatized mammals include red deer, musk-rat, and pheasant. Local mammal species included in the Red Data Book of Ukraine are the otter, the European forest cat, and the ermine. The Red Data Book of the Republic of Moldova includes 11 mammal species occurring in the Dniester Basin.



The Middle Dniester Reach within Moldova.

Photo: Valeriu Rusu, "Habitat"

1.8. Nature Reserves and Protected Areas

Although the Dniester Basin is characterized by a well-developed industry and agriculture, it also sustains rich and diverse biological and landscape resources that need to be protected and managed in a sustainable manner. The Basin's varied habitats, supporting a unique genetic diversity of plant and animal life, sites of geological interest, and invaluable historical and cultural assets together illustrate the extremely high amenity value of the Basin. The Dniester Basin has great potential as a unique recreation and tourist region.

The locations of the Basin's nature reserves and protected areas of national significance are shown in Figure 1.4, and Table 1.2 provides summary information on key nature reserves and national parks, established in the Dniester Basin within Ukraine.

The need for developing and enhancing the nature reserve capacity is fully recognized in Ukraine. This issue has been addressed in the 2000-2015 National Ecological Network Development Programme of Ukraine, which identifies priority areas for the establishment of new regional landscape parks in the river floodplains (the Opillya Park in the Zolota Lypa river valley; the Central Seret Basin Park in the Seret river valley; the Skomorokhi Park in the Strypa river valley, the Chervonohrad Park in the Dzhurin river valley), and national nature conservation parks (the Dniester Canyon and Lower Dniester National Parks).

The ***Dniester Canyon National Park*** is planned to be established along the Dniester River course, to cover the areas of the Tysmenytsia, Tlumak and Horodenkovo Districts (Ivano-Frankivsk Oblast), and the Borovsky, Zalischyki, Buchak and Monastyrsky Districts in the Ternopil Oblast. This National Park will also cover the area currently occupied by the Dnistrovsky Regional Landscape Park.

The steppe areas with unique relic vegetation and geological formations dating back to the Palaeozoic and Mesozoic Ages are especially valuable in terms of science and research. The meadow/steppe vegetation pattern, present in the National Park area, comprises glacial relic

vegetation species. About 30 plant species occurring in the meadow and steppe areas of the Dniester Basin are included in the Red Data Book of Ukraine.

Table 1.2. Major Nature Reserves and National Parks in the Ukrainian Part of the Dniester Basin

Site Name	Year of Establishment	Area
Nature Reserve “Rostochchia”	1984	2,084 ha
National Nature Conservation Park “Skolivsky Beskidy”	1999	35,684 ha, including 24,702 ha that are managed by the Park authority on a permanent basis
National Nature Conservation Park “Yavorivsky”	1998	7,078.6 ha, including 2,885.5 ha that are managed by the Park authority on a permanent basis
Nature Reserve “Horhany”	1996	5,344 ha
Nature Reserve “Medobory”	1990	9,455 ha
National Nature Conservation Park “Podilsky Tovtry”	1996	261,316 ha, including 1,300 ha that are managed by the Park authority on a permanent basis (the plan is to increase this area to 3,015 ha)

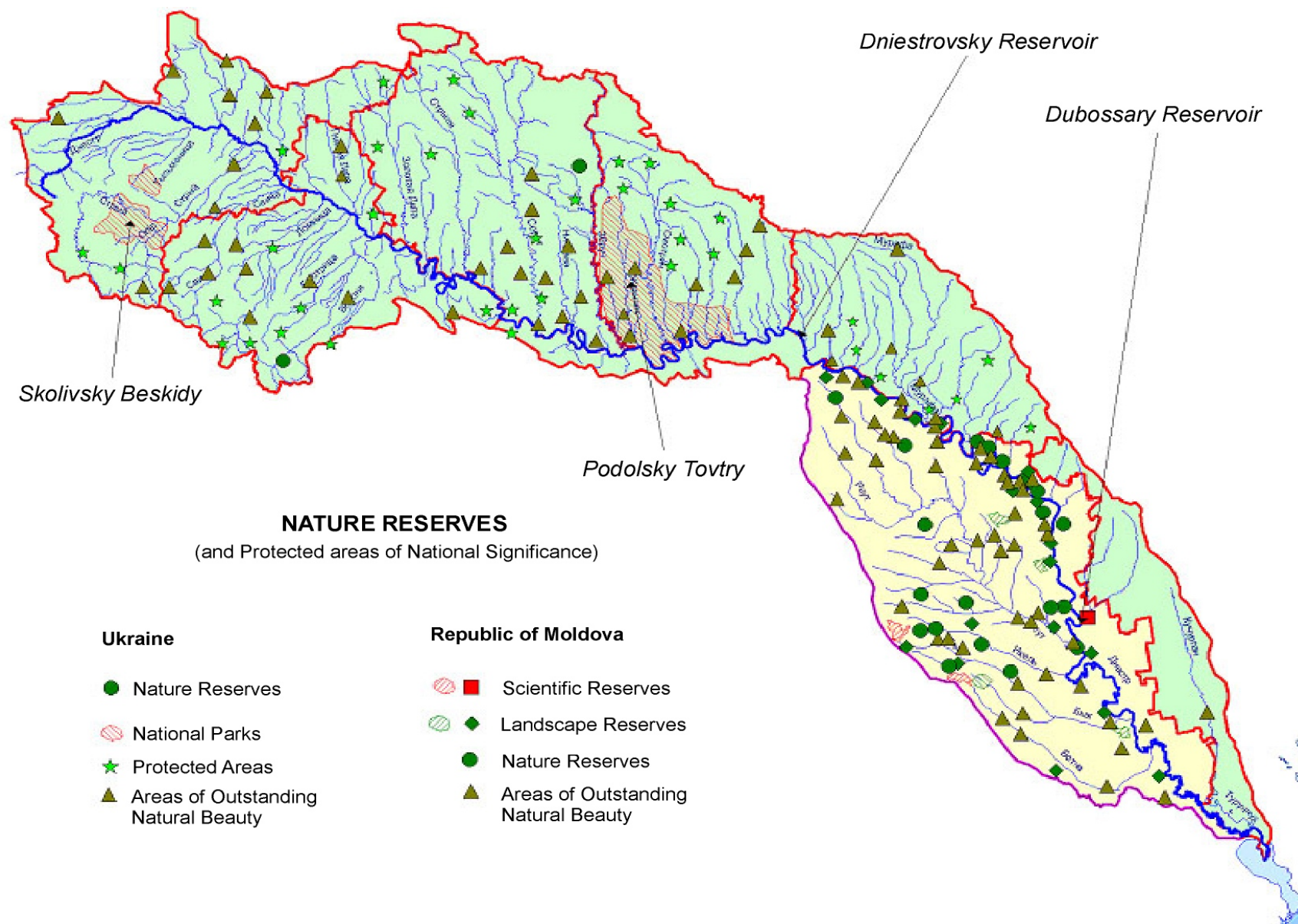


Figure 1.4. Nature Reserves and Protected Areas in the Dniester Basin

Despite the large-scale urbanization and industrialization, the Dniester Basin provides a habitat for a wide range of animal life. The Basin's forests are home to the populations of deer, wild boar, fox, grey hare, marten, squirrel, forest polecat, and red deer. The forest even provides refuge for badger, included into the Red Data Book of Ukraine. The remaining individuals of steppe polecat, a very rare and secretive animal, also included into the Red Data Book of Ukraine, find their home in the steppe areas, gullies, ravines, and forest plantations.

The **Lower Dniester National Park**, with a total projected area of 21,400 ha, is planned to be established in the Dniester Estuary to enhance the protection status of the internationally recognized Dniester Wetlands. This National Park project is of dual significance, since it is not only part of the National Programme of Long-Term Nature Reserve Development in Ukraine, designed to facilitate the implementation of the Law of Ukraine "On the 2000-2015 National Ecological Network Development Programme of Ukraine", but also a significant step to strengthening and enhancing the international cooperation with the Republic of Moldova in the transboundary sections of the Dniester Basin.

The Dniester Wetlands play a vital role in maintaining the water balance and supporting the Basin's biological diversity. They include many ecosystems that provide varied habitats and rich food base for migratory birds, mammals, amphibians and reptiles. The estuarine and littoral areas of the Dniester Wetlands are essential elements of the Dniester Basin's ecological network, which is also part of the national and European ecological network. The Dniester Wetlands have shown their potential as a unique target for developing and strengthening international cooperation with the Republic of Moldova, planning and implementing joint conservation measures, research programmes etc.

The Dniester Basin is the most powerful of four international ecological corridors existing in Moldova, with its core and buffer zones occupying over 19,000 ha [31].

Table 1.3. Core Areas of the Moldovan Ecological Network Located within the Dniester Basin

Area Name	Current Formal Status	Area, ha
Codru	Scientific Reserve	5177
Iagorlic	Scientific Reserve	836
Cosauti	Landscape Reserve	585
Valea Adinea	Landscape Reserve	214
Rudi-Arionesti	Landscape Reserve	916
Trebujeni (including Ivancea)	Landscape Reserve	504
Saharna	Landscape Reserve	674
Hirboveti	Landscape Reserve	2218
Tohai Wetland	Nature Reserve	50
Cula River Meadows	Multiple-Function Area	149
Kuchurgan Complex	No Protection Status	6200
Talmaza Wetland	No Protection Status	1100
Cremenciug-Holosnita	Landscape Reserve	199

Forty six protected areas of varying significance are scattered along the river valley slopes in Middle Dniester Basin, including 19 protected areas of natural interest and 28 areas of geological/palaeontological interest.

Especially valuable and representative part of **the Lower Dniester Basin** is the area extending between the Copanca and Palanca Villages, where the Lower Dniester National Park is to be established. This area is a habitat for 245 bird species, including at least 89 species that use this area for nesting/breeding [32].

In 2001, the Moldovan Parliament made a decision to establish the Lower Dniester National Park in the period of 2003-2005 as part of the National Strategy and Action Plan for the Conservation of Biological and Landscape Diversity. In 2003, the Moldovan part of the Dniester Estuary (60,000 ha) was included into the list of internationally important wetlands. As a result, the total area of Dniester Wetlands, enjoying the international recognition under the Ramsar Convention, has now achieved 150,000 ha (including the Ukrainian part of the Dniester Estuary). The next logical step will be the integration of the Ramsar sites in the Lower Dniester Basin into a common transboundary wetland area of international significance, to have the status of the transboundary biosphere reserve [23]. In 2005 the area along the Dniester and its valley Unguri-Holosnita on Moldova's side (Ramsar Site #1500, the area is 15,553 ha) was added to the Ramsar List. Apparently, a similar decision should be taken regarding the same area along the Dniester on the Ukrainian side and its joint management.

2. Water Resources

2.1. Availability of Hydrological Data

The Dniester River has been the subject of various hydrological studies, and available data on the river flows and discharges are characterized by a relatively high level of detail. The history of regular hydrological observations on river water levels dates back to 1850 [3]. Regular flow observations, referred to in the existing information sources, commenced in 1881 at the water gauging station in Bendery. Since the late 19th century, regular flow measurements have been carried out at a number of other gauging stations, mostly concentrated in the upper river reaches (Zhuravne, Halych, Zalischiky). The list of existing water gauging stations providing regular flow measurements along the whole course of the Dniester River (including the territory of the Republic of Moldova), is presented in Table 2.1.

Table 2.1. Hydrological Stations on the Dniester River

Hydrological Station	Distance to the Mouth, km	Catchment Area, km ²
Strelki	1317	384
Sambor	1278	850
Rasdel	1191	5700
Zhuravne	1159	9910
Halych	1117	14700
Zalischiky	936	24600
Dniestrovsky Hydropower Plant (HPP)	677	40500
Mohyliv-Podilsky	630	43000
Hrushka	509	48700
Dubossary HPP	351	53600
Bendery	214	66100
Olaneshty	67	68900
Nesavertailivka	-	-

In addition to these flow observation stations, there are over 10 water gauging stations that only provide water level measurements. These include the Nizhnev Station in the upper reach, several stations located along the Dniestrovsky and Dubossary reservoirs, in Tiraspol and in Mayaki (near the river mouth).

2.2. River Flow Pattern

The Dniester's mean annual flow is 8.4 billion m³ (discharged at an average rate of 274 m³/s). The mean annual flow discharge rate, recorded at the mouth section, is 310 m³/s [33].

The estimated total annual flow discharges in the location of the Dniester Hydropower Complex are as follows: 8.4 billion m³ (50% probability), 6.9 billion m³ (75% probability), and 4.8 billion m³ (95% probability) [17, 19, 26].

The following characteristics relate to the Dniester's flow availability in the Dniester Basin section near Bendery (catchment area 66,100 km²) [34, 35]:

- Normal annual flow: 10.7 km³;
- Mean annual flow (50% probability): 10.4 km³;
- Mean annual flow (75% probability): 8.64 km³;
- Mean annual flow (90% probability): 7.17 km³;
- Mean annual flow (95% probability): 6.56 km³.

The Dniester's annual flow discharges at the mouth section are as follows [35]:

- Estimated annual flow discharges: 10.7 billion m³ at 50% probability; 8.6 billion m³ at 75% probability; and 6.6 billion m³ at 95% probability;
- Actual 2002 flow discharges: the total annual flow discharge 9.7 billion m³, including 4.2 billion m³, discharged over the spring flood period (55% probability).

Table 2.2 provides the comparison of annual flows carried by the Dniester and other major rivers of the Black Sea Basin.

Table 2.2. Mean Annual Flow Data for Major Rivers in the Black Sea Basin

River	Catchment Area, km ²	Mean Annual Flow Discharge, m ³ /s	Total Annual Flow, km ³
Danube	817	6300	200
Dniepro	503	1375	43.5
Dniester	72.1	288	9.1
Southern Buh	63.7	69	2.2

The analysis of historical flow data indicates that there is an obvious downward trend in the annual flows carried by the Dniester River. This picture is different from the flow patterns observed in the Dniepro Basin and other major river catchments, which can be attributed to a number of factors. To some extent, this can be explained by the stronger impact of climatic changes. The available data suggest a certain downward trend in the atmospheric precipitation in the Western Ukraine, which might have affected the flow collection pattern in the Dniester Basin. Another important factor of influence relates to the proportion of river flow accounted for by non-returnable water consumption. Also, one cannot exclude the impact of long-term variability of river flow.

The Carpathian Mountainous Part of the Dniester Basin largely occupies the upper right-bank area of the river catchment, featuring a well-developed and dense hydrographic network (comprising the Strviash, Vereschytsia, Striy, Svicha, Lomnytsia, Lukva and many other tributaries) that provides a major proportion of flow to the Dniester. Despite the fact that the Carpathian Mountains (including foothills) occupy less than 9% of the Basin area, while the upper (Carpathian) Dniester tributaries drain only about 17% of the river catchment, over 50% of the Dniester flow is collected in this part. Mean annual precipitation in the mountainous area of the Basin ranges between 800 to 1500 mm, and stable heavy rainfalls, received by the north-eastern part of the Carpathian Mountains, result in numerous flooding events that shape the flow pattern of the Dniester as a whole. The Carpathian section of the Dniester Basin has the highest average rates of runoff (4.70-5.33 l/s per km²), which can be as high 10.0 l/s per km² near the river source itself.

The Podol Part of the Dniester Basin occupies the left-bank area of the river catchment, which represents a part of undulating terrain on the southern slope of the Carpathian Mountains with a dense hydrographic network (comprising the Vereschitsia, Hnyla Lypa, Strypa, Seret, Smotrich, Ushitsia, Liadova, Murafa and other tributaries). Mean annual precipitation ranges from 450 to 700 mm/year and plays a less important role in terms of the river flow formation. Local soil has higher permeability rates relative to the Carpathian part of the Dniester Basin, suggesting stronger impact of groundwater flow on the river flow pattern. The rates of runoff progressively decrease as one moves along the Podol part of the Dniester Basin, from 4.70 l/s per km² to 1.77 l/s per km².

The Lower Dniester Basin (between Dubossary and the river mouth) is characterized by low annual precipitation – about 550 mm in Codru (the upper reach of the Bic River) and below 400 mm in the river mouth section. It mainly consists of dissected and gently sloping plain land with a weak hydrographic network (comprising the Raut, Ichel, Bic, Botna and other tributaries). These tributaries are rather shallow, and their contribution to the total Dniester's flow is relatively minor.

The only exception is the Raut River that carries significant flows during the spring flooding period. In the south-easternmost part of the Basin (Black Sea Lowland), the average rates of runoff are between 1.1 to 0.2 l/s per km².

It can thus be concluded that the major proportion, or about two thirds of the Dniester's annual flow is collected in the upper part of the Basin (occupying 20,400 km², or 28% of the total catchment area), where the high-water period continues over the whole year.

Taking the non-returnable water consumption into account, the natural river flow discharge rate at the Zalischiky water gauging station can be estimated at 226 m³/s, or 7.13 km³ per year. Flow discharges in the Lower Dniester section can be estimated on the basis of historical flow measurement data from the Bendery water gauging station. Based on this data, mean annual flow discharge rate at this station is 311 m³/s (or 313 m³/s over the period of 1987-1995).

The comparison of flow discharge data from these two gauging stations indicates that the total river flow received at the Zalischiky Station is lower than the one recorded at the Bendery Station by a factor of 0.7. This is a clear evidence of the major role played by the upper part of the Dniester Basin in shaping the river flow pattern. It should be borne in mind that the catchment area feeding into the Zalischiky Station is only 37% of the catchment area feeding into the Bendery Station.

The Dniester River receives no major side inflows downstream of Bendery. Among smaller tributaries, the rivers of Botna and Kuchurgan can be mentioned, with the latter currently emptying into the cooling water reservoir at the Moldova Thermal Power Plant site. These rivers discharge their flow to the Dniester at a rate of about 1 m³/s. The estimated natural flow discharge rate at the mouth section of the Dniester River is about 322 m³/s, or 10.2 km³ per year.

The historical maximum discharges were recorded at the Zalischiky and Bendery gauging stations in 1980, being at 429 and 610 m³/s, respectively. Minimum flow discharge rates were recorded in 1961 at the Zalischiky Station (97.6 m³/s) and in 1904 at the Bendery Station (142 m³/s). The values of the 'maximum to minimum flow' ratio for the Zalischiky and Bendery gauging stations are at 4.4 and 4.3, respectively.

2.3. Seasonal Distribution of Flow

The total annual precipitation in the Dniester Basin can be broken down by season as follows: 10-20% in winter, 35-45% in summer, and 20-25% in spring and autumn. The snow cover is only stable in the upper part of the Basin. In Moldova, the snow cover settles and melts many times over the course of a winter, becoming progressively scarce towards the mouth, where it lasts only a few days or does not settle at all. On the average, the snow cover lasts for 100-140 days in the Carpathian Mountains, 60 to 100 days in the Middle Dniester Basin, and 20 to 60 days in the Lower Dniester Basin. This precipitation pattern has a major effect on the seasonal distribution of river flow, with about 60% of annual river flow being discharged over a summer/autumn period, 25% over a spring period, and 15% over the winter period, when the river is fed mainly from groundwater sources.

At the Zalischiky water gauging station, where the longest time series of observation data are available starting from 1895, the highest flow discharges have been typically recorded in April, during the spring flood-peak period. The lowest flow discharges are normally in January-February. However, the seasonal flow distribution pattern has changed over the past decade, with spring flood flows becoming lower against an increase in flow discharges recorded in the low-water periods.

