OVERVIEW MAP OF MAIN TRANSBOUNDARY SURFACE WATERS IN WESTERN, CENTRAL AND EASTERN EUROPE

The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

UNEP/DEWA/GRID-Europe 2007

OVERVIEW MAP OF MAIN TRANSBOUNDARY SURFACE WATERS IN EASTERN EUROPE, CAUCASUS AND CENTRAL ASIA

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PART 2
TRANSBOUNDARY SURFACE WATERS

SECTION I

Major Findings of the Assessment

MONITORING TRANSBOUNDARY RIVERS AND LAKES

MONITORING TRANSBOUNDARY RIVERS AND LAKES

MONITORING IN EECCA AND SEE COUNTRIES

The longstanding cooperation on monitoring and assessment under the Water Convention have encouraged EECCA and SEE countries with common transboundary watercourses to develop joint monitoring programmes and harmonize their methodologies. The *Strategies for monitoring and assessment of transboundary rivers, lakes and groundwaters*[1] have been developed to assist EECCA and SEE countries in this endeavour.

As the river basin forms a natural unit for integrated water resources management, monitoring programmes should be designed for entire river basins. This is still difficult to achieve in most EECCA countries, where water management is not always based on river basins, due to inappropriate legislation and inappropriate institutional capacity and/or the enormous size of some transboundary basins.

A specific problem for the assessment of transboundary waters in EECCA countries arises from the widely used "maximum allowable concentrations of pollutants for a specific water use" (MAC) or water quality standards that seem to be more stringent than the water quality criteria and objectives often used in other parts of the UNECE region. It is often impossible to comply with these norms, partly due to the lack of appropriate measuring devices and partly because financial and human resources are lacking. Given the experience of other countries, particularly those applying the Water Framework Directive, future joint assessments should be based on water quality objectives or even ecologically based objectives, rather than MAC values. However, it is not realistic to expect EECCA countries to amend their national legislation in the short term.

Adopting a step-by-step approach, transboundary commissions could take the lead in this process by using water quality and environmental objectives in their daily practice. They should also agree on assessment methods to be used jointly within their transboundary basin. A promising example is cooperation between Moldova and Ukraine on the Dniester basin, where data from two of the six agreed-upon measuring stations are already being gathered and exchanged. Almost all of the 30 agreed-upon physico-

[1] Strategies for monitoring and assessment of transboundary rivers, lakes and groundwaters, UNECE, 2006 (ECE/MP.WAT/2006/20).

chemical parameters are being measured, but no measurements are being taken for the agreed-on three biological parameters and four radioactive determinands. In both countries, water laboratories have been designated as well as the entities responsible for data management and information exchange.

In EECCA, the ongoing reform of ministerial environmental departments and water agencies is an opportunity to harmonize responsibilities for water management and improve cooperation among entities involved in monitoring and assessment, including new partners (e.g. the research community and academia), and to designate appropriate institutions to supervise, guide and contribute to monitoring and assessment.

Insufficient and instable financing, a decrease in supply of the stations with spare parts, insufficient replacement of stations and laboratory devices with up-to-date equipment, the worsening situation regarding sampling and sample transport from remote stations, and departures of qualified staff were among the reasons for the decline of monitoring and assessment activities in the early 1990s. After a decade of decline, the funding situation has improved considerably, also due to foreign assistance programmes. However, attempts to upgrade existing monitoring networks still result in unreasonable suggestions to re-activate previously existing networks. Unless a thorough analysis of information needs is made, which is the most basic requirement for a decision on the number of stations, their location, parameters and frequency of measurement, informed decisions cannot be taken. There is a need to set priorities jointly agreed with the major actors, both nationally and in the transboundary context.

It should also be recalled that water monitoring is only one of the many sources of data/information on the conditions of transboundary watercourses. For example, in Georgia, assessments of transboundary waters also use estimates of pollution loads based on industrial production analysis. Data should also be gathered from other sources and disciplines such as agriculture, recreation, sociology, ecology and economics. Often local governments and municipalities are able to provide data on water purification and sewage utilities, factories, farmers and/or irrigators. The results of self-monitoring (monitoring of effluents and wastewater discharges by industries or municipalities, often under the conditions of their discharge license) is a valuable additional source of information for transboundary water assessments. Increasingly, these systems are being set up in EECCA and SEE, but their use is still limited to big industrial undertakings. Thus so far no such data are being used for transboundary water assessments.

In many EECCA countries, the labour and operating costs of sample collection and field analysis, laboratory analyses and data processing, interpretation, reporting and production of outputs have often been underestimated. Ignorance and inadequate assessments of these costs have been among the reasons why activities ceased after international assistance projects ended. It is therefore important that such international assistance projects be embedded in the national plans and that systems requirements be adapted to countries' resources so that operations can continue after a project is completed. Furthermore, there have been cases in which international projects had overlapping objectives, duplicated work and did not involve the right actors, thus wasting resources without improving monitoring and assessment. Recipient countries have a responsibility to streamline donors' efforts and avoid duplications and waste. At the same time, donors should respect recipient countries' priorities and indications.

Storage of data and information probably remains the weakest point in EECCA countries, where water, environmental and health agencies often rely on hard copies of data. It is of utmost importance that policymakers and planners better understand the various steps in data management. This will facilitate data exchange among the institutions undertaking the monitoring and assessment, including joint bodies.

It is wise and economically efficient to start the development of programmes step by step and stressing the need for harmonized methodology and the use of same or similar principles in assessing the status of shared water bodies. In this process, the EECCA and SEE countries sharing waters with EU countries will have a specific role to play: they are a bridge between western and eastern praxis in monitoring, and they could serve as models for introducing "modern" monitoring and assessment praxis as stipulated in the Strategies, step by step.

MONITORING IN WESTERN AND CENTRAL EUROPE

In Western and Central Europe, the knowledge regarding the state of water bodies and possible trends is relatively good. Monitoring results have been used as the basis for various water protection measures; however, there has also been a need to improve the situation. Therefore, during the last 5–10 years significant changes in developing and especially harmonizing the monitoring programmes and their methodological basis have taken place in Western and Central Europe.

At present, monitoring, assessment and reporting activities in EU countries are mostly steered by the obligations of different water-related directives.

The key directive concerning monitoring is the Water Framework Directive (WFD).[2] The main pressures on water resources are documented as a result of the implementation of the Urban Waste Water Treatment Directive,[3] the Integrated Pollution Prevention and Control Directive[4] and the Nitrates Directive[5] as well as the Directive on Pollution Caused by Certain Dangerous Substances Discharged into the Aquatic Environment of the Community.[6]

The status of water bodies (including their chemical and ecological status) will be documented in 2009 following the provisions of the Water Framework Directive. This forthcoming status assessment of the water bodies will incorporate information received under the other above-mentioned directives. The monitoring- and assessment-related activities under the Water Framework Directive could thus be seen as a kind of guide for monitoring, assessment and reporting for water bodies in EECCA and SEE.

Annex V of the WFD and the detailed guidance documents, developed under the Common Implementation Strategy on the Implementation of the Water Framework Directive, provide a sound basis for developing a harmonized monitoring and assessment system for all types of water bodies in the entire EU area.

The programme for monitoring the status of water bodies (rivers, lakes, transitional waters and coastal waters) is based both on the use of hydrobiological characteristics, supported with some key physico-chemical determinands, and on surveillance of certain harmful substances, including priority substances. The WFD also takes into account hydrological variations during the monitoring period.

The advantage of monitoring programmes that comply with EU legislation is a harmonized methodology in a large region with different types of pressure factors and water bodies. The programme has been established to continue for a longer period, with certain assessment and reporting intervals – for example, 2015 as the deadline for the second report.

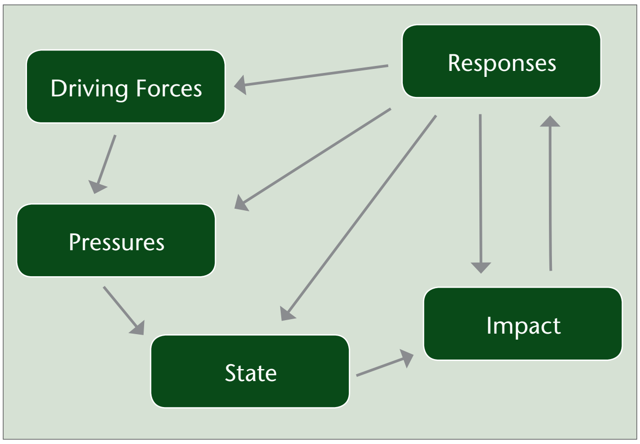
[2] Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for European Community action in the field of water policy as amended by decision No 2455/2001/EC of the European Parliament and of the Council of 20 November 2001 establishing the list of priority substances in the field of water policy.
[3] Council Directive 91/271/EEC of 21 May 1991 concerning urban waste-water treatment.
[4] Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control.
[5] Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources.
[6] Council Directive 76/464/EEC of 4 May 1976 on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community.

PRESSURES

The 2004 review by the secretariat on "Water and sanitation in the UNECE region: achievements in regulatory aspects, institutional arrangements and monitoring since Rio, trends and challenges"[1] already identified the most challenging water management issues in the UNECE region as a whole and examined further steps to be taken regarding water policies and technical/methodological work. The present assessment of transboundary waters has shed more light on particular issues of concern for countries with economies in transition and countries with market economies.

In Section II of this Part, the river basin's various uses and functions and related water management issues are described and the pressures on water resources, the status of the water bodies, the transboundary impact caused by the pressures, and future prospects, i.e. the potential improvement of the status, provided that certain management measures (responses) are put in place. Such an approach generally follows the logic structure of the "Driving Forces-Pressures-State-Impact-Responses (DPSIR) framework" adopted by the European Environment Agency (EEA) and broadly used under the Water Convention.

The Driving Forces-Pressures-State-Impact-Responses (DPSIR) framework.



The DPSIR framework assumes that social, economic and environmental systems are interrelated. These links are illustrated conceptually by driving forces of environmental change, which create pressures on the environment. These in turn affect the state of the environment. The subsequent changes in status, or "impacts", include impacts on ecosystems, economies and communities. The negative impacts will eventually lead to responses by society, such as the development of policies for river basin protection. If a policy has the intended effect, its implementation will influence the driving forces, pressures, status (state) and impacts.

In order to systematically describe and analyse pressures on water resources, a number of basic documents were used. These included the *1994 Recommendations to ECE Governments on the Prevention of Water Pollution from Hazardous Substances,* which provide an indicative list of industrial sectors/industries for which discharges should be based on the best available technology. As concerns agriculture, the *1992 Recommendations to ECE Governments on the Protection of Inland Waters against Eutrophication* and the *1995 Guidelines on the Prevention and Control of Water Pollution from Fertilizers and Pesticides in Agriculture*[2] have also been used. These also include the United Nations International Standard Industrial Classification of All Economic Activities.

The following paragraphs address the main pressure factors in general terms and provides typical examples of pressure factors from human activities in the various river basins. For a detailed description and analysis, reference should be made to Section II of this Part.

[1] Prepared for the first Regional Implementation Forum on Sustainable Development (Geneva, 15-16 January 2004) as document ECE/AC.25/2004/5 and Add.1 and Add.2.
[2] ECE Water Series No. 2, Protection and Sustainable Use of Waters – Recommendations to ECE Governments (ECE/CEP/10).

CROP AND ANIMAL PRODUCTION

Water use for crop and animal production in EECCA countries (some 50–60% of available water resources) is quite comparable with the situation in countries in Southern Europe, especially Greece, Italy, Portugal and Spain. However, water-use efficiency is much lower, and the magnitude of water pollution problems caused by agriculture is greater.

In general, crop and animal production cause increased levels of nutrients and pesticides in transboundary water bodies due to surface run-off from agricultural land, leaching and – specifically in a number of transboundary waters in the Aral Sea basin – return waters from irrigation channels.

Pollution by nitrogen and phosphorus compounds is well measured, but often badly documented and publicized in EECCA and SEE countries. In transboundary rivers in EECCA and SEE, pollution levels seem to be decreasing. This is chiefly a consequence of the still difficult economic situation and high fertilizer prices rather than of good agricultural practice. With the expected economic growth and the need to increase agricultural outputs, nitrogen and phosphorus will regain their importance as pollutants unless stringent "command-and-control" measures to cut application rates and good agricultural practice are more widely used.

Although the use of certain dangerous pesticides has been banned in countries with economies in transition, unauthorized use of pesticides (reported from some transboundary river basins) and leakages from old stocks of DDT will continue to be an important pressure factor. However, data on the concentration of pesticides in transboundary rivers are mostly unavailable: either no measurements are being carried out, or the measurements do not include sediment or biota.

Base flow from groundwaters carries nitrates and pesticides into transboundary rivers, for example, in watercourses such as the Chu and Talas and their tributaries. The relative importance of this phenomenon is not yet well known in many basins; however, the assessment of the transboundary aquifers already provides a lot of basic information.

The impact of animal husbandry (livestock breeding and grazing) on transboundary waters, particularly in the mountainous and foothill areas of the Caucasus and Central Asia, also remains little understood, although evidence of adverse effects on the many smaller rivers in these areas is growing.

Watercourses created by human activity (irrigation canals and drainage channels to collect return water from irrigation) are abundant. In the Aral Sea basin, their "management area" covers hundreds of thousands of square kilometres, and their length totals many thousands of kilometres. In Uzbekistan alone, the total length of main irrigation canals (about 450) and drainage canals (400) is 156,000 km, and their total management area amounts to about 1,100 km^2. Water delivery and use are being hampered by increasing vegetation growth in the canals, which lessens their carrying capacity; by algae blooms, which lead to deteriorating water quality and sanitary conditions; and by increasing pollution, sediment transport and sedimentation, which affect the operation of hydraulic structures.

Diffuse discharges from agriculture and the continued extensive agricultural use of water protection zones along rivers contribute to increasing chemical and bacterial pollution of water resources. Adverse effects of irrigation on aquatic- and water-related ecosystems include loss of biodiversity and extinction of whole ecosystems.

In Western and Central Europe, agriculture is also one of the most prominent pressure factors. In river basins, particularly in Central Europe, the relative importance of agriculture as pressure factors is increasing, given the decreasing amount of pollution from point source, most notably municipal and industrial wastewater treatment plants, due to investments in point source control. Agriculture in other river basins, particularly those in the basin of the Black Sea, the Mediterranean Sea and parts of the East Atlantic, is a pressure factor similar to that in countries in transition. The pressure greatly varies among basins due to countries' specific hydrometeorological conditions (e.g. need for irrigated agriculture), crop types and production patterns.

MINING AND QUARRYING

The mining of metal ores has a distinct impact on transboundary waters in the Caucasus, transboundary tributaries to the Danube and transboundary rivers discharging into the Mediterranean Sea. The impact of mining in Portuguese-Spanish river basins seems to be rather limited; however, abandoned mines remain as a significant pollution source.

The impact of mining on transboundary waters in Central Asia is less visible, mostly due to the relative importance of other pollution sources. In Central Asia, however, the pollution level will most likely increase given national plans to further develop mining and ore processing.

Mining activities, although decreasing, have also an impact in the sub-basins of the Rhine. Adverse effects, sometimes visible over a long distance, include hydraulic changes, thermal pollution, and pollution by chlorides and heavy metals. Mining of hard coal has significantly changed groundwater flow in parts of the Rhine basin, and opencast mining of brown coal requires lowering the groundwater level in parts of the Rhine, Elbe and Oder basins.

Pollutants from mining of metal ores that are of utmost concern include lead, copper, zinc, cadmium, uranium and, in some cases, mercury from gold mining. While pollution abatement technologies exist for these hazardous substances, their use in countries with economies in transition is limited to the minority of industrial plants that are economically viable.

The extraction of crude oil is another pressure factor. Surface run-off from oil production fields located in transboundary water basins is a general problem for many watercourses in the EECCA region; however, information about the relative importance of this type of pollution is still scarce.

MANUFACTURING

In many countries, manufacturing is one of the most prominent pollution sources, with a strong impact on the status of transboundary water resources.

Water-use efficiency in EECCA countries remains low compared to that in Western and Central Europe. Since the information on water use for various sectors of economy provided by countries was rather limited, water-use efficiency as a means of saving water and generating less pollution will be examined at a later stage.

The magnitude of water pollution problems in countries with economies in transition seems to originate from the abundant number of small and medium-sized industries, rather than the relatively low number of big undertakings, which were already capable of installing pollution abatement technologies and controlling pollution at the source. In addition, these big enterprises voluntarily carry out self-monitoring in an attempt to demonstrate their compliance with environmental standards.

Manufacture of refined petroleum products

A great number of transboundary watercourses in EECCA show increased levels of pollution by oil products, specifically discharges from oil refineries and surface run-off from refinery sites. Unless these countries comprehensively apply the measures set out in safety guidelines and other guidelines developed under the Water Convention and the 1992 Convention on the Transboundary Effects of Industrial Accidents (Industrial Accidents Convention), which in some cases require investments in the safety of industrial installations, a substantial reduction in oil pollution is unlikely. Countries with market economies did not report on this kind of pressure factor, as obviously high standards of pollution control at sources are complied with by the respective industry.

Manufacture of chemicals and chemical products; manufacture of basic metals and fabricated metal products

Accidental pollution from industrial installations and unauthorized discharges of hazardous substances (mostly at night and during holidays) remain major concerns in EECCA and SEE. Due to the high flow velocity of transboundary rivers and their tributaries in mountainous areas, a number of these events are beyond the detection capability of monitoring stations. The establishment of early warning and notification systems in transboundary mountainous and lowland rivers, which is currently being promoted by assistance projects, is a promising tool for the future. Future assessments are expected to shed more light on these industrial sectors/industries as a source of a great number of organic compounds with toxic effects as well as other hazardous substances.

As concerns manufacturing of chemicals and chemical products in Western and Central Europe, the assessments of the status of rivers in the basins of the Rhine and Elbe may serve as best examples. The Rhine basin, for example, is a basin with a high density of chemical and other industries, where more than 950 major industrial point pollution sources have been identified. These big and medium-sized enterprises operate their own treatment plants. However, in 2000, eight industrial enterprises were still responsible for a considerable share of the total emission of at least one of the following substances: Hg, Cr, Cu, Ni, Pb, N-total and P-total. The share of single enterprises varied between 1% (N-total) and 18% (Cr). In order to achieve the targets of the WFD related to the chemical status of surface waters, further measures have been identified as to nutrients, chromium, copper, zinc and PCB-153 as the relevant pollutants. Further “target” substances include nickel and its compounds, HCB and tributyl-tin.

Manufacture of paper and paper products

Obviously, the pulp and paper industry can become a significant pollution source in some transboundary waters, as has been reported by Finland, Lithuania, Romania and the Russian Federation. The following water-quality determinands are of concern: BOD_5, COD and some hazardous organic compounds, if bleaching processes are used.

Other manufacturing industries

A number of specific manufacturing industries, such as leather, sugar and fertilizers, are of concern, as they have a significant impact on the status of transboundary watercourses. Their relative importance will be assessed at a later stage.

HYDROPOWER GENERATION

The construction of dams and multipurpose reservoirs has many positive effects (hydropower generation, water supply, irrigation, low flows regulation, flood mitigation etc.), but also causes adverse effects. For example, the volume of biological active sediments may decrease, erosion and/or sedimentation processes in riverbeds may change, and migration of fish may become impossible.

Intense sedimentation, erosion of embankments and changes in the hydrological regime, resulting in a decrease in the self-purification capability of aquatic ecosystems, occur in lowland reservoirs. Eutrophication, a typical problem of reservoirs in lowlands, is intensified due to the shallowness and large water surface of many water bodies.

Although adverse effects of dams and reservoirs and their poor management on the downstream aquatic and terrestrial environment became obvious from the EECCA countries' assessment reports; hydromorphological alterations as a specific pressure factor have only been recognized and described by market economy countries (for basins shared by countries with market economies and some basins on borders between EU and non-EU countries). Therefore, future assessment reports will put more emphasis on this pressure factor, and examine its impact more comprehensively, including in countries in transition.

In EECCA countries, the poor management and operation of reservoirs, including those built on the interface between the high mountainous parts and lowland parts of rivers, causes a significant impact on the hydrological regime (e.g. river discharge, flooding, erosion) and water availability in the lowlands. The transboundary rivers in the Caucasus and, most notably, in Central Asia, are typical examples for this kind of pressure factor.

The conflict between consumptive and non-consumptive water use in transboundary basins in Central Asia for transboundary rivers regulated by reservoirs

Time period	Lowlands	Reservoir operation	High mountain areas
Summer	High water demand not satisfied due to small amount of water released from the reservoir	Low water release due to low energy demand and accumulation of high water discharge from upstream rivers	Large water discharges into reservoir due to melting of snow
Winter	Low water demand; flooding, bank erosion and other adverse effects may occur due to large releases of water from the reservoir	Large releases of water to satisfy high energy demand	Small water discharge into reservoir

SEWERAGE AND WASTE MANAGEMENT

Sewerage

As a rule, each person produces some 75 grams per day of BOD_5 and some 3 grams per day of phosphorus. Unless treated, sewage is an enormous pressure factor in each of the river basins.

Unfortunately, in many EECCA and SEE countries organic pollution is not being dealt with effectively because, over the last decade, the technical status of wastewater treatment plants has greatly deteriorated. Although wastewater treatment plants in big cities continue to operate (although with decreasing efficiency), most of the other treatment plants are out of order. For some cities, for instance in the Dnieper and Dniester basins, new treatment plants are under construction.

In Western and Central Europe, municipal wastewater treatment is usually not a pressure factor of particular concern, except in cases where the discharges from sewage treatment plants end up in relatively small tributaries. Municipal wastewater treatment in some new EU countries is sometimes below the required standards, but these countries have still a transition period of some more years before the relevant Council Directives have to be fully implemented.

Some new substances, including pharmaceuticals, were also reported to interfere with treatment processes and require pollution control at source.

Breakdowns of municipal wastewater treatment systems have been repeatedly reported as the cause of significant discharges of polluted waters into the rivers; these breakdowns are also responsible for bacteriological pollution in some basins and sub-basins in Central and Eastern Europe.

Disposal activities

Tailing dams and waste storage ponds containing hazardous waste from mining and ore processing, as well as hazardous waste from metal processing and the chemical industry, are important pollution sources in some of the transboundary basins and more importantly in the sub-basins of their tributaries. For EECCA and SEE countries, there is a need for better guidance on the safe operation of these installations.[3]

Illegal waste disposal along rivers as well as old and often uncontrolled waste disposal sites are reported from a number of transboundary river basins in EECCA countries and some countries in the discharge basins of the Black Sea, the Mediterranean Sea and the Eastern Atlantic. If these dumpsites are not properly taken care of, they will generate increasing pollution.

Contaminated military sites are also a festering problem in some EECCA countries. Deposit of armaments and munitions inherited from the Soviet Union and waste disposal sites belonging to the military, including toxic and radioactive material threaten transboundary surface and ground waters. Their impact will be assessed at a later stage.

TRANSPORTATION AND STORAGE

Land transport

Water pollution from land transport was reported from the narrow river valleys in the Caucasus Mountains and the ranges of Central Asia as well as from some Portuguese-Spanish transboundary waters. The analysis of the Scheldt basin also revealed transport as a matter of concern, although the pressure on the aquatic environment (e.g. by polycyclic aromatic hydrocarbons) was difficult to estimate due to still lacking accurate data.

Water pollution from leaking cars and seepage from petrol filling stations is a general problem in EECCA countries, particularly in rural areas. Losses of crude oil and petroleum products during railway transport and leaking transloading facilities are also causes of increasing water pollution in these countries.