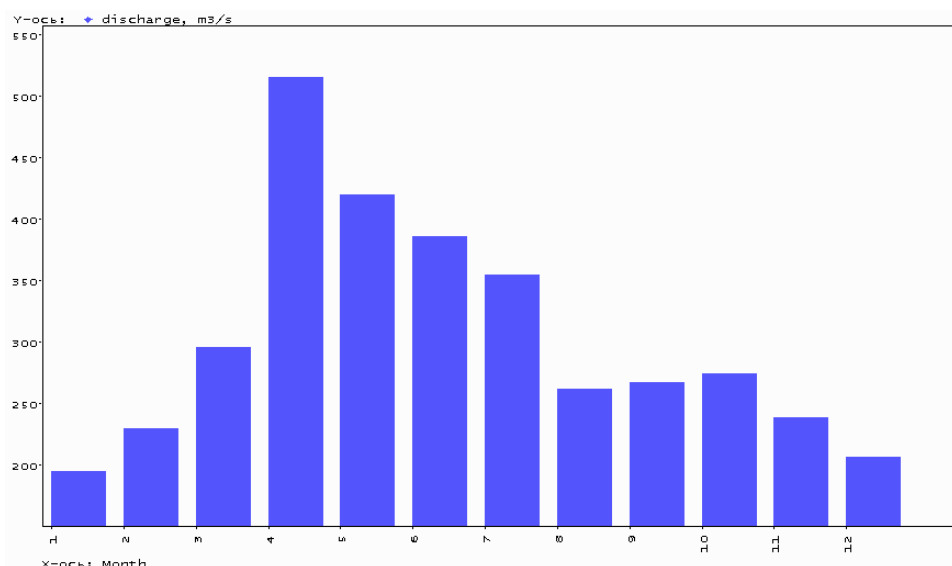


Figure 2.1. Seasonal Distribution of River Flow (Dniester near Mohyliv-Podilsky, 1995-2000)

The Dniester's flow discharge pattern features peak discharges in spring and summer. Maximum recorded discharges are 2,660 m³/s in the mouth section and 4,020 m³/s near Camenca (1%-probability spring flooding event). During a rainfall-induced flood, the river discharges can be as high as 3,010 m³/s and 5,300 m³/s, respectively [36].

Lower discharge rates are typical for the winter low-water period. The lowest recorded discharge rates are 6.98 m³/s (Zalischiky Station) and 14.7 m³/s (Bendery Station). The autumn low-water period is normally in September-October. The minimum flow discharge requirement for the middle reach of the Dniester River, set on the basis of health safety standards, is 80 m³/s (2,400 million m³/year), which is the equivalent of a mean monthly flow discharge with 95% probability [36].

2.4. Water Levels and Flood Events

Data on maximum and minimum water levels, recorded in the Dniester River, are presented in Table 2.3.

Table 2.3. Variation of Water Levels in the Dniester River

River – Location	Elevation, m ABD*	Average Level, cm	Maximum Level, cm	Minimum Level, cm
Dniester – Sambir	284.17	268	699	150
Dniester – Halych	211.26	170	990	96
Dniester – Zalischiky	140.69	358	1264	220
Dniester – Mayaki	-1.11	85	209	-50
Sriy – Verkhne Synevidne	369.62	197	643	101
Svicha – Zarichna	278.50	180	548	80
Lomnitsa – Perevosets	236.03	322	691	237
Zolota Lypa – Zadarov	209.11	227	547	154
Strypa – Buchach	266.62	133	343	95
Seret – Chortkiv	208.85	386	724	323
Zbruch – Zavalie	136.16	161	429	126
Smotrych – Tsibulivka	130.91	71	409	7

* ABD – Above Baltic Datum

The Dniester has a highly specific flood regime, featuring up to five flood events annually. During these events, water levels in the river may increase by 3-4 m, and even more at times of intensive flood. Another characteristic feature of Dniester is the fact that river discharges, recorded during a flood event, are significantly higher than those occurring during a spring high-water period.

The significant variability of water levels, especially in the upper Carpathian reach of the river, is attributed to the river channel's low capacity. The capacity is limited by the steep slopes of the river valley and the narrow floodplain, which is virtually non-existent in some locations. Furthermore, the ratio of flow regulation is extremely low in the upper reach of the Dniester River, with only one (Chechvinsky) reservoir established on one of the Carpathian tributaries of the Dniester, which is very small (full storage capacity 12.1 million m³).

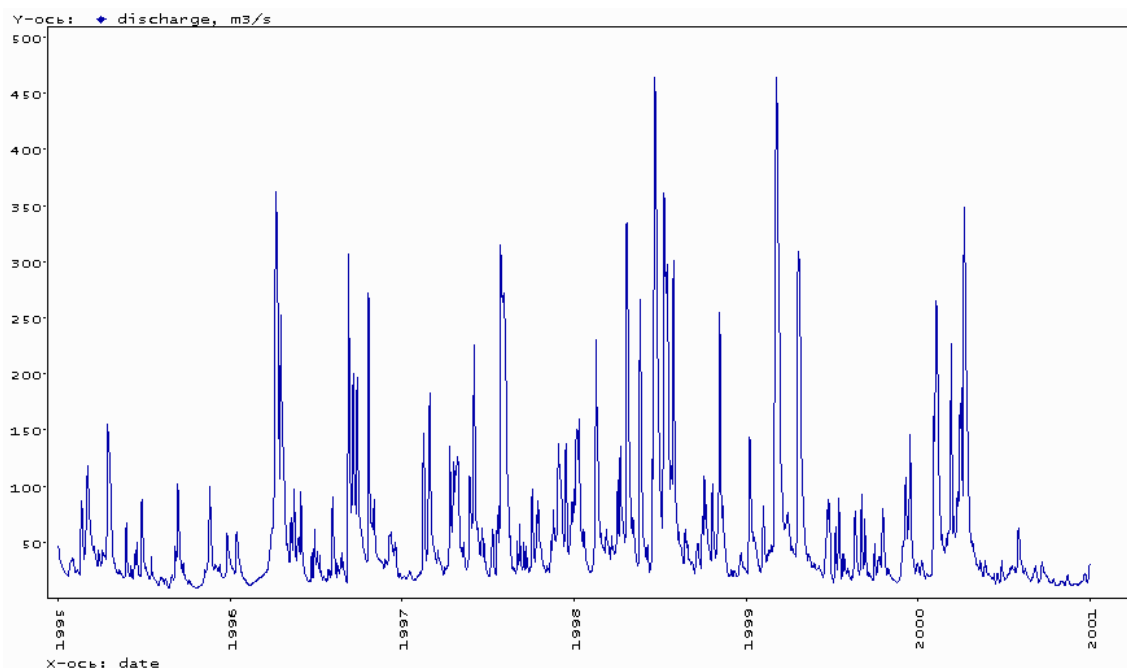


Figure 2.2. Flow Hydrograph Data for 1995-2001 (Dniester – Rasdol)

The range of variations in water levels is largest (9-10 m) in the middle reach of the Dniester, especially near the Zalischiky gauging station. Similar range of variations was also characteristic for the downstream section, which currently accommodates the Dniestrovsky reservoir.

From the history of observations, the largest and most intensive flooding event occurred in September 1941. The estimate, derived on the basis of high-water level data available from the Zalischiky Station for that period, puts the river discharge rate to some 8,040 m³/s. Another exceptional flooding event occurred in June 1969, with maximum river discharges recorded in the following gauging stations: Zalischiky (5,450 m³/s), Mohyliv-Podilsky (4,800 m³/s), and Bendery (3,000 m³/s).

The following factors are considered to play a key role in shaping the flood flow regime of the Trans-Carpathian rivers, particularly the Dniester River:

- Tectonic (endogenous character of orographic and hydrographic pattern, coupled with neotectonic movements);
- Climatic (precipitation intensity and river flow pattern);
- Geomorphologic (combination of plain surface runoff, channel flow and river valley runoff);
- Biotic (proportions of forest cover, meadow vegetation and arable land) [37].

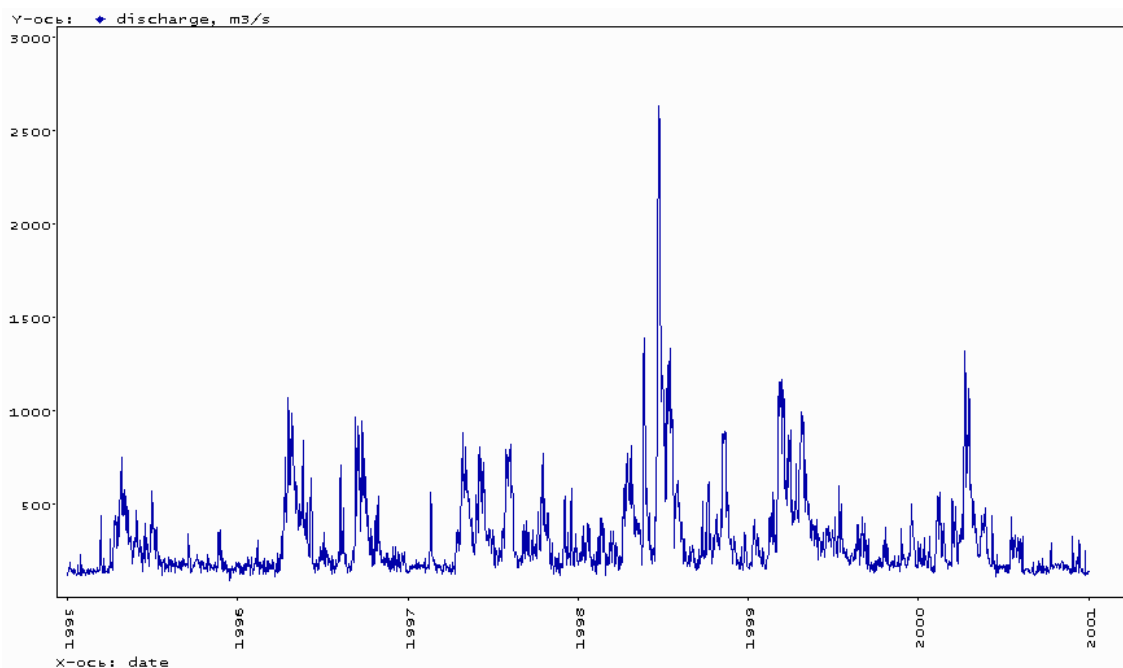


Figure 2.3. Flow Hydrograph Data for 1995-2001 (Dniester – Mohyliv-Podilsky)

The river network in the upper part of the Dniester Basin is clearly asymmetrical, with the majority of Dniester tributaries flowing from the Carpathian Mountains. In the event of heavy rainfalls or intensive snow melting, spontaneous changes in their water levels can significantly affect the water levels in the Dniester itself. Given that the average river channel slope in this section of the Dniester River is at about 0.5 m/km, with the channel slopes of its tributaries being 2-3 times steeper [38], it can be concluded that the tributary flows, discharged into the Dniester at significantly higher rates, cause a backwater effect resulting in a greater head loss and higher water-surface elevation in the Dniester upstream of the tributary inflow. The differences in geometric and hydraulic characteristics between the Dniester River and its tributaries increase the potential for flooding, especially in the event of simultaneous elevation of water levels in all tributaries or, alternatively, when the water levels start to rise first in the tributaries joining the Dniester further downstream (i.e. in the Svicha and Striy Rivers).

2.5. Sediment Transport

The Dniester is a major channel of sediment transport, which is considered to be the result of its flow collection pattern that has an obvious 'mountainous' character. In addition, significant sediment loads are contributed by various human activities, especially tree-felling activities, large-scale arable agriculture and viticulture.

According to available hydrological records from the Zalischiky gauging station, the mean annual sediment load, carried with the river flow, is 2.6 million tonnes resulting in an average water turbidity of 390 g/m³. Sediment loads and turbidity levels grow progressively higher as one moves downstream. For instance, the mean annual sediment load recorded at the Mohyliv-Podilsky gauging station is 4.9 million tonnes at an average water turbidity of 560 g/m³. Estimates, derived for the Hrushka gauging station on the basis of actual records available at the Mohyliv-Podilsky and Zalischiky gauging stations, suggest that the mean annual sediment load carried through this section of the Dniester River is as high as 5.6 million tonnes.

During intensive floods, the levels of water turbidity in the Dniester may rise up to 5-10 kg/m³. Higher water turbidity levels adversely affect the recreational potential of the river. The Dniester is a significant contributor to the total suspended solid load received by the Black Sea (Table 2.4).

Table 2.4. Sediment Transport by Major Rivers Feeding into the Black Sea [39]

River	Catchment Area, km ²	Total Annual Flow, km ³	Annual Sediment Load, thousand tonnes/year
Danube	817	200	51,200
Dniepro	503	43.5	800
Dniester	72.1	9.1	1,730
Southern Buh	63.7	2.2	200

2.6. Temperature Regime

The Dniester's temperature regime varies significantly along the river course. The 'mountainous origin' of river flow determines the temperature regime in the upper reach, where water temperatures never become too high. The anthropogenic factor has played an increasingly significant role in the recent decades, especially after the construction and filling of the Dniestrovsky reservoir. Its significant depths, reaching 50 m in some locations, and the hydropower dam design featuring the deep-lying inlet gates that feed water to the turbines from the lower layer of the reservoir, result in significant temperature fluctuations downstream of the reservoir dam (see Section 3.1.)

In certain years, especially in the spring, actual water temperatures may differ significantly from the average annual temperature pattern. For instance, monthly (April) temperature fluctuations, recorded at the Mayaki water gauging station, ranged from 6.6°C (1987) to 13.2°C (1989).

It can be concluded that the construction and operation of the Dniestrovsky hydropower dam has had a profound impact on the water temperature regime in the downstream section of the river, which has had serious implications for its downstream fish habitats.

2.7. Network of Rivers

Within Ukraine, the Dniester receives the flows of 14,886 small rivers (total length 32,300 km) and 6 medium-size tributaries (1,000 km). The summary information on major Dniester tributaries and smaller inflows is provided in Table 2.5.

Table 2.5. The Dniester's River Network within Ukraine [6, 11, 40]

River	Catchment Area, km ²	River Length, km	Number of Small Tributaries		Total Length of Small Tributaries, km	Of that, below 10 km in Length	River Network Density, km/km ²
			Total	Of that, below 10 km in Length			
<i>Dniester</i>	72100	1362	14886	14433	32272	21643	0.63
Striy	3060	232	3412	3383	4102	3589	1.42
Bystritsia	2520	17	1570	1529	2820	1919	1.13
Seret	3900	248	488	455	1447	804	0.43
Zbruch	3395	247	532	504	1550	1004	0.53
Murafa	2410	163	257	239	804	412	0.4
Kuchurhan	2090	109	81	72	324	141	0.21

Note: 453 small rivers (over 10 km in length) have the total length of 10,629 km; 6 medium-size rivers have the total length of 1,016 km; the total number of tributaries is 14,893.

Within Moldova, the Dniester has 1,685 tributaries with the total length of 8,178 km. Summary information on the Dniester's river network within Moldova is provided in Table 2.6.

Table 2.6. The Dniester's River Network within Moldova

Length, km	Number of Rivers	Total Length, km
Below 10 km	1547	4213
10-25 km	99	1699
26-50 km	24	836
51-100 km	11	735
101-200 km	3	409
201-300 km	1	286
Total	1685	8178

Smaller Dniester tributaries typically run along the dissected river valleys, especially in the left-bank part of the Dniester Basin (except the Strvyazh River). These valleys are rather wide, with gentle slopes (1-10 m/km) that tend to decrease in the downstream direction. River velocities typically range between 0.2 m/s to 0.5 m/s during the low-water periods, rising to at least 1.0 m/s during high-water periods and flooding events [40].

2.8. Groundwater Resources

The estimated groundwater resources of the Ukrainian part of the Dniester Basin are 9% of Ukraine's total groundwater resources (2.025 km³/year). The current level of groundwater exploration in the Dniester Basin is 27% [34].

Within Moldova, the groundwater table within the river floodplain is often at or near the land surface, lying at depths of up to 5 m in the areas of valley slopes, being present at 20 m and deeper in the areas of water divides. In the northern part of the Dniester Basin, groundwater is contained in the karst voids, outcropping in the river valleys.

The groundwater chemistry varies considerably across the Basin. Subsurface aquifers receive a major proportion of pollution load carried with surface runoff. Given that there is a degree of hydraulic continuity between the groundwater aquifers, there is significant potential for migration of contaminants to the deeper aquifers.

In some locations, the groundwater is characterised by elevated concentrations of certain pollutants, e.g. nitrates (up to 462 mg/l in the area of Anenii Noi); chlorine (up to 902 mg/l in the area of Stefan Voda). Elevated concentrations of ammonium (up to 49.3 mg/l) have been recorded in many groundwater sources throughout the Basin.

3. Water Uses in the Basin

For many centuries the Dniester has been a vital water artery, sustaining various economic activities, including water transport, water supply to the population and industry, fisheries, and recreation. Currently, the hydropower sector is by far the largest water user in the Basin. The Dniester also provides essential water to irrigated agriculture, industries, municipal sector, agro-industrial developments, and fisheries [3].

The Dniestrovsky Hydropower Plant is among the largest industrial developments in the Basin, producing about 800 million kWh of electricity. It is important to note that its major function is to provide peak power to the national grid.

Within Ukraine, the river is intensively used to supply water to the populations and industries in Lviv, Chernivtsy, Ivano-Frankivsk, Ternopil, Kamianets-Podilsky and other urban areas. Some major water intakes are further concentrated within the relatively small downstream section of the Lower Dniester that belongs to Ukraine.

The Belhorod-Dniestrovsky irrigation system water intake is located along the main branch of the Dniester River 1 km downstream of the Moldovan/Ukrainian border. Further downstream, after the confluence of two river branches, the river flow is abstracted to supply water to the Dniester Drinking Water Treatment Plant, and to the Mayaki-Bilyaivka and Troitsko-Hradenytsia irrigation systems. The Dniester Drinking Water Treatment Plant itself abstracts over 300 million m³ of river water per year at an estimated flow rate of 10 m³/s, to provide drinking water to Odessa, Illychivsk, and Belhorod-Dniestrovsk. Two major drinking water intakes are located along the Dniester River within Moldova to supply water to Soroki, Beltsy and Chisinau, as well as many irrigation water intakes of varying capacities. Virtually none of the latter has been in operation during recent years.¹



The Dniester River in Ribnita.

Photo: Valeriu Rusu,
“Habitat”

¹ There is no information on water intakes in the Trans-Dniester Region.

Navigation on the Dniester is very limited, with a very short section of the Lower Dniester being navigable. Small-scale shipping is operated in the Dniestrovsky reservoir [3].

The largest hydropower generation facilities and irrigated areas are concentrated in the most arid areas of the Basin, where available water resources are too scarce to meet existing demands. As a result, many areas within the Basin have experienced a continuous shortfall of water. The extremely high anthropogenic pressures have undermined the Dniester's self-purifying capacity which is no longer sufficient to restore the disturbed ecological equilibrium.

The Dniester Basin has seen a progressive reduction in available river flow since 1957, largely due to the increasing anthropogenic pressures and large-scale land reclamation activities in the river catchment. Despite the reduced intensity of economic activity in the Basin since the 1990s, there has been no perceived improvement in river's flow regime. The construction and operation of reservoirs have had a profound impact on the ecological equilibrium and natural flow regime in the Basin, with the current rate of water exchange being several times lower than under natural conditions.

3.1. Hydro-Engineering Facilities

The Dniester's potential for hydropower generation is considered to be relatively low due to low channel slopes and limited flow availability in the river. Nonetheless, two hydropower plants were constructed along the Dniester River: the Dubossary HPP (1954) and Novo-Dniestrovsky HPP (1983). Key design characteristics of these water reservoirs are shown in Table 3.1.