Transport via pipelines

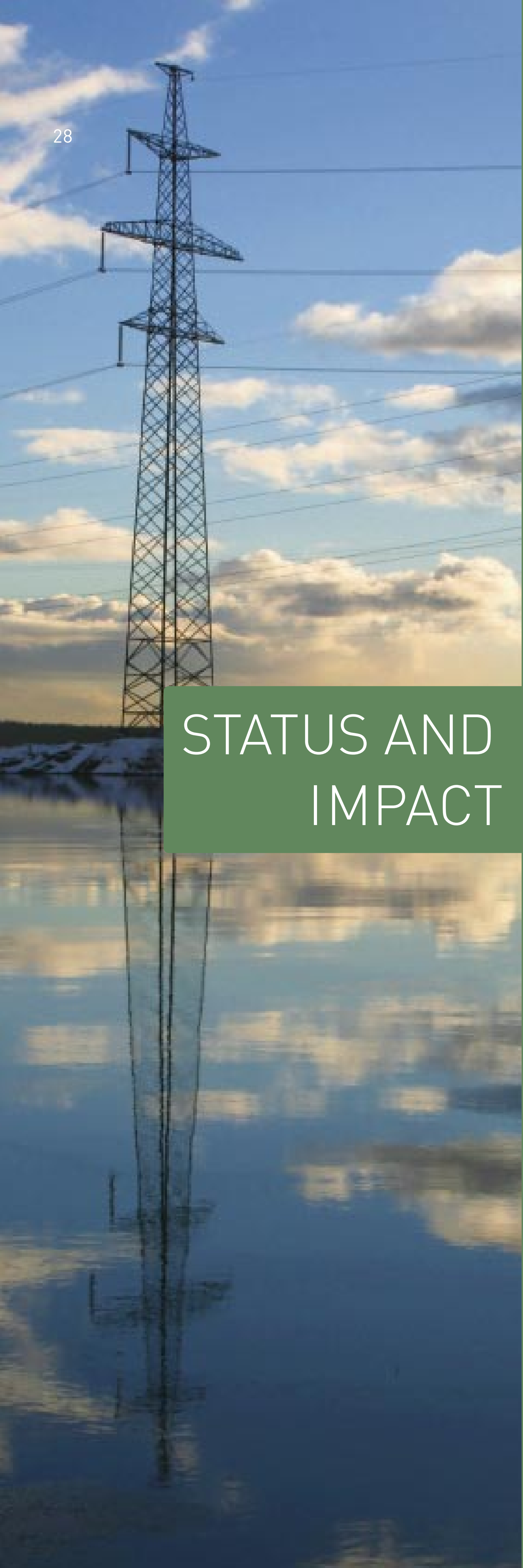
As is the case with manufacturing of refined petroleum products, a number of transboundary watercourses in EECCA countries show increased levels of pollution by oil products due to leakages from pipelines crossing transboundary rivers or their basins.

Despite the many pipelines crossing transboundary watercourses in the entire region, only Portugal (Tagus River) has referred to the potential danger of pipeline accidents and consequences on the aquatic environment. One should recognize that some pipelines already have a high standard of operation and maintenance, as it is the case with the Marseille-Geneva pipeline, located in the Rhone basin (a multiproduct pipeline along the Rhone River with a crossing of the Rhone downstream of Geneva, Switzerland). Many pipelines from oil fields in EECCA countries, for example, may not yet have such a high standard, and are potential pressure factors. UNECE therefore addressed these issues in the *2006 Safety Guidelines and Good Practices for Pipelines.*

TOUR OPERATOR ACTIVITIES

Along with the growth of urban populations and of tourism, the use of mountain areas and their watercourses for recreational purposes is increasing in the Caucasus and Central Asia. There is an urgent need to control the impact of recreation on mountain ecosystems, including rivers and lakes. It is also necessary to install hydrometeorological stations to warn tourists of extreme weather and high run-off. The intensive tourism in countries in South-Eastern Europe, particularly around Lake Ohrid and Lake Prespa, is another example of this kind of pressure factor.

[3] Such guidance is currently being developed by UNECE under the Water Convention and the UNECE Convention on the Transboundary Effects of Industrial Accidents.



STATUS AND IMPACT

The basins of transboundary rivers and lakes are widely heterogeneous from the social, economic and environmental points of view and display specific problems related to both water quantity and water quality. Nevertheless, some issues are common to most of the basins.

In many basins/sub-basins, the ecological and chemical status of transboundary rivers and lakes is under threat from a range of human activities leading to organic pollution (mostly from sewage), nutrient pollution (mostly from agriculture and sewage), pollution by hazardous substances (mostly from manufacturing and mining), and – in the case of rivers – hydromorphological alterations, mostly due to water construction works for hydropower production and navigation.

Although the relative importance of chemical and microbiological pollution varies greatly within the region, the contamination of drinking-water supplies is significant in EECCA and SEE, and water-related diseases such as cholera, dysentery, coliform infections, viral hepatitis A and typhoid are often reported.

The assessment showed that almost 20 per cent of transboundary rivers in Caucasus and Central Asia are in a "high or good chemical status"; this also applies to some transboundary tributaries to first-order rivers in Eastern Europe and SEE. Some of these water bodies, however, show signs of increasing pollution due to the ongoing revival of industry and agricultural production or are potentially threatened by mining and ore processing. The majority of the transboundary rivers included in the assessment fall into the category of "water bodies with moderate pollution". "Polluted water bodies" in EECCA and SEE basins are transboundary rivers which: (a) take up their pollution load in lowland areas due to intensive agriculture; (b) are in the vicinity of big cities and industrial centres; (c) have small water discharges; and (d) which take up their pollution load in foothills with intensive industrial (including mining) or agricultural water use. Cadmium, lead, mercury, phenols and oil products, as well as pesticides, are among the most serious pollutants.

Similarly, a number of transboundary rivers in Western Europe as well as Central Europe are in high and good status. Most rivers still belong to the category of "moderately polluted" water bodies or have a "fair water quality". There are also transboundary rivers or stretches of these rivers, for example in the Danube basin, that have been assessed as "polluted". Cadmium, lead, mercury, nickel and its compounds, tributyl-tin, hexachlorobenzene (HCB), dichloro-diphenyl-trichloroethane (DDT), lindane and atrazine are among the most serious pollutants.

Eutrophication is the worst phenomenon affecting transboundary lakes. It is increasing constantly except in areas where wastewater treatment has been effectively implemented and where small improvements are visible. In nearly all areas, increasing non-point loading from agricultural and forestry areas has spurred incipient eutrophication even in some lakes, which were earlier in good condition. High nitrate-nitrogen concentrations, particularly from fertilizers, are also a problem in groundwater (see separate groundwater assessment in Part 3). Insufficiently treated wastewaters from municipal treatment plants and return waters from irrigated agriculture also cause eutrophication in rivers (phosphorus compounds) and the sea (nitrogen compounds, sometimes phosphorus).

Geochemical processes have been repeatedly seen as an issue of concern in some river basins in the entire region due to high natural background concentration of heavy metals (mountain areas) or high turbidity (areas with peat extraction). Geochemical processes also cause high arsenic concentrations in some aquifers in SEE countries.

Deforestation, soil erosion and degradation of pastures (particularly in EECCA) are additional issues of concern. They will continue to be a problem for the proper functioning of water-related ecosystems and lead to higher risks of natural disasters as the implementation of response measures (e.g. afforestation) will take some time.

The effects of climate change are becoming visible in almost all of the analysed river basins. Most basins experience an impact of climate change on water quantity (e.g. decreasing water resources availability and extreme hydrological events, including severe floods and long-lasting droughts). With a reduction in precipitation of up to 30% over the last decade, water resources availability, for example, is decreasing in river basins in the discharge area of Mediterranean Sea. The effects of climate change on the ecological regime of rivers are also becoming visible in transboundary basins in Central Asia, where the rise in air temperatures leads to significant melting of glaciers, resulting in noteworthy changes of the rivers' hydrological and ecological regimes. Thus, climate change adaptation measures in water management and water-depended activities and services (e.g. agriculture, forestry, water supply, hydropower generation) are needed in the entire UNECE region.

Damage by floods became a costly water-quantity problem in the entire region. Too many countries still base flood prevention and mitigation solely on structural measures, such as the construction of dams and dykes and improved operations of dams and reservoirs. Holistic approaches to the prevention and mitigation of floods, applied particularly in basins in Central Europe, should be implemented more widely. These holistic approaches combine non-structural measures (e.g. giving more space to the river) with structural measures. There are also basins that suffer from the consequence of "man-made" floods, an example being basins in Central Asia where high water releases from reservoirs in wintertime for hydropower generation lead to downstream flooding.

Water sharing among countries in the same basins to satisfy demands of national economic activities (irrigation, manufacturing, energy production), continues to cause upstream-downstream conflicts, including adverse effects on the environment (e.g. the destruction of water-related ecosystems). Most affected are the basins in Central Asia (e.g. Amu Darya, Syr Darya, Ili) and the Samur basin.

RESPONSES

Chapter 4

RESPONSES

PRESSURE-RELATED RESPONSES

The assessment points to four challenge areas of further action to decrease pressures on transboundary waters: organic pollution, nutrient pollution, pollution by hazardous substances, and – in the case of rivers – hydromorphological alterations.

The relative importance of pollution and pressures due to hydromorphological alterations varies from basin to basin. This relative importance notably depends on past achievements in environmental protection and is strongly related to the effectiveness of implementing existing legislation and other measures related to integrated water resources management.

In many basins, tailor-made investments in the water sector are still needed, such as investments in municipal wastewater treatment plants and wastewater treatment in rural areas; these are often postponed in EECCA due to lack of financing or the preference given to investments in other sectors.

There is a remarkable difference in action undertaken/action needed to be undertaken to improve the status of transboundary waters in EECCA and SEE as compared to basins in Western and Central Europe.

A general comparison of the scale and severity of water management problems between various basins in the region is given in the table below, which shows that:

- Action to decrease water pollution from point sources (e.g. municipal sewage treatment, old industrial installations) is of primary importance in basins in EECCA and SEE;

- The fight against pollution from diffuse sources (e.g. agriculture, urban areas) is of much importance for action in basins in Western and Central Europe (the European Union (EU) countries, Switzerland and Norway).

The reason for such a clear distinction in further action needed is quite obvious:

- Over a period of some 15 years, countries in transition have suffered a decline in their economies, which came hand in hand with a breakdown of essential systems of water supply and wastewater treatment. These countries can substantially improve the status of their transboundary waters, if point pressures from municipal sewage treatment plants and discharges from old industrial installations were dealt with as priority tasks. This requires proper allocation of funds.

- In many countries with market economies, huge investments in point-source pollution control measures were made over two and more decades. This led to a substantial decrease of the pollution load from these sources hand in hand with an increase of the relative importance of the pollution load from non-point sources. Dealing with diffuse pressures (e.g. agriculture, urban land use) is therefore seen a priority task.

Diffuse pressures from agriculture

In Western and Central Europe, the legal framework to cut down pollution has been established many years ago (e.g. EU Directives; national legislation in the EU countries, Norway and Switzerland) and technical guidance to control water pollution by fertilizers and pesticides in agriculture is broadly available. However, given reports by EU countries located in the drainage basins of the Mediterranean Sea, the East Atlantic Ocean, the Baltic Sea and the Black Sea, the impact of agriculture on the quality of water resources is most striking, also because the implementation of these pieces of legislation and recommendations seems to take more time than expected. Experience has also shown that command-and-control approaches need to be supplemented by voluntary measures and innovative financing schemes.

Although currently classified as “widespread but moderate”, diffuse pressures from agriculture in EECCA and SEE basins will increase in the future alongside the revival of economy; thus, the use of fertilizers and pesticides will be much higher than in the last decade, causing negative effects on transboundary waters. Apart from legal and regulatory measures, it is important to focus on educa-

RELATIVE IMPORTANCE OF PRESSURES IN TRANSBOUNDARY RIVER BASINS

Scale and severity of problem *	Basins in EECCA and SEE	Basins in Western and Central Europe
Widespread and severe	**Point pressures:** municipal sewage treatment, old industrial installations, illegal wastewater discharges, illegal disposal of household and industrial wastes in river basins, tailing dams and dangerous landfills	**Diffuse pressures:** agriculture, urban land use
	Abstraction pressures: agricultural water use / water sharing between countries	**Abstraction pressures:** agricultural water use (Southern Europe)
	Morphological pressures: hydroelectric dams, irrigation channels	**Morphological pressures:** hydroelectric dams, river alterations
Widespread but moderate	**Diffuse pressures:** agriculture (except in some basins in Central Asia, where the impact is severe)	**Other (point) pressures:** industries discharging hazardous substances
Limited but severe	**Other (diffuse, point) pressures:** non-sewered population, mining and quarrying	**Other (point) pressures:** mining and quarrying
Limited and moderate	**Other (point) pressures:** new industrial installations	**Other (diffuse, point) pressures:** non-sewered population, municipal sewage treatment

* In this generalization of river basins in the region; “widespread” means that the problem appears in many river basins, whereas “limited” indicates that only some basins are affected.

tion, training and advice to promote understanding of good agricultural practice and respect for existing legislation by various economic entities.

Abstraction pressures

Abstraction pressures within the national parts of the basins (in particular, water use by irrigated agriculture in EECCA, SEE and South-Western Europe) are among the most important water-quantity issues. In some basins, particularly in Central Asia, the predominant water use for agriculture has also led to such water-quality problems as salinization of soils and high mineral salt contents in water bodies.

In a transboundary context, there are at least four areas of existing or potential conflicts over water. One area is the conflict between hydropower production and irrigational agriculture, which is particularly obvious in the basins of the Amu Darya and Syr Darya. Another area is the conflict between hydropower production and navigation, which became obvious in rivers shared by Kazakhstan and the Russian Federation, where new (private) operators are now managing reservoirs formerly managed under government responsibility. There is another conflict potential, namely the conflict between water use for economic activities and water for the maintenance of aquatic ecosystem. This conflict is particularly pronounced in the basin of the Ili River, shared by China and Kazakhstan. Also in other basins in EECCA and SEE,

ecological requirements of the water bodies are rarely considered and win-win solutions to mitigate existing – and avoid future – conflicts over water resources are not yet drawn up. In many basins in the EECCA region, water allocation among riparian countries continues to be an issue, because disagreement still exists over use quotas for the upstream and downstream users belonging to different States, as it is the case for some rivers in the discharge area of the Caspian Sea.

Hydromorphological pressures

One often overlooked problem in basins in EECCA and SEE (with the exception of reports from Central Asian countries and the Russian Federation) is linked to pressure arising from hydroelectric dams, river alterations, irrigation channels and other hydromorphological changes in river basins. The assessment of water resources in such river basins as the Danube, Elbe, Rhine, Meuse and Scheldt has clearly pointed to the severity of these pressures and has stimulated action to counteract them.

Other pressures

Other pressures in EECCA basins mostly refer to big industrial enterprises which recently became operational; these seem to cause fewer problems, as they were equipped with adequate wastewater treatment technologies. However, given economic development, it should be expected that, the relative importance of this type of pressure will increase in the future.

As concerns other pressures in basins in Western and Central Europe, a particular challenge area still to be addressed by proper response measures is the control and reduction of pollution by new substances produced by the chemical industry, including new pharmaceuticals that cannot be eliminated in wastewater treatment processes, as well as the control of pollution by priority substances given provisions of the Water Framework Directive and other applicable directives. In some other basins shared by countries with market economies, untreated or insufficiently treated industrial wastewater is still of concern and breakdowns of municipal wastewater treatment systems are the reason for significant discharges of polluted waters into rivers. The legal framework exists with the relevant directives, and compliance with these directives is needed to achieve a good status of water bodies. In some new EU countries, inappropriate wastewater treatment is still a problem, and the national sewerage and wastewater treatment plans are targeted to fulfil the requirements of the relevant directives by 2010 and 2015, respectively.

Other point pressures also refer to mining. In some basins, the mining industry (e.g. copper, zinc, lead, uranium mining) is one of the most significant (past or new) pollution sources, and a number of storage facilities (including tailing dams for mining and industrial wastes) exert significant (or at least potentially significant) pressures. In parts of the region, mining of hard coal has also significantly changed the groundwater flow. Opencast mining of brown coal, particularly in parts of Central Europe, is also lowering the groundwater level. Thus appropriate measures need to be implemented in many cases to control the adverse impact on water quality and quantity. After the termination of mining activities, rehabilitation measures need to be implemented to avoid further adverse impacts on aquatic and terrestrial ecosystems and/or to restore damaged landscapes and ecosystems, as is done in basins such as the Elbe, Oder and Rhine.

GOOD GOVERNANCE

Although the policy, legislative, institutional and managerial framework for transboundary cooperation has been developed over the last decade, the assessment revealed a number of deficiencies that call for further action.

Transboundary level

Bilateral and multilateral agreements are the basis for determined and reliable cooperation. Some river basins are still not covered by agreements and some of the existing agreements need to be revised particularly with regard to such issues as joint monitoring (see below), warning for hydrological extreme events and industrial accidents, sustainable flood management, and sharing/allocation of water resources. Major gaps also relate to the incorporation of groundwater management issues, which should be overcome most urgently.

Joint bodies are a prerequisite for effective cooperation and the joint monitoring and management of transboundary waters as is demonstrated by the well functioning joint bodies for the rivers Elbe, Danube, Meuse, Moselle/Saar, Rhine, Oder, Scheldt and Sava as well as the Finnish-Russian waters and the Kazakh-Russian waters. For such other basins as the Chu and Talas and Albanian-Greek waters, joint bodies have also been set up but are still in their infancy.

Most other basins lack dedicated joint management; lack of political will for joint action and cumbersome national procedures (coordination between national authorities/sectors) often hamper negotiations over joint measures and delay agreements on the mandates and tasks of joint bodies.

In these cases, riparian countries may decide to establish, as a first step, specific joint working groups. In these groups, experts from different disciplines should meet regularly to agree upon joint measures on integrated water resources management, including the implementation of monitoring and assessment activities, as well as the related technical, financial and organizational aspects. This has led to positive results, even in the Amur River basin (China and the Russian Federation) and the Tumen River basin (China, Democratic People's Republic of Korea, and the Russian Federation), which in the past have had a high water-related conflict potential among the riparian countries.

As a second step, joint bodies, such as river commissions or other arrangements for cooperation should be foreseen, and particular efforts should be made to build and strengthen the capacity of these joint bodies. The setting up of permanent secretariats for joint bodies can be an asset.

In a number of basins shared by EU countries with non-EU countries, there is still a conflict in applicable legislation leading to different requirements in such fields as monitoring and classification of water bodies and performance parameters of treatment technology. With the reform of the Water Law in countries bordering the EU, an approximation to EU legislation may be accomplished soon, allowing upstream and downstream countries to rely on almost the same standards.

Other EECCA countries face additional challenges. Pollution control legislation based on very similar "maximum allowable concentration levels" allows straightforward comparisons between water quality in upstream and downstream countries, but the legislation seems to be unrealistic to be complied by wastewater treatment technology. Rather than amending legislation in the short term, a straightforward way may consist in a step-wise approach, i.e. setting "realistic" target values for water quality that can be achieved over the medium term, and making these target values intermediate goals in the joint river basin management plans.

National policies and legislation

National policies and legislation should be further developed to regulate economic activities so that they do not adversely affect water and water-related ecosystems. A particular issue is agriculture, where perverse incentives that subsidize the overuse of natural resources and the decline of ecosystem health should be removed.

Legislation should be drawn up and applied to reduce fragmentation between, and improve coordination among, government departments and institutions. This requires a clear definition of the responsibilities and duties of ministries for the environment, agriculture and forestry, transport, energy, economy and finance. Legislation should also provide for coordination with stakeholders, e.g. farmers' associations and water users' groups.

Monitoring, data management and early warning

Further issues for cooperation include joint monitoring and data management. Data upstream and downstream of the borders between countries are often not comparable due to uncoordinated sampling, measurement and analytical (laboratory) methods in riparian countries. Joint programmes on monitoring, data management and assessment are therefore the key to integrated water resources management. This also applies to transboundary groundwaters as the current low level of transboundary cooperation and deficient technical guidance hamper systematic monitoring and assessment of their status.

There is a need to secure national funding, as for many basins in EECCA, the availability of data too often depends on the lifetime of international assistance projects.

Early warning (quality and quantity) is another issue of concern. Although industrial accidents and severe floods were often an important catalyst for joint measures in transboundary basins, joint action should be taken on time to prevent disasters or reduce their consequences. In many basins, this requires the establishment of early warning systems for floods, droughts and accidental pollution.

River basin management plans

Plans for integrated water resources management in a transboundary context still need to be developed for almost all basins in the region and the countries' analysis has pointed to the essential elements to be included in these plans, river-basin-by-river-basin. Proper attention should be devoted to land-use planning and management given the potential positive and adverse effects of land use on the hydrological and chemical regimes of transboundary waters. Management plans should cover both surface water and groundwater bodies, although the responsibility for protection and management may rest with different governmental authorities.

For river basin management plans, the identification and development of adaptive strategies towards effects of climate change on water management, including floods and droughts, on different levels of time and scale, and the identification of information needs in support of these strategies is also important. Such adaptive strategies should include the safe operation of water supply and sanitation facilities in urban and rural areas.

Platform for multi-stakeholder dialogues

There is a need for establishing a platform for a national interdepartmental and multi-stakeholder (e.g. Governments, NGOs, the private sector, water users' associations) dialogue on integrated water resources management. Early experience from the National Policy Dialogue under the EU Water Initiative that started under the Water Convention's overall guidance in Armenia and Moldova may serve as guidance for similar dialogues in other countries.

PART 2
TRANSBOUNDARY SURFACE WATERS

SECTION II

Fact and Figures on Transboundary Rivers and Lakes

DRAINAGE BASINS OF THE WHITE SEA, BARENTS SEA AND KARA SEA

This chapter deals with major transboundary rivers discharging into the White Sea, the Barents Sea and the Kara Sea and their major transboundary tributaries. It also includes lakes located within the basins of these seas.

TRANSBOUNDARY WATERS IN THE BASINS OF THE BARENTS SEA, THE WHITE SEA AND THE KARA SEA

Basin/sub-basin(s)	Total area (km^2)	Recipient	Riparian countries	Lakes in the basin
Oulanka	…[1]	White Sea	FI, RU	…
Tuloma	21,140	Kola Fjord > Barents Sea	FI, RU	…
Jacobselv	400	Barents Sea	NO, RU	…
Paatsjoki	18,403	Barents Sea	FI, NO, RU	Lake Inari
Näätämö	2,962	Barents Sea	FI, NO, RU	…
Teno	16,386	Barents Sea	FI, NO	…
Yenisey	2,580,000	Kara Sea	MN, RU	…
- Selenga	447,000	Lake Baikal > Angara > Yenisey > Kara Sea	MN, RU	
Ob	2,972,493	Kara Sea	CN, KZ, MN, RU	
- Irtysh	1,643,000	Ob	CN, KZ, MN, RU	
- Tobol	426,000	Irtysh	KZ, RU	
- Ishim	176,000	Irtysh	KZ, RU	

[1] 5,566 km^2 to Lake Paanajärvi and 18,800 km^2 to the White Sea.

OULANKA RIVER BASIN[1]

Finland (upstream country) and the Russian Federation (downstream country) share the basin of the Oulanka River.

The current assessment covers the Oulanka River upstream of Lake Paanajärvi. The river is part of the Koutajoki water system with a total basin area of 18,800 km² that drains to the White Sea.

Hydrology

The Oulanka River, with a total length of 135 km, has its sources in the municipality of Salla (Finland). The westernmost tributaries are the Savinajoki and Aventojoki rivers. Close to the eastern border, the River Kitkajoki flows into it. Just across the Russian border, the Kuusinki River joins it not far from Lake Paanajärvi.

High and steep cliffs flank the upper parts of the river, which mainly flows 100 m below the surroundings. In its lower part, the river meanders slowly. In some places, high sandy banks flank the river. In the course of centuries, the river has eroded the sandy soil; because of this eroding effect there is little or no vegetation in these areas.

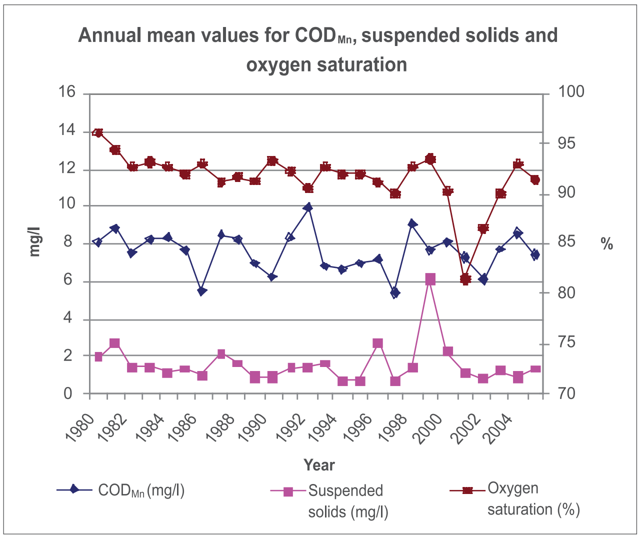
At the Oulankajoki station (Finland), the mean annual runoff was 23.9 m³/s (period 1966–1990) and 25.5 m³/s (period 1990–2000), respectively. Spring floods often occur.

During the time period 1966–1990, the statistical maximum and minimum discharge values were as follows: HQ = 462 m³/s, MHQ = 271 m³/s, MNQ = 4.92 m³/s and NQ = 3.10 m³/s. For 1991–2000, these values were: HQ = 404 m³/s, MHQ = 241 m³/s, MNQ = 5.08 m³/s and NQ = 3.37 m³/s.