Table 3.1. Design Characteristics of Water Reservoirs

Reservoir	Year of Commissioning	Distance from the River Mouth, km	Drainage area, km ²	Reservoir Length at Normal Water Level, km	Reservoir Area at Normal Water Level, km ²	Storage Volume at Normal Water Level, km ³	Live Storage Volume, km ³	Normal Water Level, m ABD	Flood-Control Storage Capacity, million m ³
Dniestrovsky reservoir	1983	677.7	40500	204	140.8	3.0	2.0	121	637
Buffer reservoir		657.9	43320			0.031		72	
Dubossary reservoir	1954	351	53590	128	67.5	0.486	0.214	28	

The Dniestrovsky Reservoir is a multi-functional facility, designed to provide water to the neighbouring settlements and irrigation systems; generate electricity; control flood flows; sustain fisheries, water transport, recreational developments, etc.

The Novo-Dniestrovsky HPP has 6 power generation turbines with a capacity of 117 MW each, and total capacity of 702 MW. The dam spillway, located above the turbine room at the crest height of 110 m, comprises 12 spans, each 7.5 m wide. The upper and lower edges of intake openings have the elevations of 95.0 m and 78.0 m, respectively. The 11 m deep stilling basin is established at the downstream slope of the dam, at an elevation of 54 m. According to the Dniestrovsky HPP design, its power generation capacity is 800 million kWh of electricity at any normal-flow year.

The Buffer Reservoir is being constructed 19.8 km downstream of the Dniestrovsky hydropower dam in order to provide an equalizing capacity for improved control of flow releases from the Dniestrovsky reservoir and water levels in the downstream section of the Dniester River. The Buffer reservoir dam has 12 spillway gates, each 7.5 m wide, located at an elevation of 64.0 m. The bottom level of the downstream stilling basin is at 61.0 m. There is a plan to construct a small HPP in the left section of the Buffer dam, to comprise three generation units, 15,500 kW each.

In order to prevent flooding downstream, mean daily discharges at the Dniestrovsky HPP under normal operational conditions are to be below 1,000 m³/s. The minimum requirement for mean daily flow is set at 100 m³/s in order to ensure that the sanitary safety guideline, set for the Dniester Estuary at 80 m³/s, is met. Other key operational requirement relates to the control of water levels downstream of the dam, with a permitted margin of water level variation to be at or below 50 cm in any period of a year other than spawning period, when the water level variation is to be within 10-cm margin.

The Dubossary Reservoir dam is located 351 km from the river mouth, with the associated upstream catchment area of 53,590 km³. The Dubossary reservoir was constructed in 1954 and filled by November 1956, to provide water to adjacent human settlements and irrigation systems; control flood flows; sustain fisheries, water transport and recreational developments.

Progressive siltation of the reservoir is a serious issue. By 1988, i.e. over 33 years of its operational life, the total volume of sediments deposited in the reservoir was estimated at approximately 202.6 million m³, suggesting the average thickness of silt layer as being at about 300 cm. As a result, the reservoir's storage volume has decreased to 283 million m³. The reservoir features a typical in-stream design, with an average water retention period of 10-11 days.

Key Impacts of the Dniestrovsky Reservoir on the Middle Dniester Ecosystem

- 1) *Modification of Seasonal River Flow Fluctuation Pattern.* Narrower margins and lower frequencies of natural flow fluctuations downstream of the Dniestrovsky HPP are considered to be detrimental to the river's biological resources that historically responded best to natural flow regimes. The most significant impact, resulting from the modification and smoothening of a spring-flood component of natural flow regime, relates to the shrinkage of spawning habitats for fish species. Increased flow abstractions have affected the flooding frequencies and intensities, putting in danger the ecological system of the Dniester Wetlands, which is closely linked with the Black Sea.
- 2) *Modification of Daily River Flow Fluctuation Pattern.* The turbines, installed at the Dniestrovsky reservoir dam, are only switched on 2-3 times per day to provide peak energy. This operational regime results in an absolutely unnatural pattern of water level fluctuations downstream of the dam, featuring several daily rises and falls in the margin of up to 1 metre. This impact is particularly damaging in spring, when sharp fluctuations in water levels result in the degradation of spawning grounds located immediately downstream of the Buffer dam. For spawning grounds located immediately downstream of the Dniestrovsky HPP dam, the acceptable margin of fluctuations in water levels is set at 0.3 m.
- 3) *Modification of Temperature Regime.* Historically, water temperatures in the Dniester River in the location of Dniestrovsky reservoir varied in the range of 0-1°C in winter, 9-15°C in spring, 18-23°C in summer, and 17-9°C in autumn. The construction and operation of the reservoir have had a significant effect on the seasonal temperature regime. The most striking evidence of this effect is a significant reduction in natural productivity of spawning areas, located immediately downstream of the Dniestrovsky HPP. Moreover, lower water temperatures in summer and narrower margin of seasonal temperature variations cause a significant decline in natural productivity of phytoplankton and zooplankton.

- 4) *Changes in Oxygen Regime.* The dam construction and operation have caused stratification of the Dniestrovsky reservoir, with resultant anoxic conditions of bottom water layer. When the water from this layer is released via the dam, oxygen concentrations gradually restore to the normal level as a result of contact with ambient air. Depending on flow velocities in the river, oxygen concentrations in river water decrease within the distance of 50-100 km downstream of the Dniestrovsky HPP. This results in a dramatic impact on the zooplankton communities and young fish species inhabiting this section of the river.
- 5) *Changes in Turbidity Levels.* The sediment trapping capacity of the Dniestrovsky reservoir has reduced the turbidity levels in the downstream sections of the river by about 10-fold as compared to the natural water turbidity. This has encouraged an intensive development of macrophyte populations, especially in the middle reach of the Dniester. The high macrophyte density promotes the zooplankton growth, creating highly suitable conditions for insect communities to flourish. Moreover, the high macrophyte density greatly contributes to the progressive siltation, so that a diverse river ecosystem is being transformed into a macrozoobenthic culture with reduced species variety.

3.2. Water Consumption

Ukraine

The Dniester is a major water source sustaining the population and industry of the whole region, where usable groundwater resources are relatively scarce: the projected groundwater resource available in the Ukrainian part of the Dniester Basin is 2.025 km³/year, accounting for about 9% of the country's total.

It appears that there has been a progressive reduction in the volumes of water abstraction in the Basin over the recent years. The data provided by the State Water Management Committee of Ukraine [35] indicate that in 2002, the total water abstraction in the Dniester Basin was at 739.6 million m³, broken down by source as follows: 529 million m³ from surface water bodies, 206 million m³ from groundwater sources, and 4.6 million m³ from other sources. At the Oblast level, the lowest proportion of total annual water abstraction was accounted for by Vinnitsa Oblast (10.22 million m³/year, or 1.4%), with the Odessa Oblast ranking first with its 297.8 million m³/year, or 40%.

Over the same period, the total non-returnable water consumption was at 446 million m³, whereas the total annual volume of effluent discharges into the Basin's surface water bodies was reported to be 294 million m³.

In 2002, the total water use within the Ukrainian part of the Dniester Basin was reported to be 603 million m³, including:

- Domestic and drinking water supply: 318 million m³ (53%);
- Industry: 198.8 million m³ (33%), with Lviv and Ivano-Frankivsk Oblasts ranking highest in terms of industrial water use in the Basin (62.74 million m³/year and 60.56 million m³/year, respectively);
- Irrigation: 11 million m³/year;
- Agriculture: 35 million m³/year, with 20.75 million m³/year being accounted for by agricultural uses concentrated in Lviv Oblast.

The 2002 water consumption data for the administrative regions located in the Dniester Basin are shown in Figure 3.1.

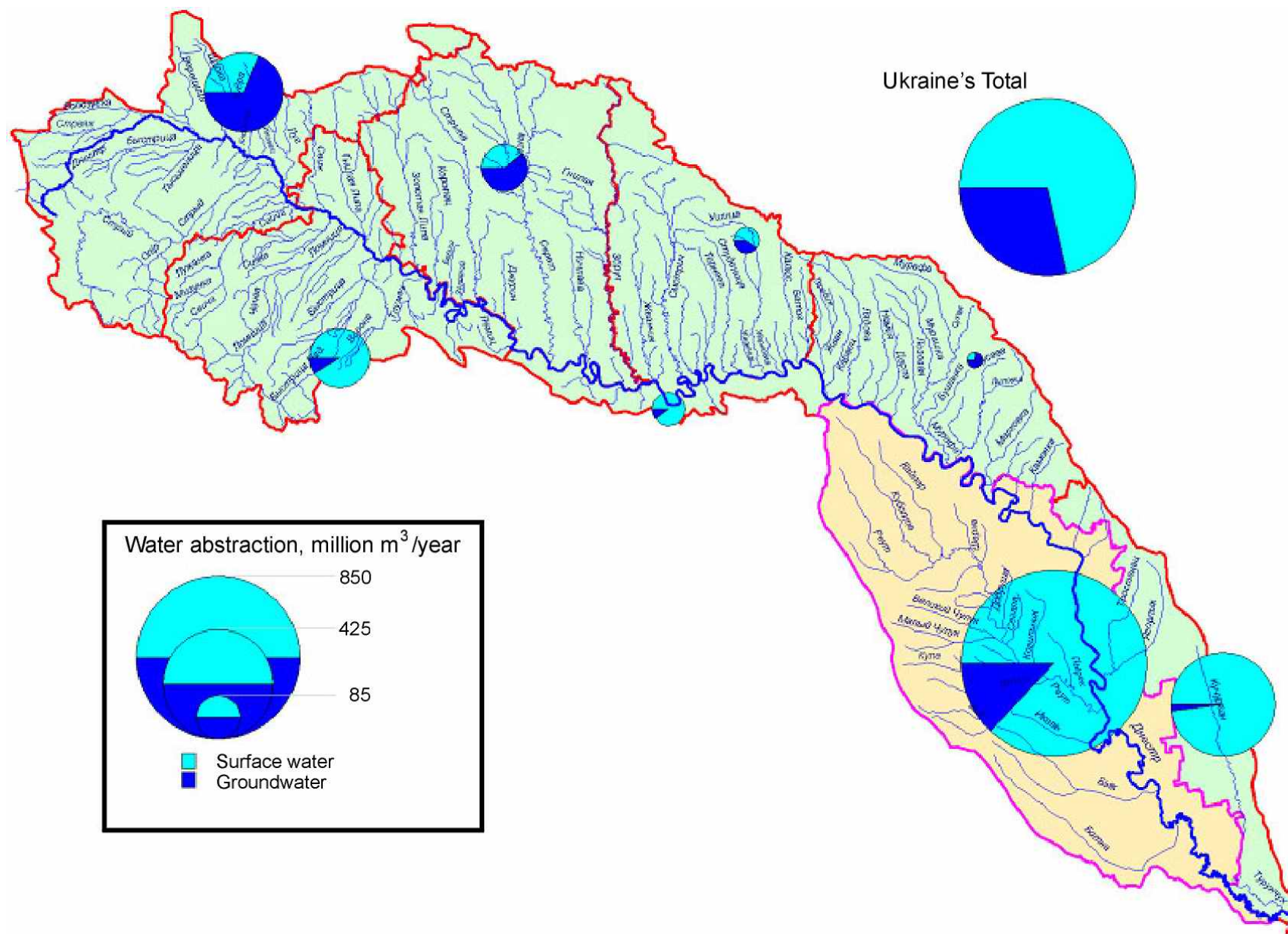


Figure 3.1. Water Abstraction in the Dniester Basin in 2002

The downward trend in the total water use within the Basin over the period of 1994-2002 is illustrated in Figure 3.2. The total annual volume of water reuse/recycling in 2002 was at 1,767 million m³/year, with Ivano-Frankivsk Oblast accounting for 78% (1,383 million m³/year).

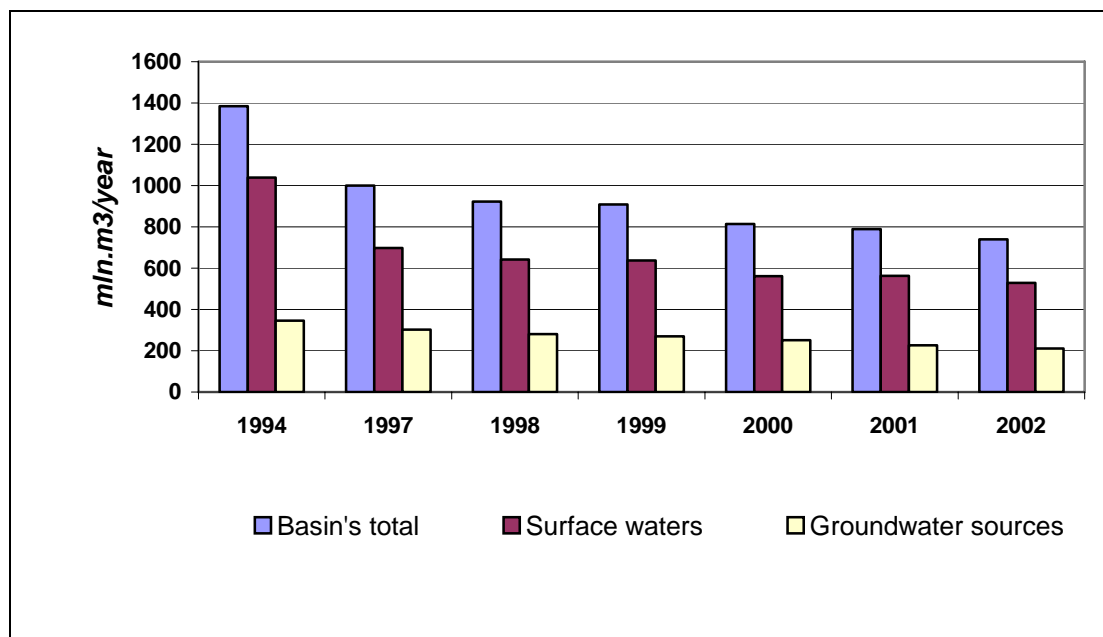


Figure 3.2. Water Abstraction in the Dniester Basin within Ukraine, million m³/year

The major water users in the upper part of the Dniester Basin are the City of Lviv, Burshtyna Thermal Power Plant, and several other municipalities. It should be noted that the demand for water in Lviv is partially covered by abstraction from the Striy River.

There are over ten major drinking water intakes along the Dniester. Drinking water treatment facilities in Odessa, Boryslav, Striy, Ivano-Frankivsk, Chernivtsy and Mohyliv-Podilsky have serious problems with regard to the quality of the water put into supply. The situation is particularly challenging in Odessa, where the quality of water in the Dniester as a sole source of drinking water supply is seriously compromised by upstream wastewater discharges, to the extent that it does not meet the requirements set for drinking water sources.

The fact that about 2 million people living in Odessa Oblast rely on the water supplied from the Dniester River adds a new serious dimension to the overall picture of surface water quality in the Dniester Basin. That is, with the state of the Basin's surface water resource being less challenging than in other large river catchments in Ukraine, the situation where the limited reserve of safe drinking water is already endangering public health cannot be regarded as satisfactory.

The estimated rate of river flow loss due to non-returnable water uses within the upper and middle reaches of the river within Ukraine is at about 8 m³/s. This rate used to be significantly higher within Moldova, where the Dniester flow was intensively used to feed large irrigation systems. In the late 1980s, the rate of non-returnable water abstraction from the river section upstream of Bendery was as high as 13 m³/s. There has been a significant reduction in non-returnable water consumption in the Dniester Basin over the past decade, both in Ukraine and Moldova.

The seasonal rates of non-returnable water consumption have been relatively stable in the smaller sub-catchments of the Dniester Basin, located within the forest-steppe zone, being mainly accounted for by relatively insignificant flow diversions to fish-farming ponds in the absence of irrigation systems.

Republic of Moldova

The Dniester is a major source of water in the Moldovan part of the Basin, though groundwater resources play a significant role in terms of providing domestic and drinking water to urban and rural population.

There has been a progressive reduction in the total volumes of water abstraction in the Dniester Basin within Moldova in the recent years (Figure 3.3). This downward trend is characteristic both for surface water and groundwater abstractions. According to the data provided by the State Water Concern “Apele Moldovei”, the total volume of water abstraction within the Dniester Basin in 2002 was 832.9 million m³ (including 723.8 million m³ of surface water and 109.1 million m³ of groundwater). If account is not taken of flow abstracted to meet the technological demand of the Kuchurgan Thermal Power Plant, the total water abstraction within the Dniester Basin was at 277.6 million m³ in 2002. Of that, 168.6 million m³ of water was abstracted from surface water bodies.

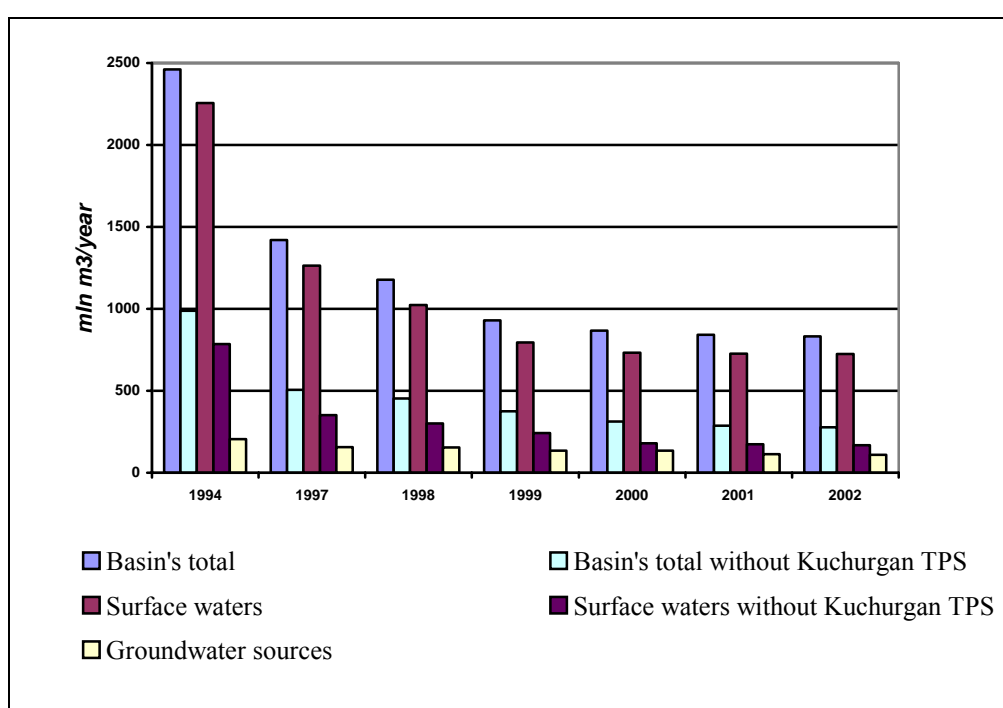


Figure 3.3. Water Abstraction in the Dniester Basin within Moldova, million m³/year

In 2002, the total annual water use in recycling systems was at 336.9 million m³, and an additional 18.9 million m³ was accounted for by water reuse schemes. As total water use falls, so does the volume of the water supplied to recycling/reuse systems. At the same time, the proportion of water recycling/reuse had been progressively increasing starting from 1998, and reached 44% of the total water use in the Dniester Basin by 2002, being an indication of more efficient and sustainable resource use practices. At the same time, the total water losses in the transmission mains were progressively increasing in 1990-2002, ranging between 61 million m³ to 106 million m³. By 2002, water losses in the mains accounted for about 8% of the total water abstraction, being the result of poor technical condition of transmission mains and distribution network.