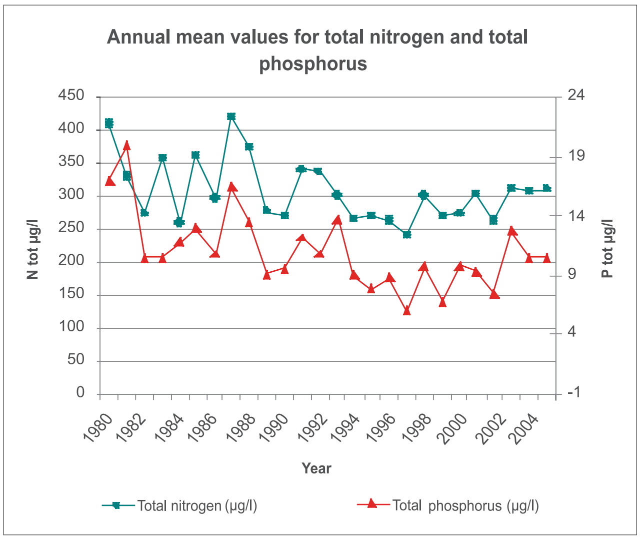
Basin of the Oulanka River upstream of Lake Paanajärvi			
Area	**Country**	**Country's share**	
5,566 km²	Finland	4,915 km²	88%
	Russian Federation	651 km²	12%

Source: Finnish Environment Institute (SYKE).

[1] Based on information provided by the Finnish Environment Institute (SYKE).



Annual mean values of chemical oxygen demand, suspended solids and oxygen saturation at the Oulankajoki station (Finland)



Annual mean values of total nitrogen and total phosphorus at the Oulankajoki station (Finland)

Pressure factors

There are no significant human activities in the Finnish part of the basin. Sewage discharges from the Oulanka Research Station is the only pressure factor.

The water quality of the Oulanka River has been monitored since 1966; sampling takes place four times a year.

The water quality was classified as excellent (in 2000–2003) as indicated, for example, by the annual mean values for COD_{Mn}, suspended solids and oxygen saturation on the Finnish territory of the Oulanka River.

Transboundary impact

There is no significant transboundary impact. In the beginning of the 1990s, the water quality was classified as "good", thereafter as "excellent".

Trends

There are no water-quality or water-quantity problems at the moment. The river at the border section will remain in the category "in high and good status".

TULOMA RIVER BASIN[2]

Finland (upstream country) and the Russian Federation (downstream country) share the basin of the Tuloma River. Usually, the basin refers to the area upstream of the Lower Tuloma Reservoir (Russian Federation). Downstream of this reservoir, the river discharges into the Barents sea through the Kola Fjord.

Basin of the Tuloma River upstream of the Lower Tuloma Dam			
Area	**Country**	**Country's share**	
21,140 km²	Finland	3,285 km²	16%
	Russian Federation	17,855 km²	84%

Source: Finnish Environment Institute (SYKE).

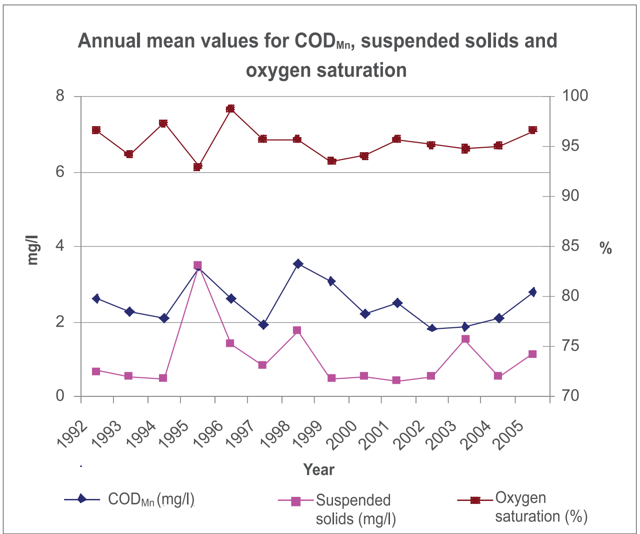
[2] Based on information provided by the Finnish Environment Institute (SYKE).

The Tuloma basin is divided into four sub-basins: the Lutto (also referred to as Lotta) and Notta/Girvas sub-basins, which are shared by Finland and the Russian Federation, and the Petcha and Lower Tuloma sub-basins, which are entirely located in the Russian Federation. This assessment covers the Lutto and Notta rivers.

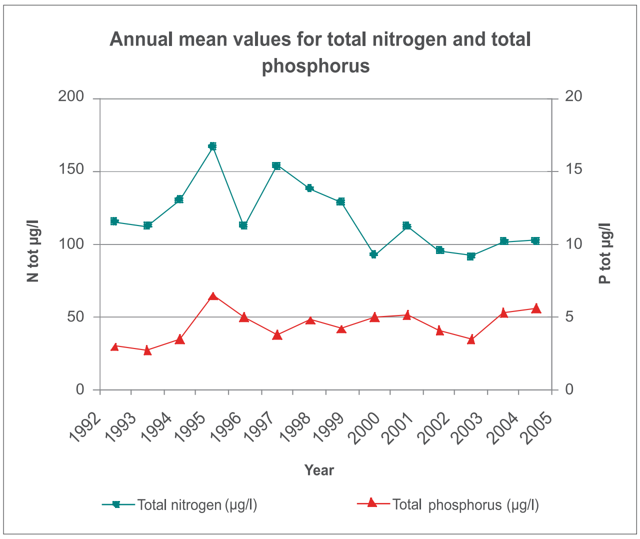
Hydrology

The mean annual discharge of the Lutto River at the Lutto site (Finland) was 22.3 m^3/s for the period 1993–2000. For the same period, the maximum and minimum values were as follows: HQ = 348 m^3/s, MHQ = 219 m^3/s, MNQ = 4.02 m^3/s and NQ = 1.76 m^3/s. Severe floods are frequent; however they do not have significant impact on human health and safety due to the regulating effect of reservoirs.

There are two reservoirs, used for hydropower generation on the Russian part of the Tuloma basin: the Upper Tuloma reservoirs and the Lower Tuloma reservoir.



Annual mean values of chemical oxygen demand, suspended solids and oxygen saturation at the Lutto station (Finland)



Annual mean values of total nitrogen and total phosphorus at the Lutto station (Finland)

Pressure factors in the Lutto and Notta/Girvas sub-basins

In the Finnish part of the Lutto and Notta/Girvas catchment areas, there are some remote settlements and there are very little agricultural activities. Thus, human impact from the settlements and diffuse pollution from the application of chemicals in agriculture are negligible.

Historically, the Tuloma River system has been an excellent river for salmon fishing. Following the construction of the two power stations on Russian territory in the 1930s and the 1960s, respectively, the migration of salmon into the upper tributaries stopped completely.

Transboundary impact in the Lutto and Notta/Girvas sub-basins

There is no significant transboundary impact.

Trends in the Lutto and Notta/Girvas sub-basins

There are no water-quality or water-quantity problems at a moment. Thus, the rivers at the border sections will remain in the category "in high and good status".

JAKOBSELV RIVER BASIN[3]

The Jakobselv River, also known as the Grense Jakob River, forms the border between Norway and the Russian Federation.

Basin of the Jakobselv River			
Area	**Country**	**Country's share**	
400 km²	Norway	300 km²	68%
	Russian Federation	100 km²	32%

Source: Finnish Environment Institute (SYKE).

The river flows between steep hills and has many rapids. It is navigable only by boats up to 3 miles from the mouth.

The river is known to be good for recreational fishing, with many big salmon.

The Jakobselv River has greater variations in water chemistry than the Paatsjoki River (see assessment below). The river basin lies in an area of very high sulphate deposition. The sulphate concentrations are higher and the alkalinity is lower than in the Paatsjoki River, and there is a marked decrease of alkalinity in the spring. The remaining alkalinity is still sufficient to avoid acid water. The nickel concentrations in the Jakobselv are higher than in the Paatsjoki and copper concentrations are lower.

PAATSJOKI RIVER BASIN[4]

Finland, Norway and the Russian Federation share the basin of the Paatsjoki River.

Basin of the Paatsjoki River			
Area	**Country**	**Country's share**	
18,403 km²	Finland	14,512 km²	79%
	Norway	1,109 km²	6%
	Russian Federation	2,782 km²	15%

Source: Lapland regional environment centre, Finland.

PAATSJOKI RIVER

Hydrology

The Paatsjoki River (also known as the Pasvikelva River) is the outlet from Lake Inari (see assessment below) to the Barents Sea. The river is 143 km long and has many rapids. During the first few kilometres, the river is on Finnish territory; it crosses the Finnish-Russian border and flows for some 30 km through the Russian Federation. Thereafter, the river for some 112 km marks the borderline between Norway and the Russian Federation. The river empties into the Varangerfjord, not far from Kirkenes.

The mean annual discharge (MQ) of the Paatsjoki River for the period 1971–2000 was 155 m^3/s (4.89 km^3/a).

Today, the Paatsjoki is mostly a slowly flowing river, more like a long line of lakes. The river is strongly regulated by seven hydroelectric power plants (two in Norway and five in the Russian Federation). These construction works induced changes in the original water level along some 80% of the watercourse and about 90% of the waterfalls and rapids have been regulated. This resulted in a severe reduction of the spawning ground for the trout population.

[3] Based on information provided by the Finnish Environment Institute (SYKE) and Ministry for Environment, Norway.
[4] Based on information provided by the Finnish Environment Institute (SYKE), the Lapland regional environment centre and Ministry for Environment, Norway.

Pressure factors

Throughout the basin, agriculture and human settlements have some impact on water quality and fauna.

In the Russian Federation, the river has been influenced by pollution from the Pechenganikel industrial complex, located nearby the city of Nikel close to halfway along the river from Lake Inari to the Barents Sea. The lower part of the watercourse drains the smelters at Nikel directly through Lake Kuetsjärvi. Pollutants from the industrial complex include SO_2-containing dust and a wide range of toxic heavy metals, transported by air and/or water from the plant and waste deposits, respectively. Thus, high levels of heavy metal contamination have been recorded in water and sediments in the vicinity of the smelters.

Transboundary impact

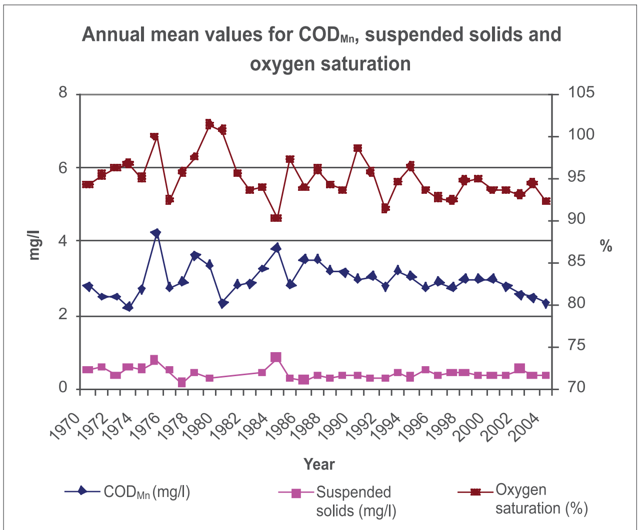
The transboundary impact from human activities on Finnish and Norwegian territory is insignificant.

On Russian territory, the activity of the Pechenganickel smelters has influenced the hydrochemical parameters of the Paatsjoki watercourse; thus the downstream river system is under severe anthropogenic influence.

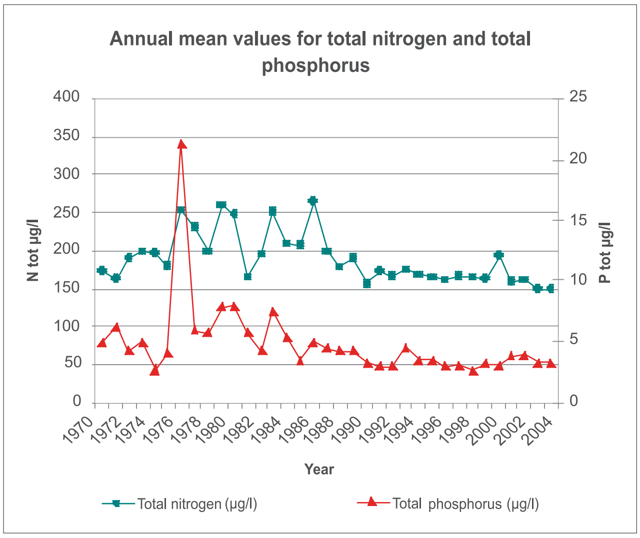
Water regulations by the power plants in Norway and the Russian Federation and introduction of alien species also cause significant transboundary impact.