The total water use within the Dniester Basin was reported to be 767.7 million m³ in 2002. Without flow diversions to the Kuchurgan Thermal Power Plant, the 2002 annual water use of 212 million m³ can be broken down as follows:

- Domestic and drinking water supply: 114.3 million m³ (14.9%);

- Industry: 584.2 million m³, including about 550 million m³ of water supplied to the Kuchurgan Thermal Power Plant (76.1%);
- Irrigation: 42.6 million m³ (5.5%);
- Agriculture: 23.7 million m³ (3.1%);
- Fish-farming: 2.9 million m³ (0.4%).

Historically, the majority of total water demand has been covered by the Basin's surface water resources, with the Kuchurgan Thermal Power Plant being the predominant user. The proportion of surface waters in the total water use decreased slightly in 1998-2002 and has now stabilized at approximately 85% of the total volume of water abstraction.

The demand for water has fallen most significantly in irrigated agriculture and fish-farming industry. In 2000-2002, total annual water use in both sectors was at only 6-7% of the 1990 levels. The progressive reduction in water demand by industry stabilized by 2000 at 24% of the 1990 level. The levels of water use in agriculture were falling less dramatically before 2000, but were only at 30% of 1990 level in 2002. The rate of reduction in the domestic and drinking water supply is considered to have been less significant, though still noticeable.

Apart from the Kuchurgan Thermal Power Plant, the major water users within the Moldovan part of the Dniester Basin include the populations and industries of Chisinau, Balti, Soroca, Orhei, Ribnita, Dubossary, Tiraspol, Bendery, and the Kuchurgan Thermal Power Plant.

A number of large drinking water intakes are in operation along the Dniester River within Moldova, providing essential water to Balti, Soroca, Chisinau, and Rezina, in addition to their local groundwater supplies. A large water pipeline was constructed to convey the river flow to Balti and Soroca, though it has been virtually out of operation during the last 3-4 years. In Beltsy, local groundwater sources have completely substituted surface water supplies, despite the fact that the water contained in the exploited aquifer does not meet the standards for drinking water. The Moldovan capital Chisinau relies on the Dniester water, conveyed by the Vadui-Voda – Chisinau transmission line.

The majority of other municipalities within the Moldovan part of the Dniester catchment receive water from groundwater sources. The largest of them (with population over 10,000 people) include Donduseni, Ocnita, Riscani, Singerei, Drochia, Floresti, Calarasi, Orhei, Straseni, Ialoveni, Anenii Noi, Durlesti, Codru, Cricova, Causeni, and Stefan-Voda. In some areas (Calaras, Orhei, Telenesti, Anenii Noi, and Stefan-Voda), the quality of groundwater supplied does not meet drinking water standard due to chemical and, in many cases, bacterial contamination.

The rural population largely relies on groundwater wells, drilled into the nearest aquifers containing water that may not necessarily be suitable for drinking.

3.3. Wastewater Discharges

Ukraine

In 2002, the surface water bodies within the Dniester Basin received 286 million m³ of wastewater discharges. Of that, 10.54 million m³ received no treatment; 77.45 million m³ was classified as 'normatively clean', i.e. not requiring treatment; 93.99 million m³ was insufficiently treated; and 104.3 million m³ was treated to established standards. Figure 3.6 shows the spatial dynamics of wastewater discharges and level of effluent treatment by administrative region in 2002.

Lviv Oblast was the largest contributor to the total annual volume of wastewater discharges in 2002 (97.42 million m³/year, or 34% of the total reported discharge of 286 million m³/year). Ivano-Frankivsk Oblast contributed the largest proportion of insufficiently treated wastewater discharges (56%, or 52.64 million m³/year).

The major pollution sources in the Dniester Basin are petrochemical industries, oil refineries and municipal wastewater treatment plants, discharging their effluents to the Dniester tributaries. 90% of total pollution load received by the Dniester comes with flows of the Tysmenytsia, Nichlava, Seret, Bystritsia, and Svicha tributaries [34].

In 2002, the Dniester and its tributaries received with wastewater discharges 3,300 tonnes of organic matter, 7.5 tonnes of oil products, 17,200 tonnes of sulphates, 29,100 tonnes of chlorides, 600 tonnes of ammonium nitrogen, 0.1 tonne of copper, 14 tonnes of surfactants, and many other contaminants.

It should be noted that the pollution load from effluents discharged into the Dniester and its tributaries is relatively low when compared with other major catchments in Ukraine, especially if account is taken of flow available in a receiving water body to dilute the discharge (see Table 3.2).

Table 3.2. Dynamics of Pollution Loads in Major Ukrainian Rivers [41]

River	Annual Pollution Load, thousand tonnes							Mean Annual Flow, km ³ /year
	1995	1996	1997	1998	1999	2000	2001	
Dniepro	1209.29	975.50	874.74	757.13	805.34	778.62	890.0	43.5
Siversky Donets	754.95	764.21	593.80	588.95	492.92	457.14	443.3	5.1 ^{*)}
Dniester	78.81	75.35	79.02	78.65	82.83	78.57	66.1	9.1
Southern Buh	60.41	57.99	63.00	49.78	47.39	47.95	43.59	2.2

^{*)} Flow rate as measured at the Kruzhylivka gauging station

Lviv Oblast and Ivano-Frankivsk Oblast rank highest in terms of their contribution to the total pollution load received by surface waters in the Dniester Basin (1,162 tonnes and 1,142 tonnes, respectively).

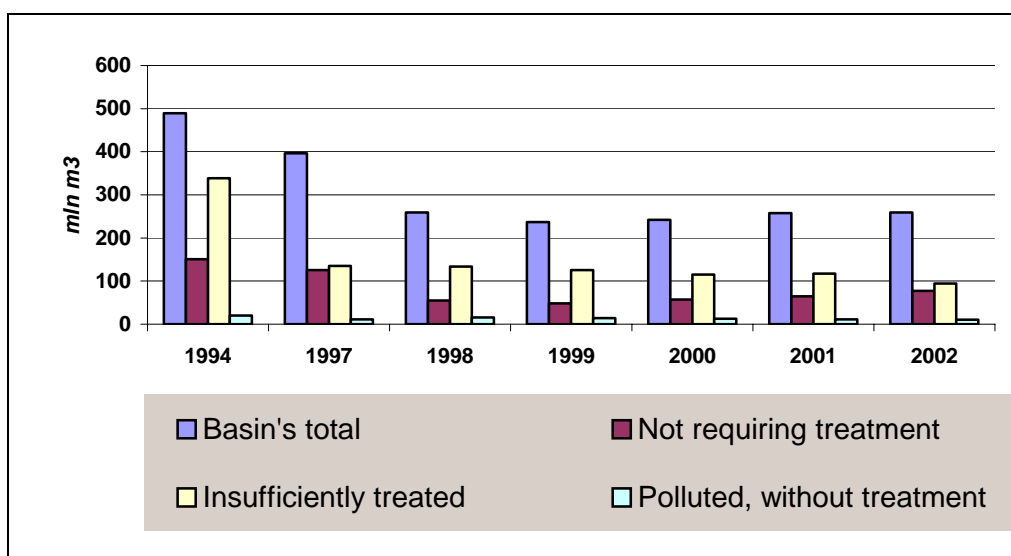


Figure 3.4. Annual Effluent Discharges in the Dniester Basin within Ukraine, million m³/year

Republic of Moldova

There has been a significant reduction in wastewater discharges in the Dniester Basin within Moldova, mirroring a continuous decrease in the total water use within the catchment (Figure 3.5). For example, in 2002 the total annual volume of wastewater discharges in the Moldovan part of the Basin was 679 million m³, or approximately 39% of the 1994 volume (over 1,760 million m³).

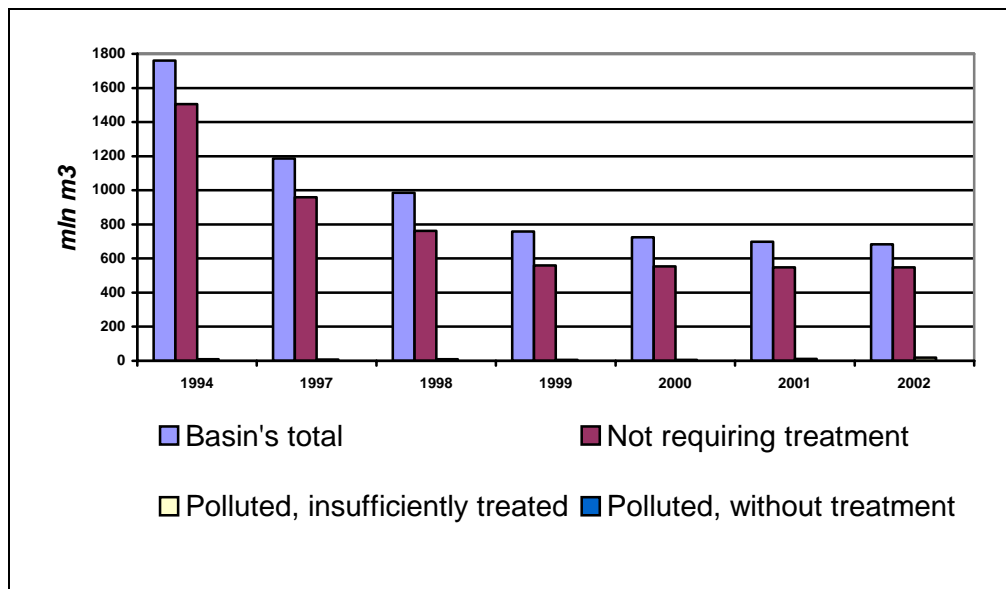


Figure 3.5. Annual Effluent Discharges in the Dniester Basin within Moldova, million m³/year

In 2002, the surface water bodies within the Dniester Basin received 678.85 million m³ of effluents from Moldovan sources, including 112.9 million m³ of wastewater treated to the standard, 17.6 million m³ of partially treated wastewater, and 0.45 million m³ of untreated effluents. The remaining part (547.9 million m³) was accounted for by 'normatively clean' wastewater discharges, that did not require any treatment since they were released from the cooling reservoir of the Kuchurgan Thermal Power Plant. A significant proportion of wastewater flow is generated in Chisinau and Balti, where local wastewater treatment facilities are reported to operate at relatively high efficiency. That said, municipal wastewater utilities have been and remain the major sources of pollution in the Dniester Basin within Moldova, especially in smaller municipalities where wastewater treatment capacity is either lacking or inefficiently operated.

The pollution load that entered surface waters with effluent discharges in 2002 comprised 2,600 tonnes of organic matter, 1,800 tonnes of suspended solids, 0.2 tonne of oil products, 18,600 tonnes of sulphates, 17,400 tonnes of chlorides, 100 tonnes of ammonium nitrogen, 0.04 tonne of copper, 21.5 tonnes of surfactants and many other polluting substances.

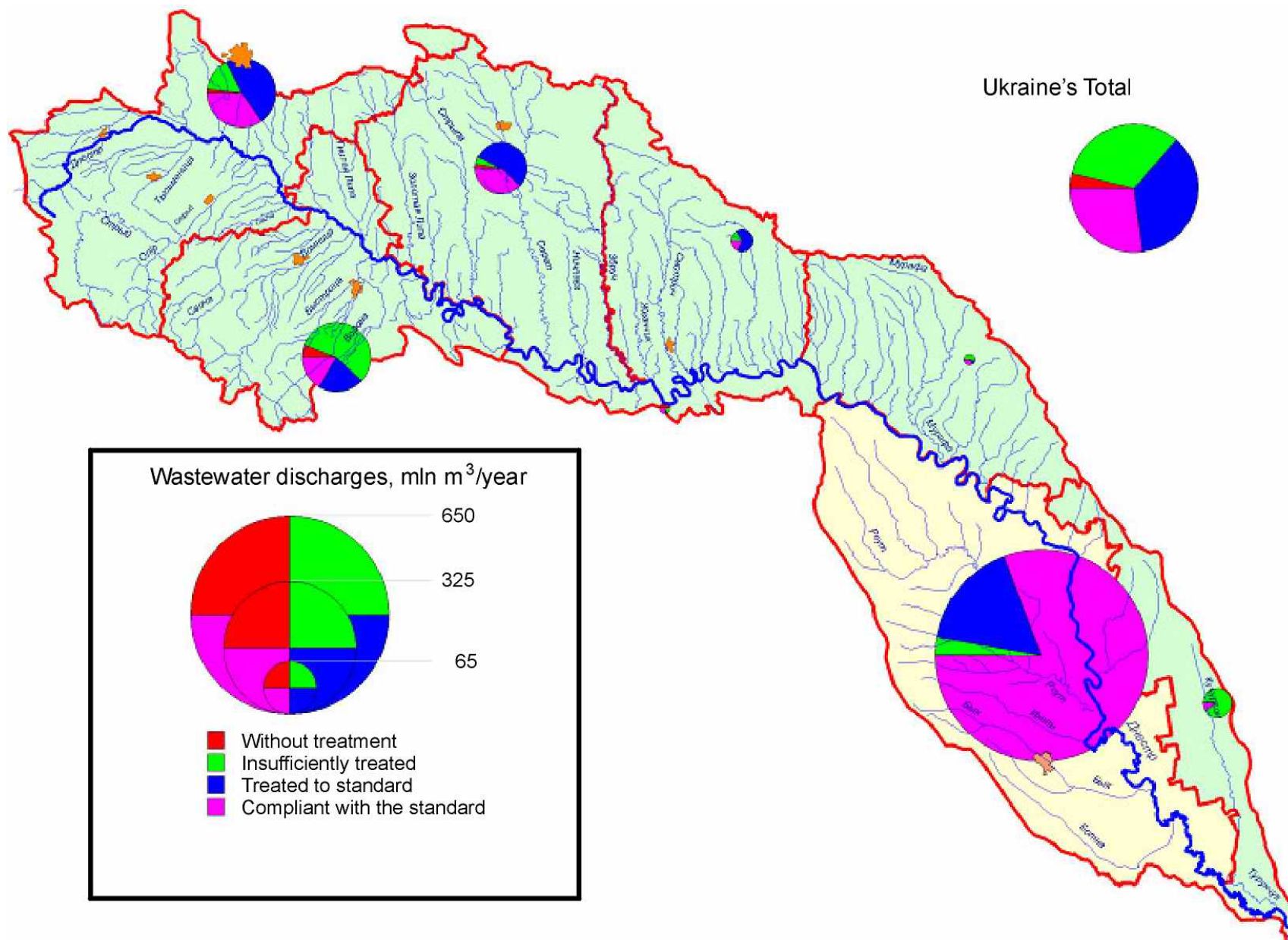


Figure 3.6. Wastewater Discharges in the Dniester Basin in 2002

3.4. Fisheries

The Basin's biological resources play a significant role in the two national economies. According to different sources, from 76 to 91 fish species have been recorded in the Dniester Basin [42]. Two major factors have been at work to affect the fish species composition in the Basin. On the one hand, alien species such as stone moroco (*Pseudorasbora parva*) and Amur sleeper (*Perccottus glenii*) have found an ecological niche in which to flourish. On the other hand, the populations of many valuable native species, including sturgeon, have declined as a result of modification/loss of their habitats. Some introduced species (e.g. the common whitefish) have not established themselves in the Basin, while other species (e.g. the silver carp, the bighead carp, and the grass carp) have lost their natural reproduction ability, but as they are artificially reproduced they continue to play a significant role in the local ecosystems.

Since the early 1990s, the Dniestrovsky reservoir has been the site of a commercial fishing operation run by two large fishing companies, the Chernivtsy and Khmel'nitsk Fishing Enterprises. Total annual catches range between 16.5 and 21.3 tonnes. Low catches are attributed to be the result of low efficiency and poor management practice, rather than limited or declined fish stocks. The major proportion of commercial catches (42.9-62.1%) is accounted for by common bream, followed by common carp (21.2-26.4% of the total catch in some years). Overall, 14 fish species have been recorded in the commercial catches, but only 8 of them are important for commercial fishing, accounting for over 90% of the total catches. The lack of adequate and sufficient spawning grounds for phytophyllic species may significantly affect the fish stocks in the Dniestrovsky reservoir, especially in spring, when significant volume of water is released downstream in order to meet the ecosystem's demand for river flow in the lower reaches of the Dniester.

Within Moldova, the water bodies designated for fisheries are generally grouped into two categories: natural water bodies, including the Dniester itself, its tributaries, cutoff meanders, and small lakes; and man-made impoundments, including fish ponds and smaller in-stream reservoirs constructed along the Dniester tributaries. The network of fish farms within Moldova comprises 12 fish-breeding hatcheries that have been used to increase fish populations in the natural water bodies, though the scale of fish-breeding activities has reduced over the past 10-12 years.

The Dniester Mouth and Estuary. The Dniester's mouth section, including the Dniester Estuary, is the second largest fishing resource in Ukraine, with about 20 fish species being exploited commercially. The areas open to commercial fisheries include the floodplain lakes and the Estuary itself, and a network of fish-breeding ponds. In the 1940-1960s, total catches in the Estuary were at about 500 tonnes per year. Since the 1970s, the catches were continuously growing, from 600 tonnes/year to 800 tonnes/year, to reach the highest levels in the 1980s (about 850 tonnes/year on the average, with a peak catch of 1,230 tonnes recorded in 1989). According to the official statistics, fish catches were almost halved to 600 tonnes/year in the 1990s, though expert estimates put the real catch at nearly twice as much, i.e. about 1,700 tonnes per year, with 1,100 tonnes per year being accounted for by local residents and amateur fishermen. It should be noted that these statistics do not include illegal fishing.

It can be concluded that fish stocks in the Dniester Estuary have retained their high natural productivity and species diversity. The Estuary resources have not been managed in a sustainable manner, and the diversity of commercial fish species has been reduced. Some species have virtually disappeared, being substituted by other opportunistic species [43]. The history of fish-farming operations in the Dniester Estuary dates back to the mid-1960s. One recent example of unsustainable management of Dniester Wetlands relates to the transformation of natural reed/wetland biotopes in the Karahol Estuary (Liman) into a system of fish ponds, which has altered

the natural water exchange between the liman and wetlands, with a dramatic impact on the fish spawning areas.

Anthropogenic Impacts on the Dniester's Fish Stocks. The Dniester has seen four major modifications of natural flow regime within a span of the past 50 years. These include:

- Construction of the Dubossary Hydropower Plant, resulting in a modified river flow pattern;
- Elimination of the floodplain lake system along the Dniester and its tributaries;
- Construction of the Dniestrovsky Hydropower Plant, which has led to the modification of flow, temperature and light regimes in the river,
- Flow regulation in the smaller river catchments, mainly drained by the second- and third-order tributaries.

All these developments have shaped the current flow regime in the Dniester Basin within Moldova, with significant impacts on its fish stocks. Large-scale land drainage system, covering 38,000 hectares in the river floodplains, was put into operation in 1950-1965 to provide more land to agriculture. As a result, the spawning and feeding grounds of all phytophillic fish inhabiting the Dniester Basin have been completely destroyed.

The construction of the Dubossary dam (see Section 3.1) has transformed the Dniester's ecosystem into two separate systems – the Dubossary reservoir and the Middle Dniester, and the Lower Dniester itself. Another major factor affecting fish stocks is the so-called thermal pollution of river flow released from the Dniestrovsky reservoir. The annual economic losses from the damage incurred to downstream fish stocks by thermal pollution are estimated to be US\$95,000. In addition, the modification of the temperature regime indirectly promotes the spontaneous fluctuations in numbers of short-cycle fish that have no commercial value (e.g. dace (*Leuciscus leuciscus*), three-spined stickleback (*Gasterosteus aculeatus*), black-striped pipefish (*Syngnathus abaster*) and some other species). It should be noted that these fluctuations remain unpredictable in terms of species, number, and population distribution along the river.

Poaching has had a devastating impact on fish stocks, both in Moldova and Ukraine. Clearly, the hydropower generation and poaching are powerful anthropogenic factors that affect the Dniester's fish stocks at a transboundary scale.

Historically, fish catches in the Dniester were very high. For example, A. Browner (1887, Notes on Fisheries in the Dniester and its Estuary) surveyed the fish stocks and reported the following annual catches for the Dniester/Turunchuk floodplain and Dniester Estuary in 1883: 18,395 poods (300 tonnes) and 1,185 poods (19 tonnes), respectively. K. Suvorov visited the Dniester Basin in 1914 and reported the total annual catch in the Dniester Wetland lake system at 7,130 tonnes per year. Only within the Kuchurhan Estuary (Liman), occupying the area of approximately 3,000 ha, total annual catches in 1904 through 1910 were at 606 tonnes per year, much of that large-size commercial fish. The total annual catch of 96 tonnes was reported for the Tudorovo Lake in 1883. More recent statistics indicate a dramatic fall in catches in the 1990s (Table 3.3).

Table 3.3. Commercial Catches in the Dniester Basin within Moldova [14]

Year	Lower Dniester	Dubossary Reservoir	Kuchurhan Liman
1980	90.2	56.0	94.7
1985	98.5	31.4	160.3
1995	11.5	14.7	33.2
1997	16.0	5.7	16.0
1998	13.8	2.1	-
1999	3.0	-	-
2000	13.0	3.4	-

Year	Lower Dniester	Dubossary Reservoir	Kuchurhan Liman
2001	5.3	11.1	-
2002	10.9	20.0	-
2003	19.2	25.2	

The current state of fish stocks in the Dubossary reservoir and Middle Dniester Basin is graphically illustrated by changes in fish catches. In the Dubossary reservoir, the highest catch at about 130 tonnes was recorded in 1964, followed by a progressive reduction that continued till 1990. Catches stabilized in the 1990s at 50-60 tonnes per year, and have fallen dramatically in the past decade, to some 3 to 20 tonnes per year.

The species pattern of fish stocks in the Lower Dniester Basin within Moldova remains largely unchanged after the regulation of the water flow, but the populations of many fish species have declined so dramatically that they no longer occur in commercial catches. Prior to damming, commercial catches were dominated by carp, bream and pike. As a result of dam construction, the natural system of floodplain lakes has disappeared, and commercially valuable fish species (carp, bream, pikeperch, roach and silver carp) were succeeded by species of little or no value.

A special point to note is the fact that fish populations inhabiting the Lower Dniester and Dniester Estuary have their spawning grounds in the Dniester within Moldova, whereas the Dniester Estuary, located within Ukraine, is their major feeding area. This is an obvious demonstration of urgent need in a really integrated approach to basin management.

3.5. Recreation Potential

The amenity value of the Dniester Basin is very high, and sustainable development of its potential as a unique recreation region will provide significant economic benefits, both directly and indirectly. The warm season, suitable for summer recreational activities, normally lasts for 6 months (May through October) in the foothill and plain areas of the Basin, and 4 months (June through September) in the mountains. The winter recreation season lasts for 3 to 6 months. The average number of sunny and clear days is 140-150 (10-20 days per month) in the foothill and plain areas, and 100-120 days in the mountains.

The Dniester Basin has picturesque landscapes, forests, meadows, wetlands, and varied terrains. Extended areas of woodland, beautiful landscapes, unique areas of wildlife and virgin nature, rich diversity of plant and animal life, a variety of terrains, a dense river network, and clean natural waters add to the high recreational and amenity value of the Basin. Natural mineral water springs provide a good basis for the development of spa resorts, especially in the Truskavets and Morshin areas.

The Dniester Basin in Moldova is the main area of recreational activities, the most popular of which are camping, hiking, hunting, fishing, and various water-based activities. The major centres of water-based recreational activities in the Moldovan part of the Basin are:

- The Dniester River sections near human settlements, Dubossary reservoir, Kuchurhan Estuary (Liman), wetland areas extending along the ancient Dniester channel;
- Protected areas of woodland located in the river floodplains and valley slopes. In the north of Moldova, these include the following sites: the 33 Fords site, the Rudi-Arionesti site, the Cosauti site, the Saharna site, and the Tipova site. In the Middle and Lower Dniester Basin, the major sites of interest are the Hirbovat Woodland, and the areas of natural floodplain landscapes (the Turkish Orchard and Kuchurhan Liman);
- Tourist centers and resorts in Vadul-lui-Voda, Holercani, Cocieri, Camenca, and Soroca.

There are many other recreational areas in the Dniester Basin, known by many tourists, both local and visitors. The most important of them include the natural parks in Reditu-Mare, Taul, and Yasna Poliana; the landscape parks and woodland areas in Dobruja, Plaiul Fagului, Codru, Capriana, Hirbovat, Trebujeni, and Pohrebeni; the spa resort in Calaras; the mineral water springs in Gura-Cainarului and Varnita, etc.

As can be seen from the above, the Dniester Basin has a unique development potential for recreation, especially agro- and eco-tourism. Recreation is an important part of any national economy, and it is sad to note that the number of people vacationing in the Dniester Basin within Moldova has fallen dramatically in recent years, mainly due to the reduction in the number of foreign visitors.

3.6. The Dniester River and Human Health

Like any other watercourse, the Dniester influences the health of local population in many ways. On the positive side, the people enjoy access to the river's rich and valuable natural resources. There are, however, factors that may cause adverse health impacts by different mechanisms, both direct and indirect. It is important to note that the nature and magnitude of these adverse impacts on human health are not only determined by its natural and geographical characteristics, but also depend on human behaviour and the ability to manage the river's resources in an adaptive and sustainable manner, in order to prevent potential risks to human health and life.

Generally, the Dniester's water meets the standards for drinking water supply [44], particularly with regard to chemical parameters. The fact is, however, that this water is only suitable for drinking and other domestic uses after a multi-stage treatment process, consisting of clarification, coagulation, filtration, and disinfection. The history and experience of the Dniester's water use for drinking water supply to Chisinau and 6 other urban areas have demonstrated that an acceptable quality of drinking water can only be ensured by operating the water treatment process in strict compliance with relevant technical standards.

Surface waters may affect human health if they contain microbial contamination. No outbreaks of water-borne enteric infections have been recorded in the Republic of Moldova over the past decade, and there is no evidence confirming any relationship between the enteric disease incidence and exposure to and/or consumption of Dniester's water. Several recent outbreaks of water-borne enteric infections are attributed to be the result of consuming the water from local shallow wells, rather than river water.

The Dniester Estuary is an area of special concern in terms of its sanitary and epidemiological situation. The river water in this section is characterized by elevated levels of pollution, especially with regard to bacterial contaminants.

According to data provided in [45], the antigens (indicator organisms) of various pathogenic viruses (hepatitis A virus, rotavirus, reovirus, and adenovirus) were regularly recorded in the Dniester water samples in the period of 1996-2002. It should be noted in this respect that the higher numbers of rotaviruses, recorded in the river water samples in 1998, remained stable in 1999-2000. This data correlate well with the results of tap water analyses in Odessa [46], suggesting that the presence of viruses in the water supplied was the major cause of enteric disease outbreak in 2000.

A particularly challenging issue relates to the presence of hepatitis A virus in water sampled in various locations. The evidence provided in [47] indicates that the growing frequency of hepatitis A incidence, recorded in Odessa in 2000-2002, was caused by poor quality of raw and tap water, and low efficiency of wastewater treatment, especially with respect to virology. According to [48], the

Cryptosporidia oocyst was found to have been present in surface water and effluent samples taken in the City of Odessa and Odessa Oblast (1% of surface water samples taken from the Category 1 water sources, 6% of samples taken from the Category 2 water sources, and 14% of sewage effluent samples).

In view of the close relationship between the river and tap water quality, the best way of improving the situation would be to address the issue of drinking water quality and public health by designing and implementing the most urgent sanitary safety measures in parallel with actions designed to improve the ecological state of the Basin's water resources. In the design and development of these measures, account should be taken of current status of water supplies in the Basin, and greater emphasis placed upon the improvement/modernization of the water treatment process.

4. Water Quality Monitoring

4.1. Water Quality Monitoring in Ukraine

The monitoring of water quality in the Dniester Basin is carried out on the basis of the Cabinet of Ministers of Ukraine Resolutions No. 391 of 30.03.1988 and No. 815 of 20.06.1996, which specify the monitoring procedure and responsibilities of relevant authorities. According to these Resolutions, the following organizations are authorized to monitor the state of surface waters: the State Hydrometeorological Service (in the Ministry of Emergencies of Ukraine), the Ministry for Environment Protection of Ukraine (through the analytical laboratories operating under the State Regional Departments for Environment Protection in the Oblasts), the State Water Management Committee, and the Ministry of Health (only in the locations of centralized domestic and drinking water intakes and designated recreational areas).

1) *The State Hydrometeorological Service (Hydromet) Network.* The Hydromet Service has the greatest density of monitoring locations in the Dniester Basin, including 26 sampling locations covering:

- The Dniester itself, Dniestrovsky reservoir, and Dniester Estuary: 10 locations;
- The 1st order tributaries: 9 locations;
- The 2nd and 3rd order tributaries: 7 locations.

18 sampling locations are combined with gauging stations. This is considered to be a significant advantage of the Hydromet Network as opposed to monitoring systems managed by other organizations, as it enables the integrated monitoring of water resource quality and quantity.

The current status of existing Hydromet Network can be briefly described as follows:

- The network does not include monitoring locations that are representative in the context of transboundary pollution loads in the Dniester Basin;
- The number of monitored parameters is limited;
- Sampling frequencies are low.

2) *Analytical Laboratories Operating under the Oblast-level State Regional Departments for Environment Protection.* These laboratories conduct water quality monitoring for pollution control purposes. According to the Annual State of Environment Reports, produced by each administrative Oblast, the water quality was reported to have been regularly sampled in over 170 locations in the recent years.

The list of parameters monitored by the State Oblast Departments for Environment Protection comprises 48 items, including 3 microbiological parameters. However, only 13 parameters are monitored regularly in all Oblasts.

2) *The State Water Management Committee Network.* According to the Regulation on the State Monitoring System, the State Water Management Committee monitors the surface waters where they are used for various purposes, in the locations of nuclear power plants, and in the transboundary water bodies. In the Dniester Basin, the State Water Management Committee has a water quality monitoring network consisting of 43 sampling locations, covering:

- The Dniester itself and Dniestrovsky reservoir: 17 locations;

- The 1st order tributaries: 12 locations;
- The 2nd order tributaries: 4 locations;
- The 3rd order tributaries: 1 location;
- Smaller reservoirs: 9 locations.

It should be recognized that the overall efficiency of the monitoring effort is significantly undermined by the lack of a coordinated approach to the selection of monitoring locations. As a result, very few sampling stations of the State Water Management Committee Network match the locations of gauging stations operated by the State Hydrometeorological Service. The range of analysed water quality parameters varies from 27 to 35, depending on the availability of adequate equipment. In addition, the levels of radionuclides (¹³⁷cesium and ⁹⁰strontium) are monitored in the majority of sampling locations. Samples are taken on a monthly basis in the locations of drinking water intakes, and on a quarterly basis in all other locations, in order to cover all major hydrological phases.

4.2. Water Quality Monitoring in the Republic of Moldova

In Moldova, the monitoring of surface water quality in the Dniester River Basin is carried out on the basis of the Law on Environment Protection (16 June 1993, No 1515-XII) and the Law on Hydrometeorological Service Activities (25 February 1998, No. 1536-XIII). Pursuant to these Laws and related Regulations, overall responsibility for surface water quality monitoring at the national level rests with the Environmental Quality Monitoring Centre within the State Hydrometeorological Service of the Republic of Moldova.

Other relevant bodies with monitoring responsibilities include: the State Environmental Inspectorate, conducting water quality monitoring for pollution control purposes; the National Scientific and Practical Centre of Preventive Medicine within the Ministry of Health, conducting water quality monitoring in the locations of centralized drinking water intakes; and the Geological Agency of Moldova along with the State Water Concern “Apele Moldovei”, conducting the monitoring of groundwater quality, quantity and uses.

There is no integrated system for surface water quality monitoring in the Dniester Basin. Due to the lack of funding, the existing monitoring network does not cover all of the Dniester’s tributaries and is not capable of ensuring the proper quality of monitoring data. The monitoring is further impaired by insufficient sampling frequency, a limited range of pollutants monitored, and inadequate analytical equipment. There is little coordination between different organizations involved in the monitoring of water quality in the Dniester Basin, and similarly little coordinated reporting of the data collected.

1) The State Hydrometeorological Service Network

This monitoring network was designed to monitor the ambient pollution levels in surface waters in order to track any abnormally high pollution levels and provide information in a prompt and timely manner to the relevant local and central government bodies that are authorized to make decisions on required measures to prevent/minimize the adverse impacts of pollution on the environment and human health.

Within Moldova, the routine monitoring programme includes 47 parameters and additional 5 biological indicators (zooplankton, zoobenthos, phytoplankton, periphyton, aquatic microbiology). In 2001, as part of the successfully implemented project “Real-Time Monitoring and Decision Support systems for International Rivers: Application The Dniester and Prut Rivers” (funded under the NATO Science for Peace Programme), the State Hydrometeorological Service of the Republic

of Moldova received 4 automatic monitoring stations capable of determining the following surface water quality parameters: pH, temperature, water level, conductivity, turbidity, and dissolved oxygen. By the joint decision of the State Hydrometeorological Service staff and NATO experts, these stations have been put into continuous operation in the cross-border sections of major transboundary rivers, including the Dniester, where two stations have been installed in the following locations:

- In the north, near the Naslavcea village, where the Dniester enters the territory of Moldova;
- In the south, near the Tudora village, where the Dniester leaves the territory of Moldova.

The following key objectives have been achieved through the installation and operation of these stations in the cross-border sections of transboundary rivers:

- Systematic and integrated control of water quality in the cross-border locations;
- Reliability of monitoring data and adequate quality of measurements;
- Prompt and timely reporting of the data collected;
- Prompt and timely exchange of information, and early notification of neighbouring countries, governmental bodies, ministries, agencies, and general public about any extreme pollution events affecting the transboundary waters.

2) *The State Environmental Inspectorate Network (Ministry of Ecology and Natural Resources)*

The State Environmental Inspectorate (SEI) maintains the water quality monitoring network for control of pollution sources in the Dniester Basin, with its 12 monitoring stations being mainly located downstream of major human settlements. The monitoring of surface water quality is carried out on the basis of the officially approved Monitoring Programme. The collected samples are delivered to the relevant territorial laboratories for subsequent analysis.

The key difference between the SEI Monitoring Network and the Hydromet Monitoring Network is that the former conducts water quality monitoring for pollution control purposes (discharges from industries and municipal wastewater treatment plants).

3) *The Monitoring Network of the National Scientific and Practical Centre of Preventive Medicine within the Ministry of Health of the Republic of Moldova*

The focus of this Monitoring Network is the quality of drinking water supplies in the Republic of Moldova. The Centre's role is to carry out the monitoring of surface water and groundwater quality in a systematic manner, with a special emphasis on the microbiological parameters.

3) *The Geological Agency of Moldova*

In accordance with the State Monitoring Programme, the Geological Agency of Moldova is responsible for the monitoring of groundwater quality and levels in the Dniester Basin. Due to the lack of funding, the monitoring activities have been carried out on a very limited scale during the last 5-6 years.

After processing, analysis, and summarization, the collected monitoring data are shared with the non-governmental organizations, local authorities, ministries, agencies and other stakeholders.

4.3. Issues Relating to the Organization and Management of Monitoring Activities

The existing arrangements for surface water quality monitoring in the Dniester Basin as a whole have common flaws, stemming from the lack of feedback between the process of environmental quality monitoring and process of water resource management and protection. This results in:

- Lack of adequate coordination between various monitoring systems, managed/maintained by different agencies;
- Suboptimal choice of sampling/monitoring locations;
- A limited number of monitoring parameters and monitored media; and inadequate monitoring frequencies;
- Inadequate analytical and methodological capability of laboratories, with the analysis of the full range of pollutants and their respective MAC's (maximum admissible concentrations) being severely impaired by the lack of adequate equipment;
- Lack of effective data quality control/assurance arrangements;
- Undeveloped information management and data exchange;
- Inadequate methodological framework for data analysis and interpretation, and underdeveloped procedures for water quality assessment.

5. Surface Water Quality

Ukraine and Moldova use different methodological approaches to the assessment of surface water quality.

The surface water quality assessment methodology used in Moldova is based on the maximum admissible concentrations (MAC's), defined for a range of parameters. The data on the MAC exceedences are used to derive the value of Water Pollution Index (WPI) as an integral measure reflecting the state of surface waters. In Ukraine, the integrated assessment of water quality is undertaken on the basis of the "Technique for Assessment of Ecological Status of Surface Waters in Terms of Water Quality Categories" [49], which involves a range of physical, chemical, microbiological and biological parameters of water quality. This methodology demonstrates a significant level of compatibility with the requirements of the EU Water Framework Directive.

5.1. Surface Water Quality in the Ukrainian Part of the Dniester Basin

The ecological status of surface waters in the Dniester Basin was assessed on the basis of the "Technique for Assessment of Ecological Status of Surface Waters in Terms of Water Quality Categories" [49] and "Technique for Calculating and Setting the Ecological Quality Standards for Surface and Estuarine Waters in Ukraine" [50], over the periods of 1986-1990 and 1995-2001. The surface water quality in the Dniester Basin was assessed on the basis of official monitoring data, available in the state monitoring system. The 1986-1990 monitoring data were available for 23 parameters, sampled at 34 monitoring locations covering 15 rivers in the Basin. The 1995-2001 monitoring data were available for 23 monitoring parameters, sampled at 25 monitoring locations (15 rivers and Dniester Estuary). The locations of sampling stations are shown in Figure 5.1.

In each sampling location, for which data was available, water quality was assessed on the basis of actual concentrations of specific parameters, measured on a specific sampling date. A mean value was derived for each of three Group Indices, characterizing specific water quality aspects, namely: Chemical Pollution Index, Ecological/Sanitary Index (characterizing the trophic and saprobiological state of water body in a given location), and Toxic Effect Index. The values of these indices were used to assign a water quality category to an examined river section in accordance with the existing Ecological Quality Classification System [49]. The values of the Ecological Quality Index for various sections of the Dniester Basin, averaged over the period of 1995-2001, are shown in Figure 5.1.

5.2. Surface Water Quality in the Moldovan Part of the Dniester Basin

The surface water quality in the Moldovan part of the Dniester Basin was assessed on the basis of the Water Pollution Index (WPI) methodology. At the national level, the preparation of the surface water quality assessment reports is the responsibility of the State Hydrometeorological Service of the Republic of Moldova, which conducts the environmental quality monitoring of various media (surface waters, ambient air, soil, background radioactivity levels) and maintains an extensive monitoring network nationwide.

Available analytical results indicate that the ambient water quality in the Dniester is now generally better when compared to the 1980-1990 data, especially in terms of organoleptic and biological criteria. Mineralisation of the river water has decreased by 10-15%, to 248-473 mg/l. Over the same period, reductions have been reported in the concentrations of the following pollutants: nitrates and phosphates (2-3 times, to 0.2-0.3 mg/l and 0.08-0.1 mg/l, respectively) and humus compounds (2-5 times).