Trends

At the Finnish-Russian border, the river is in a good status. Improvements in water-quality in the Russian Federation will require huge investments in cleaner production and the cleaning up of waste disposal sites.



Annual mean values of chemical oxygen demand, suspended solids and oxygen saturation at the Kaitakoski station (Finland)



Annual mean values of total nitrogen and total phosphorus at the Kaitakoski station (Finland)

LAKE INARI[5]

Lake Inari is a large (1,043 km²), almost pristine clear-water lake situated in northern Finland, some 300 km north of the Arctic Circle. The lake belongs to the Paatsjoki basin.

The lake is relatively deep (maximum depth 92 m, mean depth 14.3 m) and has a total volume of 15.9 km³ with a retention time of a bit over 3 years. The shoreline is very broken and there are over 3,000 islands in the lake. The lake drains through the Paatsjoki River to the Barents Sea. The lake is regulated by the Kaitakoski power plant located in the Russian Federation. The annual water level fluctuation is normally 1.45 m. The freezing period starts in November and lasts until June.

The drainage basin is very sparsely populated (0.47 persons/km²), and consists mainly of mires, low-productive

[5] Based on information provided by the Finnish Environment Institute (SYKE) and the Lapland Regional Environment Centre.

land and pine forests on moraine soil, and is mainly used for forestry and reindeer herding. Due to lack of substantial human impact in the lake basin, a lot of relatively small nutrient loading, especially nitrogen loading, comes as atmospheric deposition. Ivalo village (4,000 inhabitants) discharges its purified wastewaters through the Ivalojoki River to the south-western corner of the lake. The lake retains nutrients effectively and thus the transboundary impact to the Russian Federation is very low.

The lake has been monitored intensively for decades for physico-chemical determinands by the Finnish environmental authorities. Furthermore, biological monitoring (phytoplankton, macrophytes, fish) is getting more important, as the Water Framework Directive requires it. The discharge has been monitored daily since 1949 in the Kaitakoski power plant.

The water quality of Lake Inari is excellent. Nutrient levels and colour values are low and oxygen concentrations of the deep areas remain good throughout the year. The western parts of the lake are naturally more nutritious and coloured than the eastern and northern parts due to inflow from several large rivers. Although the regulation has some undesirable effects on Lake Inari's biota, the overall status is good. Fish stocks and community structure are in good status, bearing in mind that the natural state of fish fauna has been altered by former introduction of new species and present compensatory fish stockings. The water quality and ecological status have remained quite stable for several decades.

There is no finalized classification of Lake Inari's ecological status according to the classification requirements set by the Water Framework Directive. However, it is probable that no major changes compared to the general national classification of water quality are to be expected in the near future. Lake Inari will most likely maintain its reputation as one of the most pristine and beautiful lakes in Finland. However, it is likely that water level regulation will likely have adverse effects on the lake (bank erosion and impaired circumstances for fish spawning and bird breeding).

NÄÄTÄMÖ RIVER BASIN[6]

Finland (upstream country) and Norway (downstream country) share the basin of the Näätämö River, also known as Neiden.

The river is an important watercourse for the reproduction of Atlantic salmon.

Basin of the Näätämö River			
Area	**Country**	**Country's share**	
2,962 km²	Finland	2,354 km²	79.5%
	Norway	608 km²	20.5%

Source: Finnish Environment Institute (SYKE).

Hydrology

The river flows from Lake Iijärvi (Finland) to Norwegian territory and and discharges into the Barents Sea. On Finnish territory, it flows about 40 km through wilderness; there are many rapids in the river.

The mean annual discharge of the Näätämö River at the Iijärvi site (Finland) is 8.55 m^3/s. For the period 1991–2000, the maximum and minimum values were as follows: HQ = 145 m^3/s, MHQ = 62.0 m^3/s, MNQ = 1.95 m^3/s and NQ = 1.60 m^3/s.

Pressure factors and transboundary impact

The anthropogenic pollution in the river is very low. With total nitrogen values on the order of 200 µg/l and total phosphorus values of around 150 µg/l (Näätämöjoki station, Finland, period 1981–2005), there is no significant transboundary impact on Norwegian territory.

Trends

The river will remain in a good water-quality and ecological status.

TENO RIVER BASIN[7]

Finland and Norway share the basin of the Teno River, also known as the Tana River. With its headwaters, the Teno River forms 283 km of the Finnish-Norwegian border.

The river is known as one of the most important rivers in the world for the reproduction of Atlantic salmon.

Basin of the Teno River			
Area	**Countries**	**Countries' share**	
16,386 km²	Finland	5,133 km²	31%
	Norway	11,253 km²	69%

Source: Lapland regional environment centre, Finland.

Hydrology

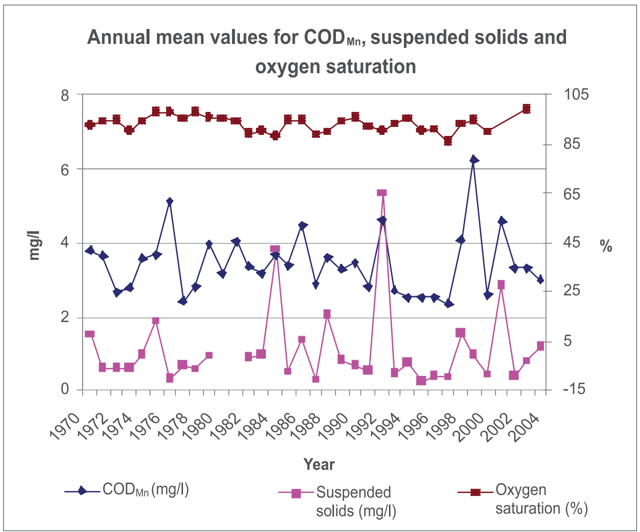
The Teno River flows along the border of Finland and Norway and discharges into the into the Barents Sea. The Teno's headwaters are the Inarijoki River (mostly in Norway) and Kaarasjoki (in Norway); their sources are in the Ruija fjeld highland.

The river's mean annual discharge at the Polmak station (Norway) is 163 m^3/s (5.14 km^3/a). The average maximum discharge is 1,767 m^3/s with an absolute maximum in 2002 of 3,544 m^3/s. At Alaköngäs (Finland), the discharge values for the period 1976–2005 were: MQ = 177 m^3/s (5.6 km^3/a), NQ = 21 m^3/s and HQ = 3147 m^3/s. Spring floods are common.

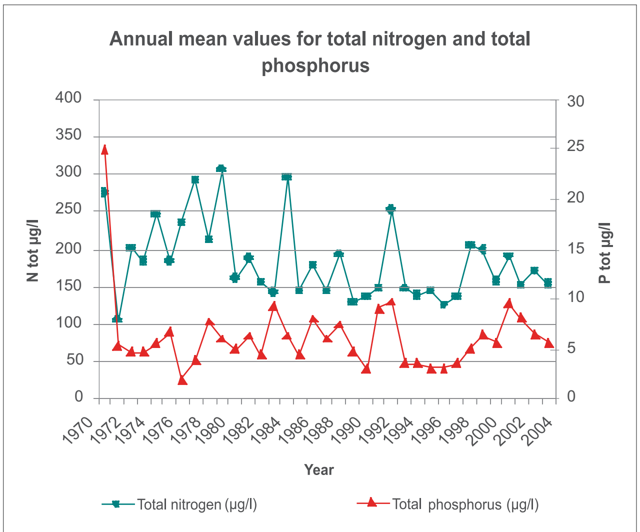
[6] Based on information provided by the Finnish Environment Institute (SYKE) and Ministry for Environment, Norway.
[7] Based on information provided by the Finnish Environment Institute (SYKE) and Ministry for Environment, Norway.

Pressure factors

The Teno has a high content of dissolved minerals due to erosion of bedrock that is partly rich in calcium. It has moderate concentrations of organic matter, mainly due to leakage from soil and bogs. The load of organic matter from villages does not measurably affect water quality in the main river. Analyses of heavy metals in the river show natural background levels. In the lower part of the river, there are episodes of increased content of particles (high turbidity), mainly due to erosion during heavy rainfall and snowmelt. Although this does not have any pronounced negative effect on aquatic organisms, high turbidity may negatively affect the water supply.



Annual mean values of chemical oxygen demand, suspended solids and oxygen saturation at the Tenojoki station (Finland)



Annual mean values of total nitrogen and total phosphorus at the Tenojoki station (Finland)

Generally, there are very few anthropogenic pressures on water quality in the whole river basin.

Urban wastewater at Karasjok, Tana Bro and Seida in Norway and at Karigasniemi in Finland undergoes biological and chemical treatment. Urban wastewater at Nuorgam (Finland) is treated biologically and chemically; the plant has as rotating biological contactor with natural lagooning and chemicals' addition. The urban wastewater treatment at Utsjoki (Finland) is a chemical sewage treatment plant and has a leaching bed.

In the past, the river downstream of Karasjok (Norway) was heavily polluted by insufficiently treated municipal wastewaters. In 1993, a new biological/chemical sewage treatment plant was built, reducing the pollution in the upper part of the river to a low level. Biological/chemical sewage treatment plants at Tana Bro and Seida in Norway reduced the pollution in the lower part of the river.

Transboundary impact

The transboundary impact is insignificant. According to the criteria of the Norwegian Pollution Control Authority, in 2002 all the sampling stations showed "good" or "very good" water quality.

Trends

The Teno is in a high status. The status is stable; only natural variations in water quality will occur.

YENISEY RIVER BASIN[8]

Mongolia (upstream country) and the Russian Federation (downstream country) share the Yenisey basin.

The Yenisey River flows only on Russian territory. However, the upper part of the Yenisey River basin is transboundary, including parts of the transboundary Selenga River (total length 1,024 km; 409 km in Russia), and shared by Mongolia (upstream) and the Russian Federation (downstream).

Basin of the Yenisey River			
Area	**Country**	**Country's share**	
2,580,000 km²	Mongolia	318,000 km²	12.3%
	Russian Federation	2,261,700 km²	87.7%

Sources: Integrated Management and Protection of Water Resources of the Yenisey and Angara rivers, Krasnojarsk Regional Branch of the International Academy of Ecology and Nature, Krasnojarsk, 2006; Surface water resources of the USSR, Gidrometizdat, Leningrad, 1973.

Hydrology

The recharge area of the Yenisey basin is made up of the following principal watercourses: the Selenga River, Lake Baikal (31,500 km²) Angara River and the Yenisey itself.

The Yenisey's source is the confluence of the Bolshoy (Bij-Chem) and Malyi (Kaa-Chem) Yenisey rivers at the city of Kyzyl. The river's length from this confluence to the mouth at the Kara Sea is 3,487 km; the total length from the source of the Bolshoy Yenisei is 4,092 km. The total discharge at the mouth is 18,730 m³/s.

According to natural conditions, the character of valleys, the features of the riverbed and the hydrological regime of the Yenisey River, the entire basin is usually split into three parts: the Upper Yenisey (from the source of the Bolshoy Yenisey to the mouth of the Tuba River; 1,238 km),

[8] Based on information provided by the Federal Water Agency, Russian Federation.

the Middle Yenisey (from the mouth of the Tuba to the mouth of the Angara River; 717 km) and the Lower Yenisey (downstream from the mouth of the Angara to the Kara Sea; 2,137 km).

Discharge characteristics of the Yenisey River		
Discharge characteristics at the Kyzyl gauging station (Russian Federation)		
Q_{av}	1,010 m^3/s	1927–1968
Q_{max}	7,990 m^3/s	21 April 1940
Q_{min}	153 m^3/s	…
Discharge characteristics at the Igarka gauging station (Russian Federation)		
Q_{av}	17,700 m^3/s	1927–1968
Q_{max}	153,000 m^3/s	11 June 1959
Q_{min}	3,540 m^3/s	…
Total discharge at mouth (Kara Sea)		
Q_{av}	18,730 m^3/s	1927–1968

Source: Surface water resources of the USSR, Gidrometizdat, Leningrad, 1973.

Pressure factors in the transboundary sub-basin of the Yenisey River

The population density in the transboundary part of watercourses in the sub-basin of the Upper Yenisey (border area between the Russian Federation and Mongolia) is very small and the area is practically not economically developed.