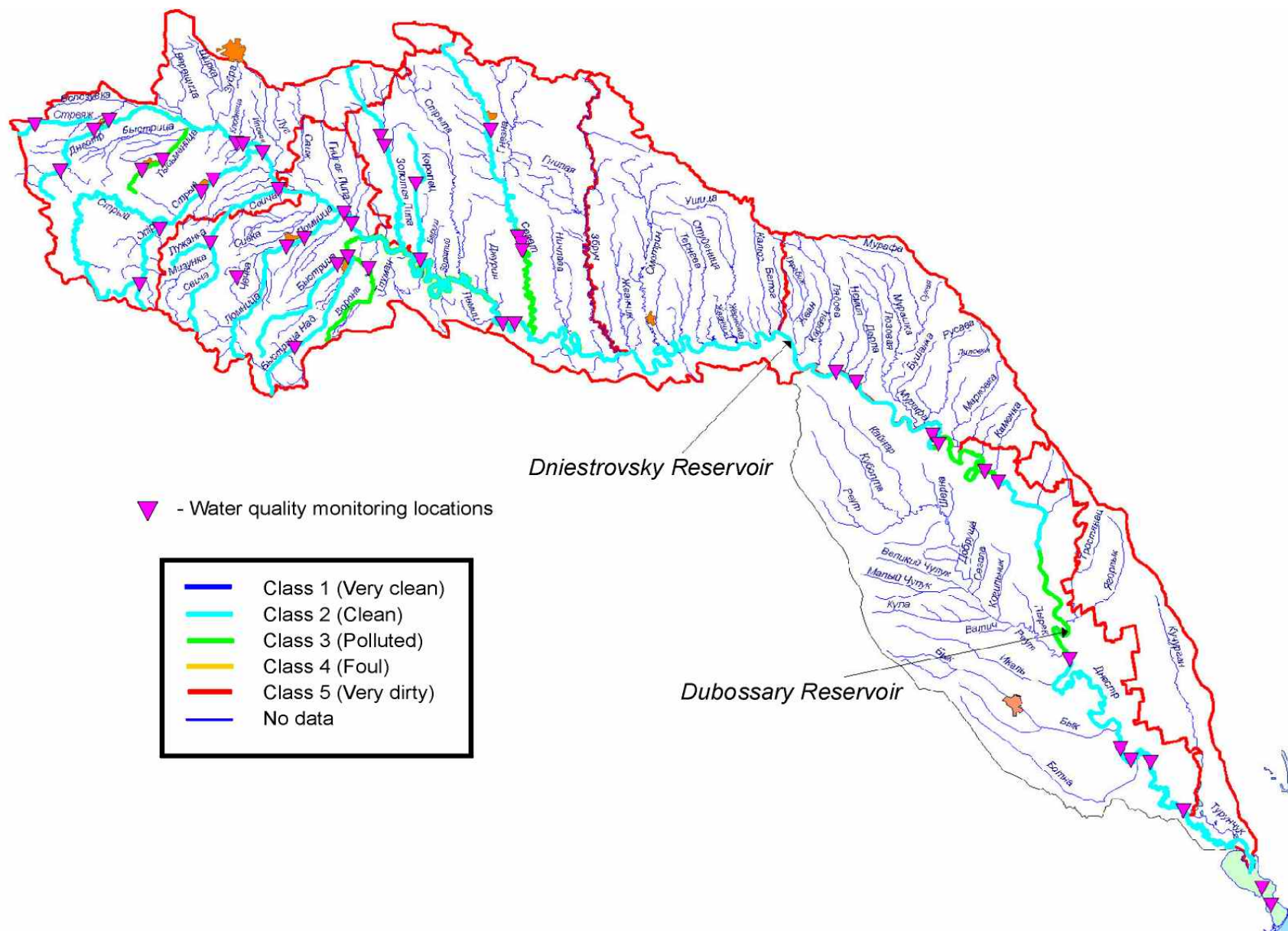


Figure 5.1. Results of Water Quality Assessment on the Basis of National Classifications Adopted in Ukraine and Moldova (2002)

In 2003, oxygen levels were reported to be relatively good throughout the river. Relative to 2002, the 2003 average concentrations of nitrite nitrogen were slightly lower, with the levels of ammonium nitrogen being higher. Copper concentrations remain high throughout the river, ranging from 0.001 mg/l (within the MAC limit) to 0.003 mg/l (3 times higher than MAC limit). The highest copper concentration (0.009 mg/l, or 9 times higher than MAC limit) was recorded near Bendery.

The highest average concentration of phenols was 0.005 mg/l (5 times higher than MAC), and their maximum concentration 0.02 mg/l (20 times higher than MAC) was reported on a single occasion near Camenca. The average concentrations of oil products were consistently high, ranging from 0.11 mg/l (2.2 times higher than MAC) to 0.30 mg/l (6 times higher than MAC), and the most striking exceedence (1.63 mg/l, or 32.6 times higher than MAC) was recorded downstream of Dubossary. The concentrations of surfactants remained low throughout the river. In terms of Water Pollution Index (WPI), the Dniester River water can be described as moderately polluted (Water Quality Class III).

In 2003, the elevated concentrations of nitrite nitrogen were recorded in all monitoring locations. The analysis of available monitoring data over the past 5 years indicates that the nitrite nitrogen concentrations varied from 0.01 mgN/l (0.5 times higher than MAC) to 0.12 mgN/l (6 times higher than MAC). Both these exceedences were recorded near Soroka in 2000. In 2003, average copper concentrations exceeded the prescribed admissible limits in all monitoring locations. The analysis of monitoring data available for the past 5-year period indicates that average copper concentrations ranged from 0.001 mg/l (within the MAC limit, 2003, near Olanesti) to 0.01 mg/l (10 times higher than MAC). This rate of exceedence was recorded in 2000 downstream of Soroka, and in 2001 near Bendery.

Water quality trends in the Dniester River over the past 5 years were assessed on the basis of the Water Pollution Index methodology, which involves 6 priority parameters, and actual measurement data from 9 monitoring locations. In terms of WPI, the Dniester River water can be generally characterized as 'moderately polluted (Water Quality Class III), with the WPI values for the river section near Dubossary (downstream of the Reut River inflow) ranging from 0.64 in 2001 to 2.64 in 2003 (Figure 5.2.)

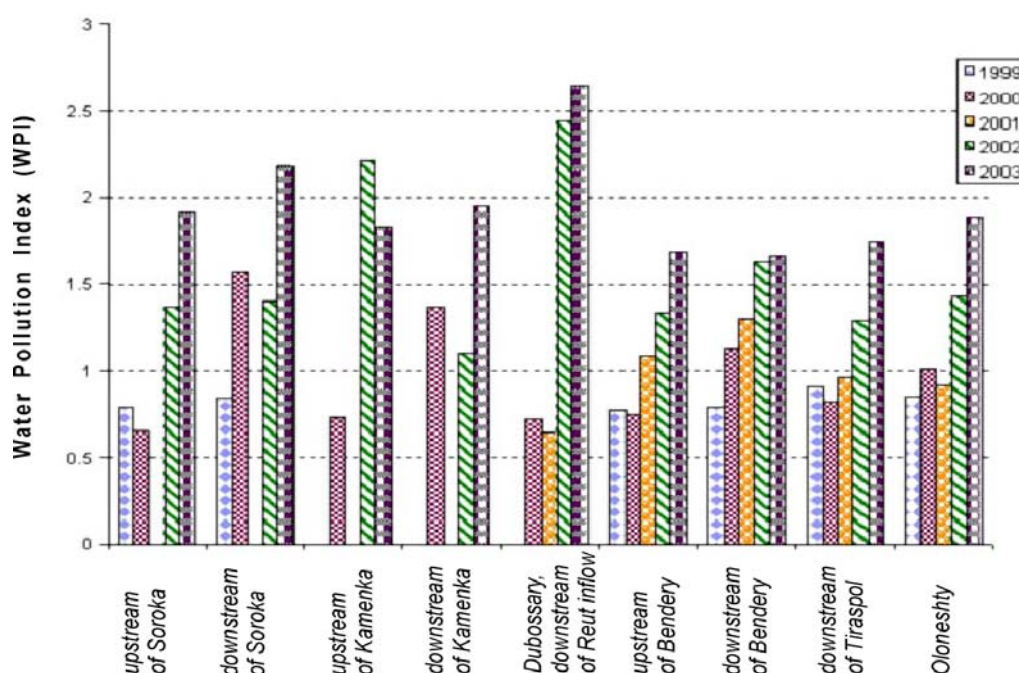


Figure 5.2. Changes in the Dniester's Water Quality, 1999-2003 (within Moldova)

6. Environmental and Water Policies

6.1. Legal Framework

All riparian parties¹ sharing the Dniester's water resources have already developed and adopted their national legal framework for the management and protection of water resources, conservation of biodiversity and natural habitats, management of water uses, and public participation. The following national environmental laws have been adopted by each riparian party to provide a legal framework for the protection and management of their water resources:

- Environment protection laws;
- Water Codes and related regulations, detailing the water use management procedures;
- Laws regulating the Hydrometeorological Service activities in each country;
- Laws regulating the management and protection of flora and fauna.

According to the Law of Ukraine "On Protection of the Natural Environment" (1991), Ukraine's national environmental policy aims to protect and maintain a natural environment that is safe for plant and animal life; protect the human life and health against the adverse impacts of environmental pollution; achieve and maintain the harmonic interaction between the society and nature; and ensure the protection, sustainable management and reproduction of natural resources.

In 1998, the Verkhovna Rada (Parliament) of Ukraine adopted "Main Directions of the National Policy of Ukraine in the Field of Environment Protection, Nature Resource Use and Environmental Safety". The document emphasised that the implementation of environmental actions would require significant amounts of funding. It also states that the country's financial capacity is likely to remain quite limited in the short- to medium-term (i.e. the next 5-10 years) and therefore clearly defined key priorities for action are required in order to maximise the benefits associated with their implementation. Given the actual environmental situation within Ukraine, the following key factors and criteria need to be taken into account:

- Human health is adversely affected by environmental factors;
- Losses resulting from damage to and/or degradation of physical assets and natural resources lead to a decrease in production output;
- The deteriorated state and/or the threat of irreversible damage to biological and landscape diversity (e.g. meadows, pastures, lakes, rivers, forests, coastal and marine ecosystems, and mountain areas);
- The efficiency of environmental actions in terms of environmental and economic benefits.

In the existing economic situation, the main focus of Ukrainian environmental policy is on low-cost and no-cost actions that are likely to achieve significant environmental benefits, in particular:

- Improved housekeeping in industry;
- Strict enforcement of technical standards regulating water consumption;
- Proper maintenance and operation of existing wastewater treatment facilities;
- Emergency avoidance;
- Maintaining the proper sanitary state of urban areas;
- Strengthening the control role of environmental authorities;

¹ The 'Riparian Parties' refers to the parties bordering the same transboundary waters, according to the definition provided in the Helsinki Convention, to which Ukraine and Moldova are parties.

- Enforcement of legislation relating to the management regime of water and coastal protection zones;
- Control over storage and application of pesticides, mineral fertilizers and oil products.

Moldova is currently reforming its national water policy in line with the Water Sector Development Concept, adopted by the Moldovan Parliament, which sets out three priority development areas in the field of water resource management and protection. They relate to the development and introduction of water management and protection system, to be based on: (1) the integrated approach, (2) basin-specific approach that takes account of specific features of each hydrographic basin and its elements; and (3) the involvement and participation of all stakeholders [51].

The key objective of the national water policy [51] is defined as **“the achievement of sustainability in managing the water as a natural component (resource) and a product of socio-economic value (commodity); the establishment and maintenance of healthy and safe living conditions”** in line with the following priority goals:

- Developing and testing various options that combine legal, institutional, regulatory, financial, economic, informational, educational, enforcement and other relevant mechanisms in a manner that facilitates and ensures the sustainable management of waters in the long-term perspective;
- Achieving the reliability of the drinking water supply by ensuring adequate access to safe drinking water;
- Ensuring the country’s food-supply security by promoting the sustainable development of irrigated agriculture, adapted to farmers needs and capabilities;
- Promoting the harmonization of sectoral development plans of those sectors that rely heavily on water resources (industry, power generation, tourism and recreation, fisheries and aquaculture, transport) and development of civil society on the basis of active involvement and participation of all stakeholders in the mutually responsible decision-making.

The Law of the Republic of Moldova “On Environment Protection” (1993) sets out key principles of environmental management and protection, based on the recognition of the fact that the protection of environment is the country’s top priority, which has direct implications for human health and safety, economic and humanitarian interests of the society, and country’s long-term sustainable development agenda.

The harmonization of national environmental legislation with EU laws is among the key priorities of national environmental policies of Ukraine and Moldova. To this end, the Integration Strategy and Programme were developed and approved by the President of Ukraine, and a detailed action plan was developed by the Cabinet of Ministers of Ukraine, outlining the key steps and phases of the harmonization effort of Ukraine, with a particular focus on environmental legislation. A similar document, the Moldova-European Union Action Plan, was adopted in Moldova in 2005. It defines key phases and priorities of country’s integration to the European Union, which include, *inter alia*, implementing measures designed to ensure the sustainable management of environment; taking steps that aim to prevent the environmental degradation and ensure the sustainable management of natural resources; improving and enhancing cooperation with other parties in the field of environment protection.

A number of important regional regulations have been adopted in the Transdnistrian Region in order to ensure the environment protection, sustainable management of natural resources, and environmental safety. These regulations set out the institutional and financial arrangements relating to the organization and management of environment protection activities.

The current systems of environmental laws and regulations, adopted by the riparian parties of the Dniester Basin, provide a basis for the management of water resources and control over activities that affect their quality and quantity. The full-scale implementation and enforcement, however, represent a significant challenge for both countries. In many cases, the existing implementation and enforcement arrangements lack a sufficient degree of flexibility to be adapted to certain specific legal relations, emerging in the course of that or another economic activity. The need to improve these arrangements stems from the fact that the application of certain legal provisions in some cases is not geared to ensure the achievement of the societal objectives they were initially designed for. For example, the majority of Moldovan laws date back to the early 1990s, when a new, market-based, economy was in an embryonic state, as was the country's state sovereignty. Despite some recent updates and amendments, the current legislation is not always adequate in terms of ensuring that the recent market reforms and socio-economic changes are fully reflected and taken account of.

A further point of note relates to the fact that the current water legislation of the riparian parties does not provide the sufficient level of convergence towards existing internationally recognized practices, approaches and principles, especially with respect to the integrated basin management concept and public participation in decision-making, though these aspects have been addressed to some extent in a number of laws.

It should be also noted that the key provisions of the EU Water Framework Directive have not been fully reflected in the national laws or regulations. There is therefore an obvious requirement for revising and amending the national water legislations in the light of an internationally adopted basin management approach, and moving towards the water management, planning and monitoring arrangements set out in the water-related EU Directives.

Another common issue for the riparian parties in the Dniester Basin is the lack of efficient and effective (economic) mechanisms to ensure the enforcement of existing environmental legislation, promote the introduction of resource-saving practices in industries and improved management practices in water sector.

6.2. Institutional Framework

In Ukraine, the Ministry for Environment Protection has the overall responsibility for the management and protection of the environment and, in particular, water resources. Regional offices of the Ministry for Environment Protection of Ukraine are present in the Oblasts, Republican Cities, and the Autonomous Republic of Crimea. The Ministry has an extensive network of research centres and institutes, nature reserves and protected areas, national parks, hydrometeorological centres, regional geological and geophysical survey companies, land surveying/mapping/inventory companies and institutions.

Introduction of a basinwide approach to planning and management of environmental actions is considered as a cornerstone of the national environmental strategy. The following key tasks need to be solved:

- Establishing institutional and financing arrangements to support management decision-making at the basin level;
- Strengthening the methodological and regulatory framework of environmental investment planning and management infrastructure functioning at the basin level;
- Establishing and maintaining basinwide geoinformation systems supported by environmental/water management databases.

In Moldova, the management of water resources is carried out by several different organizations and governmental bodies, responsible for specific aspects of water management in line with the provisions of the national legislation and/or the Moldovan Government decisions.

The Ministry of Ecology and Natural Resources (MENR) is a central governmental authority, responsible for the management of environment protection activities and implementation/enforcement of all relevant laws, resolutions, programmes and standards. The MENR structure comprises several departments, including the department of natural resources, responsible for the management of water resources. Other key departments and services of the Ministry include the State Environmental Inspectorate, the Hydrometeo Service, and the State Geological Agency (AGeoM.).

The Ministry of Agriculture and Agro-Processing Industry (MAPI) exercises its water-related functions through the Republican Water Concern “Apele Moldovei” (RWC “Apele Moldovei”), which holds overall responsibility for managing the country’s water sector at the national level. Key tasks of the RWC “Apele Moldovei” include: management of water resources on behalf of the state; sectoral control over the use and protection of water resources, aiming to ensure that the demands of all country’s economic sectors and population are met; control and management of floods and flooding events; and management and maintenance of water-related land.

The Ministry of Health and Welfare (MHW) is a central government body, responsible for the human health and safe sanitary/epidemiological situation in Moldova. The Ministry’s structure comprises the National Scientific and Practical Centre of Hygiene and Epidemiology (NSPCHE), which exercises control over the sanitary and epidemiological status of the environment, including the monitoring of surface water and groundwater quality where drinking water is extracted and effluents are discharged. The Centre has a network of local sanitary-epidemiological service offices covering all administrative districts.

Local self-governance bodies also have their role to play with respect to the environment protection and management, being responsible for the implementation of environmental laws and regulations. Within the scope of their competence, these bodies develop and approve the resource use limits and emission/discharge limit values, and supervise/coordinate the development and operation of wastewater treatment capacities in their respective jurisdictions.

From the previous it can be concluded that the institutional framework is in place in Moldova to manage the country’s water resources, in terms of quantity as well as quality aspects. The organizations and agencies with water management responsibilities have extensive practical experience and qualified staff to fulfil their specific tasks at the national level.

There are, however, many institutional issues that impede effective decision-making. Specific management functions are distributed among several different organizations and agencies, with little coordination between the agencies, managing, for example, surface water and groundwater resources. The practice still exists of management/supervision functions being combined with those of an operating agency. There is little coordination and integration between the national organizations involved in the management of water resources. There is similarly little coordination of monitoring activities undertaken by different organisations, and little coordinated reporting and exchange of the data collected. The river basin management concept cannot be introduced in the absence of institutional structures with adequate mandates and areas of responsibility. It can be concluded that a new unified approach to water resource management, designed to ensure the sustainable management and protection of water resources at the national, basinwide and local levels in an environmentally responsible manner, has yet to emerge in Moldova. Under the present

arrangement, natural resources (including water resources of the Dniester Basin) are managed on the basis of administrative boundaries, rather than by river basin.

6.3. Existing Financial Arrangements and Sources of Funding

The national legislation of the riparian parties of the Dniester Basin specifies a range of economic instruments designed to encourage the implementation of pollution reduction measures at the company level. These include:

- Environmental pollution fees (air emission fees, water discharge fees, and waste disposal fees);
- User charges levied upon the natural resource uses (water resources, forests, mineral resources);
- Non-compliance penalties and compensation payments for the damage incurred as a result of non-compliant activity;
- Grants and soft loans provided to finance the implementation of environmental improvements (from the national and local environmental funds).

With the system of economic instruments and incentives, reflecting the ‘polluter pays’ principle, being largely in place, there is an obvious requirement in improving their efficiency and transparency.

The current financial flows in the national water sectors of the Basin’s parties mainly consist of revenues collected in the form of pollution fees, resource use charges, and non-compliance fines. At the same time, each country has its own revenue distribution pattern, which is generally regulated by the laws on the national and local budgets, or by the environmental fund mechanism, or by a combination of the two. In recent years, grants and loans from international finance agencies have played an increasingly important role in financing environmental projects. The contribution of private sector remains marginal in both countries of the Basin.

In Ukraine, the programme-based approach has been adopted to facilitate the implementation of the country’s environmental policy, involving the design and implementation of specific priority action programmes at the national, sectoral, regional and local levels. The following national programmes include specific measures designed to address the most urgent environmental problems in the Dniester Basin:

- The 2002-2011 State Water Sector Development Programme (2002);
- The 2001-2005 Integrated Programme for the Protection of Rural Areas and Agricultural Land against the Harmful Impact of Waters (adopted in 2000, with the provision for extension up to 2010);
- The 2002-2005 Municipal Sector Restructuring and Development Programme (adopted in 2002, with the provision for extension up to 2010);
- The Water Supply and Wastewater Treatment Capacity Development Programme (2002);
- The Household Solid Waste Management Programme (2004);
- The 2002-2015 State Programme “Ukrainian Forests” (2002);
- The 2000-2015 National Programme for the Eco-Corridor Network Development in Ukraine (2000);
- The Long-Term Programme for Nature Reserve Capacity Development in Ukraine (the “Nature Reserves” Programme, 1994);
- The 2001-2005 Programme for Land Reclamation Development and Environmental Rehabilitation of Irrigated/Drained Land (adopted in 2000, with the provision for extension up to 2010);
- The 2004-2010 State Fisheries Sector Development Programme (2004);
- The 2003-2011 State Industrial Development Programme (2003).

Table 6.1 summarises the projected expenditures over 2004-2010, included into the Draft State Programme for Environmental Rehabilitation of the Dniester Basin within Ukraine (2004), broken down by sector.

Table 6.1. Estimated Funding Requirements for Priority Actions in the Dniester Basin

	Sector	Total, million €	State Budget, million €	Local Budgets, million €	Other Sources, million €
1	Environmental Management	4.08	2.86	0.22	1.00
2	Water Sector	65.33	65.33	0.00	0.00
3	Municipal Service Sector	39.67	19.00	11.83	10.50
4	Industry	14.30	12.50	0.73	2.07
5	Agriculture *)	0.83	0.42	0.42	0.00
6	Forestry	0.18	0.18	0.00	0.00
7	Fishery	1.43	0.18	0.03	1.22
8	Nature Reserve Management, Biodiversity Conservation	10.15	6.72	0.33	1.37
	TOTAL:	135.97	107.19	13.56	16.16

A number of state programmes, developed and adopted in Moldova, directly address the issue of protecting and managing the country's water resources in a sustainable manner, namely:

- The 2002-2006 Water Supply and Sanitation Development Programme (2002, being updated);
- The Republic of Moldova's Water Supply and Sanitation Master Plan up to 2005 (extended to 2015);
- The Integrated Flood Protection Plan (2000);
- The Integrated Plan for Control of Elevated Groundwater Levels (2000);
- The 'Moldovan Village' Programme (2005);
- The Economic Growth and Poverty Reduction Strategy (2004).

Funding required for the implementation of these programmes comes from various sources. According to the Environmental Policy Concept of the Republic of Moldova, approved by the Parliament Resolution No. 605-XY of 2 November 2001, the environmental expenditure financing mechanism provides a sufficient degree of flexibility for the state budget procedure in order to enable the mobilization of funds from various sources (earmarked reserves held by the operating agencies, local budgets, and environmental fund budget) to finance the implementation of priority environmental actions that are not included into the approved national programmes and projects.

Water protection expenditures are financed from the following sources: state budget, environmental fund, and other specialized funds. According to the official statistics, the environmental expenditures in the Republic of Moldova account for 0.8% of country's GDP, being mainly associated with the improvement of existing wastewater treatment capacity. The funds necessary to finance the water sector activities are disbursed on the basis of approved water supply and sanitation service plans, flood control programmes, water supply and sanitation sector development programmes, and specific sectoral projects, associated with the construction of water pipelines and sewage collection systems in urban areas.

The current crisis, faced by the Moldovan water supply and sanitation sector, is the direct result of drastic cuts in government funding starting from 1991. The poor technical state and low efficiency of water supply and wastewater treatment facilities pose a continuous threat to human health and safety. In view of this threat, the government has now increased the budget transfers to the sector in order to finance the priority capital improvements.

The environmental expenditure studies, commissioned by the OECD, DEPA/DANCEE, indicate that the current levels of per capita expenditure related to water supply and sanitation range between 1.8 to 2.7 USD. In financing the priority investments in the sector, the Republic of Moldova relies heavily on grants and loans provided by the international financial institutions (IFIs), but the level of international environment-related assistance to Moldova remains rather low relative to other NIS countries.

The National Programme “Moldovan Village”, approved by the RM Government Resolution in January 2005, includes a suite of water-related actions with a total cost of about 120.7 million €, to be financed up to 2015 from a range of sources, including:

- State budget: 28.1 million €;
- Local budget: 23.1 million €;
- Social security fund budget: 0.03 million €;
- Earmarked reserves: 0.4 million €;
- Grant funding: 21.9 million €;
- Loan funding: 38.2 million €;
- Special funds: 9.0 million €.

The analysis of current and projected water-related expenditures, financed from various sources, suggests that the main emphasis of funds released from the state budget is on the development of existing water supply and wastewater collection/treatment capacity and rehabilitation of water sector infrastructure (water/wastewater treatment plants, water distribution and sewage networks etc.).

According to the estimates provided by the OECD/DANCEE study “Moldova: Municipal Water and Wastewater Sector: Environmental Financing Strategy”, the total annual supply of finance to water sector is at about 30.8 million € (including all current loans), whereas the total financing requirement is 61.5 million €. Clearly, there is a substantial financial gap to be closed.

The following regional programmes have been adopted in the Transdnistrean Region to address the priority issues in the field of environment protection and sustainable management of natural resources:

- The Earmarked Central Environmental Fund Budget Planning Programme, which forms part of the annual regional budget;
- The Earmarked Local Environmental Fund Budget Planning Programmes, which form part of respective local annual budgets.
- The Land Resource Inventory Development Programme.

The 2005 Budget Planning Programme for the Central Environmental Fund includes the provision for releasing 630,000 Transdnistrean Roubles (63,000 Euro) to finance the implementation of priority water protection actions in the Dniester Basin, out of the total annual budget of 1,958,800 Transdnistrean Roubles (195,900 Euro), allocated for the implementation of all planned environment protection measures.

6.4. International Cooperation (International Legal Instruments and Principles of Transboundary Cooperation in the Dniester Basin)

The legal framework for international cooperation between Ukraine and Moldova includes signed/ratified international conventions and treaties, and bilateral agreements in the field of environment protection. The following table summarises the commitments of the two countries to key international conventions relating to water resources and biodiversity conservation.

Convention/Treaty	Ukraine	Moldova
Convention on the Protection and Use of Transboundary Watercourses and International Lakes, including:	+	+
• Protocol on Water and Health	+	+
• Protocol on Civil Liability and Compensation for Damage Caused by the Transboundary Effects of Industrial Accidents on Transboundary Waters	signed (2003)	signed (2003)
Convention for the Internationally Important Wetlands Especially as Waterfowl Habitats	+	+
Convention on Biological Diversity	+	+
Convention on the Protection of the Black Sea against Pollution	+	-
Convention on Protection of Wild Flora and Fauna and Their Habitats in Europe	+	+
Convention on the Conservation of Migrating Species of Wild Animals	+	+
Convention on the Transboundary Effects of Industrial Accidents	-	+
Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters, including:	+	+
• Protocol on Emission Inventories	signed (2003)	signed (2003)
UN Declaration on Environment and Development	signed	signed
Convention on the Environmental Impact Assessment in a Transboundary Context, including:	+	+
• Protocol on Strategic Environmental Assessment	signed (2003)	signed (2003)
Stockholm Convention on Persistent Organic Pollutants	signed (2001)	+
Agreement on Cooperation in the Field of Ecology and Environment Protection between the CIS Member Countries	+	+

Both Ukraine and Moldova are parties to the international environmental conventions and agreements, adopted under the UNECE auspices in order to facilitate the management and protection of transboundary water resources, including the Dniester Basin. Among the most important of them is the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Helsinki, 1992). Ukraine and Moldova are parties to this Convention, since 8 October 1999 and 4 January 1994, respectively. The Convention obliges the parties to take action, individually and jointly, in order to prevent, control and reduce the transboundary water pollution from point and non-point sources by taking appropriate measures, where possible, at source. Of particular importance are the Convention provisions addressed to the riparian parties, sharing the same transboundary waters. Pursuant to Article 9 of the Convention, the key requirement on these parties is to enter into bilateral and multilateral agreements or other arrangements in order to define their mutual relations and conduct within specific shared water basins. This provision obviously applies to the Dniester Basin.

The legal regime, established under the Helsinki Convention, was further developed through the adoption of two Protocols to the Convention: the Protocol on Water and Health (London, 1999) and Protocol on Civil Liability and Compensation for Damage Caused by the Transboundary Effects of Industrial Accidents on Transboundary Waters (Kyiv, 2003). Ukraine joined the Protocol on Water and Health on 26 September 2003, while Moldova signed the Protocol on 10 March 2000 and ratified it on 29 July 2005, with the effective date of 4 August 2005. The Protocol on Civil Liability was signed by Ukraine and Moldova, but still remains to be ratified in order to come into force.

Apart from the Helsinki Convention, three other UNECE Conventions are to be taken into account when addressing the issues pertaining to the transboundary water management. These include: the Convention on the Transboundary Effects of Industrial Accidents (1992, Helsinki), the Convention on Environmental Impact Assessment in a Transboundary Context (1991, Espoo), and the Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters (1998, Aarhus). The status of international commitments of Ukraine and Moldova to each of these conventions is different. Only Moldova is party to the Convention on the Transboundary Effects of Industrial Accidents (since 4 January 1994); the Espoo Convention was signed/ratified by both Ukraine (on 20 July 1999) and Moldova (on 4 January 1994). Similarly, both Ukraine and Moldova are parties to the Aarhus Convention, since 18 November 1998 and 9 August 1999, respectively. Both countries have signed, but not yet ratified the Protocol on Strategic Environmental Assessment and Protocol on Emission Inventories to the Espoo Convention, adopted in 2003.

Ukraine and Moldova are also bound by commitments ensuing from other international conventions, including the Ramsar Convention for the Internationally Important Wetlands Especially as Waterfowl Habitats (1971), to which they are parties since 1 January 1991 and 20 October 2000, respectively. There are 33 and 2 Ramsar sites within the territories of Ukraine and Moldova, respectively, including in the Dniester Basin area. Consequently, the national efforts of both countries in the field of water resource management and protection in the Dniester Basin should be geared to meet the provisions of this Convention, especially its Article 5 relating to the international wetlands and transboundary water systems.

6.5. Bilateral Cooperation on Water Protection

In addition to international environmental commitments, Ukraine and Moldova are bound by a number of bilateral agreements, relating to the management of transboundary water resources. With respect to the Dniester Basin, Ukraine and Moldova have signed the following agreements:

- Agreement between the Governments of the Republic of Moldova and Ukraine on the Joint Management and Protection of Cross-Border Waters (23 November 1994);
- Inter-Ministerial Protocol, signed between the State Department of Environment Protection and Natural Resources of the Republic of Moldova² and the Ministry of Environment of Ukraine (19 November 1993, Kyiv, Ukraine);

The Agreement between the Governments of the Republic of Moldova and Ukraine on the Joint Management and Protection of Cross-Border Waters (23 November 1994) is the key bilateral document, setting out the framework for the joint management of shared water resources, in many aspects similar to the bilateral agreements on transboundary waters, signed in that period between Ukraine and Russia, and between Russia and Kazakhstan. The Agreement is applicable to all cross-border waters, defined as ‘the sections of rivers and other surface water bodies, which are crossed by the state border’, and ‘surface waters and groundwater sources in the areas, which are crossed by the state border’.

The Agreement sets out joint obligations of the parties with regard to the use and management of cross-border waters and transboundary water bodies. It requires the parties to negotiate and agree any actions that are likely to cause any impact on the state of cross-border waters in the territory of the riparian country.

² The State Department has now been reorganized into the Ministry of Ecology and Natural Resources of Moldova

The Agreement stipulates the appointment of Plenipotentiaries and establishment of an organizational mechanism in the form of annual (planned) and extraordinary meetings of the Plenipotentiaries. It is, however, very general in specifying the competences and mandates of the Plenipotentiaries and their meetings. Generally, the document lacks a clear definition of its purpose and area of applicability, with many provisions duplicating and overlapping each other.

It can be concluded that while the 1994 Agreement on Cross-Border Waters between Ukraine and Moldova provides a basis for bilateral cooperation in the field of transboundary water protection and management, neither its provisions nor structure meet the relevant international standards and criteria, applied to agreements of this type.

7. Public Participation

Social partnership can only be effective if it relies on strong democratic institutions and values, the most important being publicity, openness of state authorities, transparency of state governance and the decision-making processes. The principle of public involvement and participation is reflected in the Moldovan and Ukrainian laws. In 1999, Moldova and Ukraine ratified the Aarhus Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters, which, along with the relevant national laws, forms a legal basis for the NGO activities and their relations with the state authorities. The Law “On Access to Information” was adopted in Moldova in 2000 to ensure that the right of the public to information is realised. In Ukraine, the information right of the public is supported and protected by the Laws of Ukraine “On Information” and “On Public Appeals”.

Both in Moldova and Ukraine, the right of the public to participate in decision-making on environmental issues is stipulated by the national laws and regulations, the most important being the Law of the Republic of Moldova “On the State Environmental Review and Environmental Impact Assessment”, the Moldova’s Government Resolution “On the Approval of the Regulation on Public Participation in Decision-Making on Environmental Issues”, and the Law of Ukraine “On the Environmental Review”.

The fact, however, is that public participation in the governance decision-making process remains rather limited. There is little or no public involvement in the local budget planning process, preparation and discussion of regional development plans. In other words, there remains a significant space for increasing and enhancing the level of public participation in the strategic planning process, with a particular focus on the sustainability aspects. There is similarly insufficient involvement of the public in the river basin management planning. In order to ensure a greater and more effective participation of the public in these processes, the law enforcement mechanism needs to be enhanced. In addition, there is an obvious requirement for more efficient information management and dissemination procedures. This could be achieved by the expansion of the existing network of information centres operating in the higher and secondary educational institutions, and in cities and villages.

Historically, the environmental NGOs have played a significant role in promoting social partnerships and relations between the broad public and the authorities in order to ensure sound and equitable environmental management at all governance levels. Environmental NGOs can be instrumental in gaining a broader public support to the international/national/local environmental action plans, encouraging a more active involvement and participation of local authorities, research communities and civil society groups in water resource management planning on a catchment basis, raising awareness of environmental issues among the public, and helping people to secure their access to natural resources and environmental infrastructure.

There is an extensive network of environmental NGOs in the Dniester Basin, both within Ukraine and Moldova, with their efforts being focused on improving the ecological status of the Basin and its water resources. Only within the Transdnistrian Region, the environmental NGO network comprises about 15 NGOs and five information resource centres that have specialized environmental libraries and access to the Internet. These NGOs contribute significantly to the regional studies, environmental education, and development of eco-tourism potential [52, 53]. In Ukraine, the environmental NGO activities are coordinated through the Dniester Basin Working Group, operating within the Ukrainian River Basin NGO Network, which comprises 21 non-governmental organisations. These organizations have had a major impact on increasing broad public understanding of the fact that society is collectively responsible for the environmental degradation in the Dniester Basin.

The following environmental NGOs have actively worked in the Dniester Basin for over ten years:

- The BIOTICA Ecological Society;
- MAMA-86 NGO;
- The Eco-Tourist Club of Teachers;
- The International Charity Fund “EcoPravo-Lviv”;
- Vernadsky’s Youth Ecological Centre;
- Tourist Association “Courier of Peace”;
- Odessa Branch of the International Socio-Environmental Union;
- Pusanov’s Wildlife Protection and Rehabilitation Fund “Natural Heritage”.

In the light of the transboundary status of many environmental problems in the Dniester Basin, the importance of international cooperation between environmental NGO’s has gained a broad recognition. In 1999, the group of environmental NGOs from Moldova and Ukraine established the International Environmental Association of River Custodians “Eco-TIRAS”, registered in Moldova, which currently includes 46 NGO-members. The Association maintains its own web site in order to facilitate the coordination and access of its NGO-members to information.

The Moldovan and Ukrainian NGOs have established and maintained close and continuous cooperative links. They initiated and held three international scientific and practical conferences, and two Dniester River NGO Forums (“Eco-Dniester-1999” and “Eco-Dniester-2004”). The resolutions adopted by these forums reflected the common vision of key environmental problems in the Dniester Basin and steps required to address them, shared by the environmental NGOs in the two countries. These steps include, *inter alia*:

- Strengthening the legal and institutional framework for the basinwide cooperation in line with the Helsinki Convention and EU Water Framework Directive;
- Establishing the Dniester River Forum as a regular consultation body comprising all stakeholder groups, to operate on the basis of existing legal mechanisms, stipulated by the Intergovernmental Agreement on Cross-Border Waters; and the formulation of the Dniester Basin Strategic Action Plan for the riparian countries;
- Establishing and maintaining a shared data base to collect and store information on the status of water and other resources in the Dniester Basin, and maintain the pollution source inventory; and regular publication of information about the state of environment in the Basin;
- Developing the environmental education and awareness-raising programme for the public and representatives of the authorities;
- Establishing and maintaining a permanently active public Internet-forum (Ukraine, Moldova, Transdnistrian Region, Poland) to coordinate public initiatives in the Dniester Basin;
- Promoting and encouraging dissemination of information, consultation and participation of the public in the development, review and updating of basin management plans and other water protection programmes and policies;
- Promoting a coordinated approach to nature resource use planning and policy development in the Dniester Basin in Moldova and Ukraine, to ensure the sustainable management of water and biological resources, conservation of biological and landscape diversity, and development of ecological network in the Dniester Basin. Enhancing the capacity of nature reserves and protected areas in the Dniester Canyon and Lower Dniester areas, and establishing/maintaining a jointly managed network of wetland areas;
- Promoting the development of ecological tourism and environmental education system in the Dniester Basin;
- Strengthening the cross-sectoral cooperation with the active involvement of environmental NGOs and local authorities in planning and implementing environmental actions, and promoting the sustainable development and transboundary cooperation agenda in the Basin.

8. Priority Environmental Problems, Anthropogenic Factors Contributing to These Problems, and Their Primary Causes

An analysis of the current ecological status of the Dniester Basin and existing water resource management arrangements enables the identification of priority environmental problems that require urgent action. These problems are:

- 1) Harmful effects of waters: disastrous floods, water erosion, river bank degradation;
- 2) Inadequate water quality, especially in the locations of drinking water intakes;
- 3) Inadequate sanitary, ecological, and hydrological state of smaller river catchments in the Basin;
- 4) Depletion and deficit of the Basin's water resources;
- 5) Eutrophication;
- 6) Reduction/loss of biological diversity of the Basin's aquatic ecosystems;
- 7) Decrease of hydrobiological resources.