The water pollution in the Yenisey basin stems mainly from Mongolia (the Selenga River) and, partly, from the Russian Federation through the Selenga's tributaries. Lake Baikal serves as a natural barrier for the transboundary flow of pollutants, preventing their impact on the downstream parts of the watercourse.

Transboundary impact

Following the 1995 Agreement between the Russian Federation and Mongolia, a number of measures are being jointly carried out to protect, rationally use and rehabilitate the water resources of the Yenisey.

These include monitoring and assessment of the status of watercourses in the Yenisey basin, establishment of water protection zones, planting of vegetation strips on riverbanks, cleaning of riverbeds of small tributaries, siting of management structure as well as land use in protected zones. Measures also include environmental impact assessment, safe operation of water construction works and the operational schedule of hydropower installations. In the Russian Federation, wastewater treatment, including the construction of new and rehabilitation of existing wastewater treatment plants, became part of these measures in order to treat wastewater from municipalities and small enterprises and storm water overflow.

Trends

The status of the watercourses is "stable". An increasing human impact on the river Angara (Russian Federation) is most likely after completion of the construction of the Boguchansk hydropower dam.

Further planned measures to protect the waters of the Yenisey basins in the Russian Federation include: changes of the operational regime of reservoirs (hydropower stations in the Angara-Yenisey cascade of dams) and Lake Baikal; protection of human settlements against floods and adverse effects of rising groundwater levels; further cleaning up of riverbeds of small watercourses; further development of wastewater collection systems; construction and/or rehabilitation of wastewater treatment plants; construction of systems for the collection of storm water overflows and their treatment in wastewater treatment plants; fight against illegal waste disposal and cleaning of water protection zones from such illegal deposits; fight against erosion through afforestation and other types of vegetation; and further development of monitoring and assessment of the status of watercourses.

OB RIVER BASIN[9]

OB RIVER[10]

China, Kazakhstan, Mongolia and the Russian Federation share the basin of the Ob River as follows:

Basin of the Ob River			
Area	**Country**	**Country's share**	
2,972,493 km²	Russian Federation	2,192,700 km²	73.77%
	Kazakhstan	734,543 km²	24.71%
	China	45,050 km²	1.51%
	Mongolia	200 km²	0.01%

Source: Ministry of Environmental Protection of Kazakhstan.

Hydrology

The Ob together with its first-order tributary, the Irtysh, forms a major river basin in Asia, encompassing most of Western Siberia and the Altai Mountains.

The Ob River basin includes major transboundary rivers, including the Irtysh (1,914,000 km²), which is the chief tributary of the Ob, and the Tobol (395,000 km²) and Ishim (177,000 km²), which are both tributaries of the Irtysh. The River Tobol has a number of transboundary tributaries.

[9] Based on information provided by the Ministry of Environment Protection, Kazakhstan and the Federal Water Agency, Russian Federation.
[10] Source: Drawing up of the water management balance for the Ob River, phases I and II, ZAO PO "Sovintervod", Moscow, 2004.

Pressure factors

In addition to the pressure factors in the catchment areas of the Irtysh and its tributaries (see following section), other pressure factors on the Ob River basin arise from the large oil and gas deposits in the Russian Federation, which are located in the middle and lower Ob. Severe pollution in the lower Ob has damaged the river's formerly famous fisheries.

Transboundary impact and trends

For transboundary impact and trends, see the assessment of the rivers Irtysh, Tobol and Ishim in the following sections.

IRTYSH RIVER

China, Kazakhstan, Mongolia and the Russian Federation share the catchment area of the Irtysh River, located in the Ob River basin, as shown in the following table.

Sub-basin of the Irtysh River			
Area	**Country**	**Country's share**	
1,643,000 km²	Russian Federation*	1,099,000 km²	67%
	Kazakhstan**	498,750 km²	30%
	China and Mongolia**	45,250 km²	3%

Sources:
* Схема комплексного использования и охраны водных ресурсов бассейна р. Иртыш. Том 2. Водные объекты и водные ресурсы. ЗАО ПО «Совинтервод», Москва, 2006г. (Integrated water resources management of the Irtysh basin, volume 2, water bodies and water resources, ZAO PO "Sovintervod", Moscow, 2006).
** Ministry of Environmental Protection of Kazakhstan.

Hydrology

The River Irtysh, with a total length of 4,248 km (1,200 km in Kazakhstan), has its source in the Altai Mountains in Mongolia, at an altitude of 2,500 m. The Irtysh flows through Chinese territory for a distance of 618 km, along which water abstraction for irrigation decreases water flow. In Kazakhstan, a cascade of large hydroelectric power stations (Bukhtarminskaya, Shulbinskaya, Ust-Kamenogorskaya and others) influences the water level.

A cascade of reservoirs in Kazakhstan (the Bukhtarminsk, Ust'-Kamenogorsk and Shul'binsk reservoirs) regulates the river flow.

For hydrological measurements and hydrochemical analysis, one transboundary monitoring stations on the Irtysh was recently established: the station at Tartarka on the border between Kazakhstan and the Russian Federation.

Discharge characteristics at the two gauging stations in Kazakhstan		
Buran gauging station on the Irtysh (Black Irtysh): distance to mouth – 3,688 km		
Q_{av}	296 m³/s	1937–2004
Q_{max}	2,330 m³/s	21 June 1966
Q_{min}	20.4 m³/s	30 November 1971
Bobrovsky gauging station on the Irtysh: distance to mouth – 2,161 km		
Q_{av}	730 m³/s	1980–2004
Q_{max}	2,380 m³/s	June 1989
Q_{min}	285 m³/s	September 1983

Source: Ministry of Environmental Protection of Kazakhstan.

Pressure factors

In the upper reaches of Mongolia, the Irtysh is one of the cleanest and least mineralized rivers in the world.

Regarding pressure factors in China, Kazakhstan reported[11] that pollution sources include industry and irrigated agriculture. At the border with China, near the village of Buran (Kazakhstan), the concentrations of copper and oil products exceeded the maximum allowable concentration (MAC) values by a factor of 4 and 5, respectively. Regarding pressure on water availability, an irrigation canal more than 300 km long and 22 m wide stretching from the Black Irtysh to Karamay (China) is estimated to take 20% of the annual water flow of the Black Irtysh.

In Kazakhstan itself, according to the 1997 Kazakhstan Action Plan for the Protection and Rational Utilization of Water Resources, the Irtysh River was in the mid-1990s one of the most polluted transboundary rivers in Kazakhstan. According to research by Kazhydromet, in the 92 days of the fourth quarter of 1996, for example, 94 cases of water pollution with copper, zinc, boron and/or phenol and two cases of extremely high-level pollution with zinc, exceeding the MAC by a factor of 190, occurred on the Irtysh or its tributaries. The sources of pollution included the metal-processing industry, discharge of untreated water from mines and ore enrichment and leakages from tailing dams. The level of water pollution in the Irtysh River rose considerably in Ust-Kamenegorsk and the lower Irtysh under the influence of sewage discharges and industrial wastewater discharges (heavy metals, oil and nitrogen products).

Water management strongly depends on the requirements of the main users: hydropower production and water transport. These requirements, but also the need for water to support flora and fauna in the flood plain areas, are to be taken care of in the operation of the reservoirs on the Irtysh (Bukhtarminsk and Shul'binsk hydropower stations). Due to limited water resources availability, the conflict between hydropower production and shipping is increasing. Over the recent years, hydropower production at Shul'binsk considerable increased in wintertime as the new (private) owner gives priority to energy production; thus releasing water over winter and retaining water in the reservoir over summer time.

Due to a decrease of river flow, industrial wastewater discharges from Ust-Kamenogorsk (Kazakhstan) have a more pronounced negative effect on the pollution level in the Irtysh, the quality of drinking water supplied to Semipalatinsk and Pavlodar, and the water transfer through the Irtysh-Karaganda Canal (which is the main source of water supply to Central Kazakhstan).

Transboundary impact

The following table shows the improvement of water quality along the watercourse in Kazakhstan.

Water pollution index[12] and water quality classification for two monitoring stations in Kazakhstan

Measuring station	1997	2000	2001	2002
Ust Kamenogorsk	1.02 (class 3)	1.55 (class 3)	1.62 (class 3)	1.47 (class 3)
Pavlodar	…	1.09 (class 3)	0.97 (class 2)	0.97 (class 2)
Measuring station	**2003**	**2004**	**2005**	**2006**
Ust Kamenogorsk	1.18 (class 3)	1.90 (class 3)	1.12 (class 3)	1.56 (class 3)
Pavlodar	1.00 (class 2)	1.39 (class 3)	1.22 (class 3)	1.06 (class 3)

Note: Class 2 – clean; class 3 – moderately polluted.
Source: Ministry of Environmental Protection of Kazakhstan.

Given measurements by the Russian Federation, pollution by oil products, phenols and iron exceed the MAC values, both for the maintenance of aquatic life and other uses.

The maximum concentration of oil products occurs downstream of Tobolsk (44 times MAC for maintenance of aquatic life). The iron concentration at all measuring points exceeds the MAC values (both aquatic life and other uses), sometimes by a factor of 12. Copper and zinc concentrations are also above the MAC values for aquatic life, whereby the highest value for copper was observed downstream of Tobolsk (15 times MAC, with a maximum

[11] 1997 Kazakhstan Action Plan for the Protection and Rational Utilization of Water Resources.
[12] The water pollution index is defined on the basis of the ratios of measured values and the maximum allowable concentration of the water-quality determinands.

of 30 times MAC). In some watercourse, pesticides (DDT and γ-HCH) have been found with concentrations exceeding the WHO recommended values (6–7 times for DDT and 10 times for γ-HCH).

The declining water quality of the Irtysh has also negative impact on water management in Omsk Oblast (Russian Federation). The potential threat to these downstream parts of the Irtysh sub-basin is mercury from "hot spots" in Kazakhstan. Since 1997, the Russian Federation (through its Ministry of Natural Resources) has been involved in the abatement of mercury pollution sources.

In the Russian Federation, the water quality of the Irtysh falls into the classes "polluted" and "very polluted".

Trends

In the first half of the 1990s, the Irtysh was classified by Kazakhstan as polluted in the upstream section and extremely polluted in the downstream section. In the second half of the 1990s, the quality of water in the Irtysh basin tended to improve, although the overall water pollution situation remained unfavourable. Starting in 2000, water quality improved.

In order to improve water quality through more stringent measures to prevent, control and reduce pollution, a number of joint projects are being carried out by the Russian Federation and Kazakhstan as part of activities under the joint Russian-Kazakh Commission on the Joint Use and Protection of Transboundary Waters.

In the period 2001–2003, an international project, financed by France, has prepared the ground for an international system for the assessment and management of Irtysh's water resources, based on the principles of integrated water resources management. It is expected that China will become involved in these activities.

TOBOL RIVER

The Russian Federation and Kazakhstan share the sub-basin of the Tobol River.

Sub-basin of the Tobol River			
Area	**Country**	**Country's share**	
426,000 km^2	Russian Federation*	305,000 km^2	71.5%
	Kazakhstan**	121,000 km^2	28.5%

Sources: * Схема комплексного использования и охраны водных ресурсов бассейна р. Иртыш. Том 2. Водные объекты и водные ресурсы. ЗАО ПО «Совинтервод», Москва, 2006г. (Integrated water resources management of the Irtysh basin, volume 2, water bodies and water resources, ZAO PO "Sovintervod", Moscow, 2006).
** Ministry of Environmental Protection of Kazakhstan.

Given its total water discharge, the Tobol is the biggest tributary to the Irtysh. Of its total length (1,591 km), the river flows for 570 km in Tyumen' Oblast (Russian Federation). The Tobol's main tributaries include the Ubagan, Uy, Ayat, Sintashty (also known as the Dshelkuar) and Toguzyak rivers.

For hydrological measurements and hydrochemical analysis, two transboundary monitoring stations on the river have been recently established: the station at Zverinogolovsk and Lioutinka.

Hydrology

The River Tobol is 1,591 km long (including 800 km in Kazakhstan) and has its source in the south-western part of Kostanai Oblast in northern Kazakhstan.

The basin has 190 reservoirs, among them the Kurgan reservoir (Russian Federation), with a storage capacity of 28.1 million m^3; 23 reservoirs with storage capacities of 5 to 10 million m^3; and 166 reservoirs with a storage capacity below 5 million m^3. In addition to hydropower production, these reservoirs provide drinking water and regulate water flow.