The status and urgency of these issues vary across the Basin. The flow chart presented in Figure 8.1 graphically illustrates the complexity of relationships between the key environmental problems in the Dniester Basin, anthropogenic factors contributing to these problems, and major direct causes of the problems, stemming from various sectors of human activity.

8.1. Transboundary Environmental Problems in the Dniester Basin

A broad range of priority environmental problems in the Dniester Basin have an obvious transboundary dimension stemming from the transboundary scale of adverse impacts associated with these problems, which include:

- 1) The transboundary impact of the regulation of the river on the quantity and availability of water resources in various sections of the Basin, with adverse effects on the flow regime and ecological status of the Basin;
- 2) The transboundary impact of flow regulation and water pollution (in terms of physical, chemical and microbiological parameters) on the state of biological resources and fish stocks, arising in Ukraine and affecting Moldova;
- 3) The transboundary impact of chemical and microbiological pollution, arising in Moldova and affecting the water quality and ecosystem health in the Lower Dniester Basin within Ukraine;
- 4) The adverse impact on the Black Sea ecosystem due to significant pollution load carried with the Dniester flow into the sea;
- 5) The need for coordinated transboundary cooperation to ensure the conservation of the Basin's ecosystem, and its biological and landscape diversity, especially the unique system of natural wetlands in the Lower Dniester Basin. The establishment of ecological coherent network and expansion of nature reserve network in the Basin.

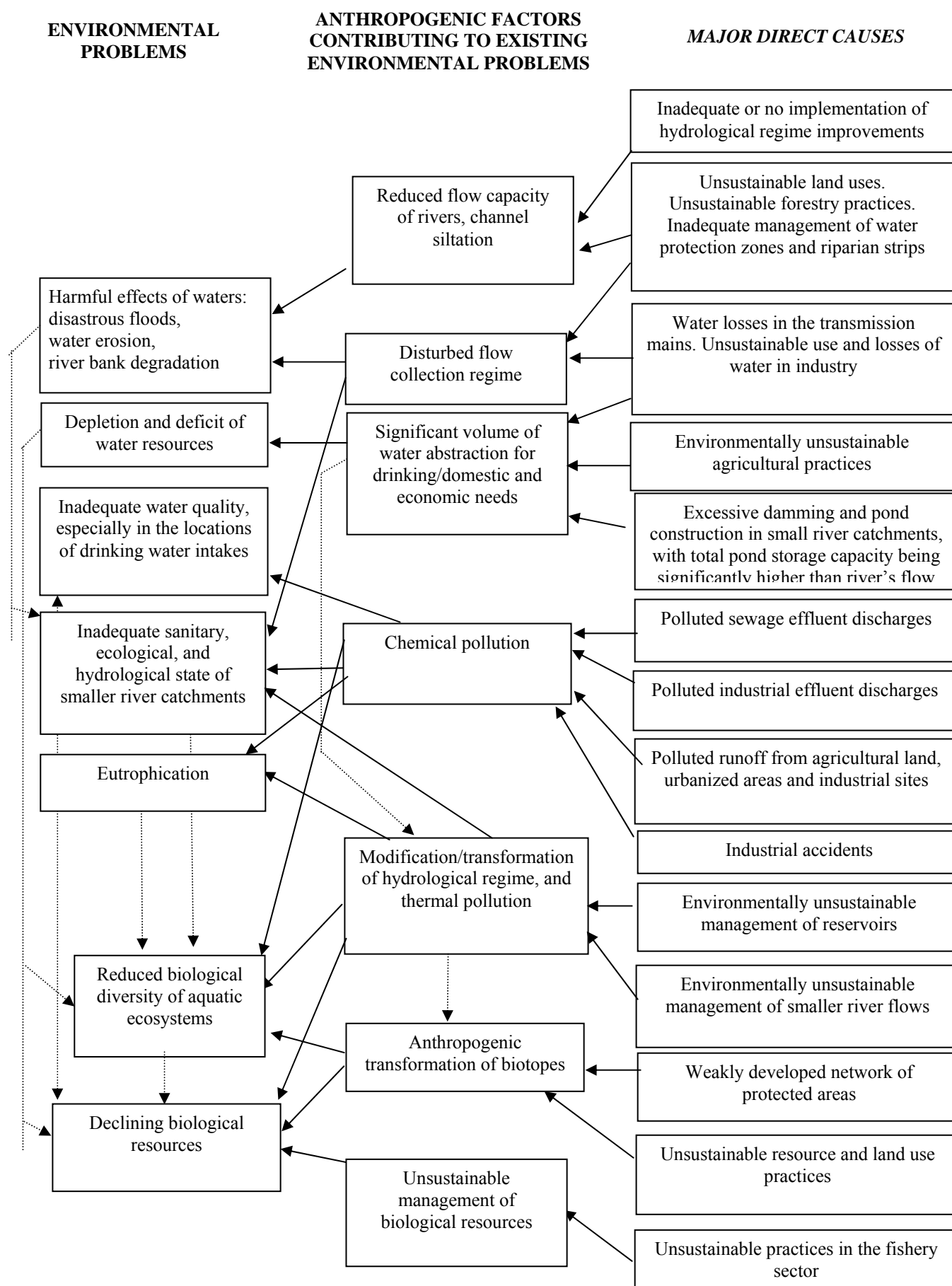


Figure 8.1. Priority Environmental Problems in the Dniester Basin and Their Linkages to Anthropogenic Factors and Major Direct Causes

8.2. Anthropogenic Factors Causing Environmental Problems

The following *major anthropogenic factors* contribute directly to environmental problems in the Dniester Basin:

- 1) **Harmful effects of waters** are caused by:
 - Modified and disturbed flow regimes of rivers draining the mountainous areas of the Basin as a result of reduced forest cover; loss of stabilising vegetation cover on the river banks, caused by human activities;
 - Environmentally unsustainable forestry and forest use practices (distorted age and species pattern of forests);
 - A high proportion of arable land and eroded land;
 - Water protection zones have not been established and/or are inappropriately managed, leading to a reduction in the flow capacity of rivers.
- 2) **Inadequate water quality** is caused by:
 - Polluted sewage and industrial effluent discharges, including accidental releases;
 - Polluted surface runoff from agricultural land, urbanized areas and industrial sites;
 - Polluted effluent discharges from livestock husbandry sites;
 - Pollution arising from storage or disposal of solid and liquid waste, both household and industrial;
 - Non-compliance with regard to management of water protection zones;
 - Reduced self-purifying capacity of rivers due to the modification of hydrological regime and water pollution;
 - Inadequate water protection measures.
- 3) **Unsatisfactory sanitary, ecological, and hydrological status in the catchments of smaller rivers** in the Basin is caused by:
 - Modified/disturbed hydrological regime of smaller rivers (straightening of the river channel and environmentally unsustainable flow regulation);
 - Non-compliant management of water protection zones/strips along the smaller rivers;
 - Inadequate implementation of land restoration programmes in agriculture, forestry, and land reclamation/irrigation;
 - Inadequate and environmentally unsustainable agricultural practices;
 - Loss of natural grass vegetation due to intensive livestock grazing, lack of organized livestock watering sites;
 - High density of municipal utilities and industries in smaller river catchments with lacking/inadequate wastewater treatment capacity;
 - River contamination as a result of illegal waste dumping activities.
- 4) **Depletion and deficit of water resources in the Basin** are caused by:
 - Low level of water reuse/recycling in industry;
 - Flow diversions to irrigated agriculture;
 - Water losses in pipelines, non-productive losses and unsustainable management of water;
 - Lack of coordinated water use planning between various sectors;
 - Conflict over water between the economic development and ecosystem sustainability;

5) **Eutrophication** is triggered by:

- Modification of hydrological regime in the Dniester and its tributaries;
- Reduced river flow discharge as a result of flow regulation and non-returnable water consumption;
- Unsustainable land management practices, lacking/inadequate land restoration measures;
- Non-compliant management of water protection zones/strips along the smaller rivers; poor sanitary state of river floodplains;
- High nutrient and organic load entering the water bodies with effluent discharges from municipal wastewater treatment plants, livestock husbandry sites, and food-processing industries.

6-7) **Reduction/loss of biological diversity of the Basin's aquatic ecosystems and decrease in biological stocks** are caused by:

- Loss of the Basin's ecosystem's integrity as a result of construction of in-stream reservoirs;
- Modification of hydrological regime of the Dniester as a result of flow regulation;
- No account being taken of ecological requirements/constraints in planning the use of water resources in the Basin;
- Physical contamination of the river as a result of construction and operation of the Dniestrovsky Hydropower Plant;
- Anthropogenic modification of biotopes;
- Lack of fish screens/barriers at water intakes;
- Chemical and microbiological pollution, caused by poorly/insufficiently treated municipal, industrial and agricultural discharges, including accidental releases;
- Pollution from diffuse sources;
- Lacking or inadequate implementation of fish stock restoration measures in the Basin;
- Modified hydrological regime and poor sanitary/ecological state of smaller river catchments;
- Inadequate development of nature reserve capacity;
- Illegal fishing activities, inadequate protection of fish stocks.

At the sectoral level, the existing adverse impacts on the Basin's ecosystem arise from the lacking or inadequate integration of environmental agenda into the sectoral development strategies, low level of environmental management capability at the sectoral and industry level, continuing use of obsolete and environmentally dangerous production processes. The underlying causes of environmental problems in the Dniester Basin are associated with resource uses and practices in various sectors of the economy.

The excessive anthropogenic pressures and the lack of progress in addressing the most urgent environmental problems are also considered to be the result of systemic problems, faced by the existing environmental management authorities in the Basin, in particular:

- Inadequate efficiency of existing water resource management and protection system due to deficiencies in the legal and institutional framework; gaps in the existing legislation and regulations; low level of development of institutional arrangements for managing resource use at the sectoral level and promoting the water resource management on a catchment basis; inadequate mechanisms for enforcement and implementation of the legislation;

- Lack of a programme-oriented basin management; little or no consideration given to the perceived environmental damage in the economic development plans, with similarly little focus placed upon the environmental performance of industries;
- The lack of proper justification when setting fees and charges for natural resource usage and environmental pollution ;
- An ineffective credit finance policy, lack of incentives to encourage the introduction of environmentally sound practices and implementation of environmental improvements; limited supply of domestic investment finance and unfavourable investment climate;
- Low level of information support to the decision-making process, with the existing monitoring capacity being inadequate to the management needs in the Basin;
- Inadequate methodological support, technical and staff resources of environmental authorities, monitoring and research organisations;
- Little focus placed upon the environmental education and awareness raising in the state environmental policies; inadequate participation and involvement of the public in the formulation/implementation of environmental programmes and decision-making on environmental issues.

9. Findings and Recommendations

9.1. Findings

1. Dniester is the largest river in the Western Ukraine and Moldova, draining to the northern shore of the Black Sea along with the Danube, Dniepro and Southern Buh Rivers. The Dniester Basin extends into the territories of 7 Oblasts of Ukraine, covering the larger part of the Republic of Moldova. The total population of the Dniester Basin within Ukraine and Moldova is about 7 million people. Of that, over 5 million people live in Ukraine. The Dniester is the source of drinking water for additional 3.5 million people, living outside of the Basin area, i.e. in Chernivtsy and Odessa.
2. Ukraine and Moldova are bound by a number of bilateral agreements, relating to the management of transboundary water resources. The Agreement between the Governments of the Republic of Moldova and Ukraine on the Joint Management and Protection of Cross-Border Waters (23 November 1994) is the main bilateral document, setting out the framework for the joint management of shared water resources.
3. The ecosystem of the Basin is overused and overstressed and is burdened by numerous problems relating to the quality and quantity of available water resources, the decrease in the amount and diversity of biological resources, and devastating effects of the waters.
4. The Dniester River sustains a large multi-sectoral economy, comprising heavily polluting mining activities (potassium salts, sulphur, gas, oil, building materials etc.); chemical industries, oil refineries, machine-building plants, food and textile industries. Hydropower is one of the major sectors affecting the ecological status of the Dniester Basin. The Dniester flow in its middle section is regulated by two major reservoirs, the Dubossary and Dniestrovsky reservoirs.
5. About 67% of the Dniester Basin area within Ukraine is agricultural land, most of which is arable land (78% vs. Ukraine's average of 66%). Within the Moldovan part of the Dniester Basin, 86% of land is used for agriculture, with only 9% occupied by forests. Such a high level of land usage for arable agriculture has led to a significant increase of pollution loads from diffuse sources. The high proportion of ploughed land adversely affects water quality and biological diversity in the Basin.
6. The biological diversity of the Dniester Basin has been shaped by various natural factors. The biogeographical setting of Dniester is unique, with its upper section lying near the Vistula River. The inter-basin links have promoted the migration of aquatic species and mutual enhancement of flora and fauna in these Basins. The current state of biodiversity in the Basin is largely a reflection of increasing pressure from human activities.
7. Despite the large-scale agricultural and industrial developments, the recreation potential of the Dniester Basin is very high, and its sustainable development as a unique recreation region will provide direct economic benefits.
8. By flow collection pattern, water regime and physical/geographical characteristics, the Dniester is generally divided into three reaches:
 - The Upper (Carpathian) Part of the Dniester Basin, featuring a well-developed and dense hydrographic network that provides about 70% of the total Dniester's flow;
 - The Middle (Podol) Part of the Dniester Basin has a dense hydrographic network and is regulated by two large in-stream reservoirs, the Dniestrovsky and Dubossary reservoirs.

These reservoirs have a profound impact on the hydrological and thermal regime of the river, with serious implications for the Basin's biological resources.

- The Lower Dniester Basin has a weak hydrographic network and vast areas of wetlands that have been affected by intensive human activities: part of the wetlands has been drained to provide more land for agriculture, while another part is occupied by fish-farming ponds.
9. The groundwater chemistry varies greatly across the Basin. Subsurface aquifers receive a major proportion of the pollution load from surface runoff. Given that there is some extent of a hydraulic continuity between the groundwater aquifers, there is a significant potential for migration of contaminants to the deeper aquifers.
 10. In 2002, the surface water bodies in the Dniester Basin received 965 million m³ of wastewater discharges. Of that, over 24% (235 million m³) received no or only partial treatment.
 11. The existing arrangements for surface water quality monitoring in the Dniester Basin as a whole have common flaws, stemming from the lack of feedback between the process of environmental quality monitoring and process of water resource management and protection. This results in:
 - Inadequate coordination between various monitoring systems, managed/maintained by different agencies, with the choice of sampling/monitoring locations remains far from optimal;
 - A limited number of monitoring parameters and monitored media; and inadequate monitoring frequencies;
 - Inadequate analytical and methodological capability of laboratories, with analysis of the full range of pollutants and their respective MAC's (maximum admissible concentrations) severely impaired by the lack of adequate equipment;
 - Ineffective data quality control/assurance arrangements;
 - Inadequate information management and data exchange.
 12. The priority environmental problems in the Dniester Basin are:
 - Harmful effects of waters: water erosion, river bank degradation, disastrous floods in the upper part of the Basin;
 - Inadequate water quality, especially in the locations of drinking water intakes;
 - Inadequate sanitary, ecological, and hydrological state of smaller river catchments in the Basin;
 - Depletion and deficit of water resources;
 - Eutrophication;
 - Reduction/loss of biological diversity of the Basin's aquatic ecosystems;
 - Diminishing biological resources.
 13. The excessive anthropogenic pressures and the lack of progress in addressing the most urgent environmental problems are also considered to be the result of systemic problems, faced by the existing environmental management authorities in the Basin, in particular:
 - An inadequate efficiency of the existing system for water resource management and protection;
 - The basin management not being programme-oriented;
 - Lack of incentives for environmentally sound practices and environmental improvements;
 - Low level of information, methodological and technical support to the environmental authorities;
 - Inadequate participation and involvement of the public in decision-making on environmental issues.

14. The majority of the environmental problems are clearly transboundary in nature, and coordinated efforts of Ukraine and Moldova are required to address them effectively. The scale of transboundary problems, particularly those that relate to the conservation of biological resources and their diversity, and the recognition of the fact that they can only be resolved through a coordinated approach by riparian countries to the management of their shared water resources, as well as international commitments of the countries to various environmental conventions – these are the factors demanding an overall strengthening of international cooperation in the Basin, with particular focus on upgrading of the legal framework and institutional mechanisms and the introduction of a basin management system.
15. This project has provided an excellent precedent for effective cooperation between NGOs, governmental bodies and international organizations. The major environmental NGOs – Eco-Tiras (Moldova), MAMA-86 (Ukraine) and Eco-Sphere (Transdnistrian Region) – have been involved in the project since a very early stage. The Public Participation Section of the present report was disseminated among environmental NGOs in Moldova and Ukraine. The draft Report itself was published on the website maintained by the “Eco-Tiras” organisation, and other NGOs were invited to provide their comments and recommendations. Also, the present Report was discussed at roundtable meetings held in Moldova and Ukraine. The majority of comments and recommendations received from environmental NGOs in Moldova and Ukraine have been reflected in the final version of the report.

9.2. Recommendations

1. Develop a Concept and draft Agreement on the Protection of the Dniester Basin, and agree on these documents at the governmental level;
2. Prepare a Transboundary Diagnostic Analysis for the Dniester Basin taking into account the impact of the Dniester on the Black Sea;
3. Develop and agree on an international strategic action plan for the environmental management of the Dniester Basin;
4. Develop an integrated strategy for the sustainable management of biological resources in the Basin;
5. Promote and facilitate the active participation of non-governmental organizations from Moldova and Ukraine, as well as other stakeholders, in the transboundary cooperation in the Basin; ensure transparent decision-making on environmental issues and access to environmental information;
6. Develop and agree on, at the inter-governmental level, a Transboundary Water Quality Monitoring and Assessment Programme consistent with the requirements of the EU Water Framework Directive; promote the development and application of biological diagnostic tools for assessing the water quality and status of the ecosystem;
7. Establish a basinwide (international) system for effective exchange of environmental information;
8. Institute a transboundary early-warning system to prevent/minimize the disastrous consequences of flooding events and industrial accidents;
9. Analyse the needs for bringing the Ukrainian and Moldovan legislation into line with the EU Water Framework Directive, and examine the financial and institutional implications of implementing the WFD; identify and recommend improvements to the existing national water legislation and related institutional framework in order to introduce the basin management approach;
10. Prepare an inventory of pollution hot spots in the Dniester Basin and rank them in terms of their environmental impact; compile a register of major polluters;
11. Identify and compile an inventory of (potentially) dangerous facilities (storage of hazardous materials; operation of dangerous processes/equipment; storage of chemicals, ammunition, oil products; gas/oil/ammonia pipelines etc.). Rank these facilities in terms of perceived environmental risk and prepare risk level maps reflecting the locations of these facilities across the Basin. Develop emergency response plans to prevent/minimize the effects of extreme events, accidents and disasters;
12. Prepare inventories of water bodies, plant life and animal life; and develop strategies for their conservation;
13. Design and establish an ecological network in the Dniester Basin to ensure the conservation of its landscape and biological diversity and improved conditions for the formation of the river's water resources quality;

14. Prepare the eco-corridor development concept for the transboundary sections of the Dniester Basin. Establish protected areas and Ramsar sites in the cross-border sections of the Dniester Basin, to be jointly managed and operated;
15. Establish an international working group to facilitate the cross-border cooperation of local self-governance bodies, with the representation of key stakeholders (water users, non-governmental organizations etc.);
16. Develop and enhance scientific cooperation between the riparian countries on various issues relating to the protection of the Dniester River; establish and ensure integrated hydroecological scientific support to the international cooperation.

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