Discharge characteristics at two stations on the Tobol in Kazakhstan		
Grishenka gauging station: 1,549 km upstream from the river's mouth		
Q_{av}	8.54 m^3/ s	1938–1997, 1999–2004
Q_{max}	2250 m^3/ s	2 April 1947
Q_{min}	No flow	For 10% of time during 9 June–23 October 1985; for 74% of time in winter
Kustanai gauging station: 1,185 km upstream from the river's mouth		
Q_{av}	9.11 m^3/s	1964–1997, 1999–2004
Q_{max}	1850 m^3/s	12 April 2000
Q_{min}	0.13 m^3/s	10 September 1965

Source: Ministry of Environmental Protection of Kazakhstan.

Pressure factors

Parts of the Tobol catchment area, which stretch into the Ural region in the Russian Federation, have mineral-rich bedrock that causes high natural background pollution with heavy metals in many water bodies in the Tobol catchment area; even under natural conditions, the MAC values are often exceeded. In Kazakhstan, the natural salt lakes in the catchment area of the River Ubagan produce additional background pollution of up to 0.8 g/l of salt ions, which cause problems for the drinking-water supply in the Kurgan area (Russian Federation). The significant salinity of soils and a high geochemical background in the Kazakhstan part of the catchment area are further reasons for the pollution of watercourses; the acid snow-melting waters enrich themselves with chlorides, sulphates and a number of other substances (e.g. Na, Fe, Mn, B, Be, Al, As, Ni, Co, Cu, Zn, Pb, Cd, Mo).

The sub-basin of the Tobol belongs to a region with developed industry and agricultural activities as well as developed water management infrastructure. The human impact on the river flow and the availability of water resources is clearly visible: abstractions of water from the river, inter-basin water transfer, operation of dams and reservoirs and melioration work on agricultural land and forested areas. Having a mean annual flow of 0.48 km^3/a, the Tobol's real flow largely varies (between 0.2 km^3/a and 0.4 km^3/a) depending on the operation of the Karatomarsk reservoir. In Kazakhstan, the main anthropogenic pollution sources are municipal wastewaters, wastewater from ore mining and processing, residual pollution from closed-down chemical plants in Kostanai, accidental water pollution with mercury from gold mining in the catchment area of the River Togusak, and heavy metals from other tributaries to the Tobol. While diffuse pollution from fertilizers in agriculture is decreasing, it remains a problem, as does polluted surface runoff during spring flood periods.

Through transboundary tributaries to the Tobol, notably the Uy River, the Russian Federation contributes to the pollution of the Tobol River on Kazakhstan's territory with nutrients and organic substances from communal wastewater as well as hazardous substances from urban waste dumps, power stations' ash deposits and the fat-processing industry.

Transboundary impact

The pollution load of the Tobol River at the Kazakhstan-Russian border originates from pollution sources in Kazakhstan and pollution carried by the transboundary tributaries to the Tobol from pollution sources in the Russian Federation. Downstream of the border with Kazakhstan, the Tobol is further polluted from Russian point and diffuse sources.

Water pollution in the Tobol River in Kazakhstan upstream of the border with the Russian Federation

Year	Determinands	Mean concentration (mg/l)	Factor by which MAC is exceeded	Water quality
2001	Sulphates	159.0	1.59	Class 5
	Iron (total)	0.168	1.68	
	Iron (2+)	0.056	11.3	
	Copper	0.029	28.7	
	Phenols	0.002	2.0	
2002	Sulphates	122.129	1.22	Class 5
	Iron (total)	0.258	2.58	
	Iron (2+)	0.109	21.8	
	Copper	0.022	22.1	
	Zinc	0.011	1.07	
2003	Sulphates	167.176	1.67	Class 3
	Iron (total)	0.159	1.59	
	Iron (2+)	0.065	13.06	
	Copper	0.010	10.0	
	Phenols	0.002	2.0	
2004	Sulphates	145.55	1.46	Class 3
	Iron (total)	0.18	1.8	
	Iron (2+)	0.054	10.8	
	Copper	0.0103	10.3	
2005	COD	38.3	1.1	Class 2
	Nitrite Nitrogen	0.022	1.1	
2006	Sulphates	228.8	2.3	Class 6
	Copper	0.0167	16.7	
	Iron (total)	0.16	1.6	
	Nickel	0.034	3.4	
	Manganese	0.17	17.0	

Note: Class 2 – clean; Class 3 - moderately polluted, Class 5 –polluted, Class 6 - heavily polluted.
Source: Ministry of Environmental Protection of Kazakhstan.

The Ubagan, a right-hand-side (eastern) tributary to the Tobol which is entirely on Kazakh territory and discharges into the Tobol, carries an additional pollution load and adds to the load of the Tobol from Kazakhstan sources.

Water pollution index in Kazakhstan upstream of the border with the Russian Federation

Measuring station	2001	2002	2003	2004
Tobol (Kazakhstan)	5.53	4.20	2.55	2.78

Source: Ministry of Environmental Protection of Kazakhstan.

Also downstream of the Kazakhstan-Russian border, pollution from the territory of the Russian Federation adds to the pollution load of the Tobol. This is particularly visible in the Kurgan reservoir (upstream of Kurgan), where to date the annual mean concentrations of copper have exceeded the MAC by a factor of 16.7, zinc by a factor of 2.5, and total iron by a factor of 4.6. Downstream of Kurgan, the annual mean concentrations of copper continue to exceed the MAC value 17.8 times, zinc 2.4 times, manganese 32.3 times, total iron 6.2 times, and oil products 2.8 times.

Annually, more than 25,000 tons of BOD; 6,000 tons of oil products; 21,200 tons of suspended matter; 1,560 tons of phosphorus; 4,800 tons of ammonia nitrogen; 618 tons of iron; 167 tons of copper; 296 tons of zinc; 5.7 tons of nickel; 4.9 tons of chromium; and 2.13 tons of vanadium are discharged into water bodies in the Tobol River catchment area.

Given data from the Russian Federation, the main pollutants originating from wastewater discharges include chlorides (40%), BOD_5 (6%), sulphates (33%), ammonium-nitrogen (2%) and other pollutants (13%). The total mass of substances discharged into the watercourses of the Tobol's sub-basin amounts to 58% (BOD_5) and 7% (zinc), respectively, of the total mass of these substances discharged into the watercourses of the entire Irtysh sub-basin. A comparative analysis of wastewater discharges from different sources has shown that only 29% of pollutants originate from industrial enterprises.

In the period from 1995 to 2000, water pollution in the Tobol River decreased. Compared to the 1985–1990 data, a significant decrease of phenols and oil products was observed over the total length of the river. Characteristic pollutants, whose concentrations are above the MAC values, include ammonium-nitrogen and nitrites-nitrogen (MAC exceeded by a factor of 2), iron compounds (2–7 times MAC), copper (3–12 times MAC), zinc (1–2 times MAC), manganese (17–34 times MAC), phenols (5–7 times MAC) and oil products (1–13 times MAC). A number of extreme pollution events occurred, obviously caused by accidental discharges.

In the Russian Federation (Tyumen' Oblast), the water quality of the Tobol falls into the classes "polluted" and "very polluted".

Trends

As the water pollution index indicates, pollution has been decreasing since 2001, and water quality has been upgraded from class 5 (very polluted) to class 3 (moderately polluted), supported by a slight decrease in concentrations of individual water-quality determinands.
Nevertheless, pollution will continue to have an adverse impact, particularly on the drinking-water supply. This is a critical issue for both countries, as the supply of drinking water relies exclusively on surface-water resources.

In order to improve water quality through more stringent measures to prevent, control and reduce pollution, a number of joint projects are being carried out by the Russian Federation and Kazakhstan as part of activities under the joint Russian-Kazakh Commission on the Joint Use and Protection of Transboundary Waters.

Flooding will also remain a problem.

ISHIM RIVER

Kazakhstan (upstream country) and the Russian Federation (downstream country) share the catchment area of the Ishim River, a tributary to the Irtysh River in the Ob River basin, as shown in the following table.

Sub-basin of the Ishim River			
Area	**Country**	**Country's share**	
176,000 km^2	Russian Federation*	34,000 km^2	19%
	Kazakhstan**	142,000 km^2	81%

Sources: * Federal Agency for Water Resources, Russian Federation.
** Ministry of Environmental Protection of Kazakhstan.

Hydrology

The River Ishim has a total length of 2,450 km, of which 1,089 km are in Kazakhstan.

Discharge characteristics at two gauging stations in Kazakhstan		
Turgenyevka gauging station on the Ishim: distance to river's mouth 2,367 km		
Q_{av}	3.78 m^3/s	1974–2004
Q_{max}	507 m^3/s	16 April 1986
Q_{min}	No flow	For 19% of time in period of open riverbed (12 July – 23 October 1986); for 100% of time in winter period (24 October 1986 – 12 April 1987)
Petropavlovsk gauging station on the Ishim: distance to river's mouth 7.83 km		
Q_{av}	52.5 m^3/s	1975–2004
Q_{max}	1,710 m^3/s	28 April 1994
Q_{min}	1.43 m^3/s	27 November 1998

Source: Ministry of Environmental Protection of Kazakhstan.

On the Ishim River, there are 16 reservoirs with a volume exceeding 1 million m^3; all of them are located in Kazakhstan.

Over the last decades and given the operational rules for the joint management of two reservoirs (Segrejevsk and Petropavlovsk reservoirs), the guaranteed minimum flow at the border section was 1 m^3/s. After reconstruction of the Segrejevsk dam, the minimum guaranteed discharge has been increased to 2.4 m^3/s, which has favourable effects on the downstream territory of Tyumen' Oblast in the Russian Federation.

A specific working group under the auspices of the joint Russian-Kazakhstan Commission[13] deals with water-quantity issues, including operational issues of flow regulation at the border depending on the actual hydrological situation after the spring floods.

For hydrological measurements and hydrochemical analysis, two transboundary monitoring stations on the rivers have been recently established: the station at Dolmatovo (Kazakhstan) and the station at Il'insk (Russian Federation).

Transboundary impact

According to data from Kazakhstan (see table below), there should be no major transboundary impact from Kazakhstan on the Russian part of the Ishim River.

Water pollution index for the Ishim River at monitoring stations in Kazakhstan				
Measuring station	**1997**	**2000**	**2001**	**2002**
Astana	0.51 (class 2)	1.01 (class 3)	1.09 (class 3)	0.09 (class 2)
Petropavlovsk	0.93 (class 2)	0.99 (class 2)	0.71(class 2)	0.71 (class 2)
Measuring station	**2003**	**2004**	**2005**	**2006**
Astana	0.92 (class 2)	0.84 (class 2)	0.75 (class 2)	0.87 (class 2)
Petropavlovsk	0.89 (class 2)	0.90 (class 2)	1.24 (class 3)	0.95 (class 2)

Note: Class 2 – clean; class 3 – moderately polluted.
Source: Ministry of Environmental Protection of Kazakhstan.

[13] Лротокол пятнадцатого заседания Российско-Казахстанской Комиссии по совместному использованию и охране трансграничных водных оъектов от 08 нояря 2006 г. Астана (Protocol of the 15th meeting of the Russian-Kazakh Commission on the Joint Use and Protection of Transboundary Waters, Astana, 8 November 2006).

Given data from the Russian Federation, iron, copper, zinc, lead, manganese, phenols, pesticides and oil products cause transboundary impact.

According to 2006 data by the Tyumen' Branch of the Hydrometeorological Service (Russian Federation), the MAC values for some pollutants were significantly exceeded: iron in February, copper in January–May, zinc in January–May and manganese in March. In the period October 2005 – May 2006, high nickel pollution was observed. In May 2006, extreme high pollution by oil products occurred. The reasons for these pollution events are not yet fully understood. However, both countries started with joint measurements for nickel.

Trends

From the mid-1990s onwards, the water quality can be described as "clean" (class 2) or "moderately polluted" (class 3). This shows that there was no significant impact from Kazakhstan on the downstream part of the Ishim in the Russian Federation or on the Irtysh River.

Given data from the Russian Federation, the trend analysis for 1999–2005 has shown that there is an improvement of water quality as regards BOD_5, COD, manganese, phenols, nitrites copper and zinc. Significantly, the mean annual concentrations of nickel increased and some increase in iron concentration also occurred.

DRAINAGE BASINS OF THE SEA OF OKHOTSK AND SEA OF JAPAN

This chapter deals with major transboundary rivers discharging into the Sea of Okhotsk and the Sea of Japan and their major transboundary tributaries. It also includes lakes located within the basins of these seas.

TRANSBOUNDARY WATERS IN THE BASINS OF THE SEA OF OKHOTSK AND THE SEA OF JAPAN[1]

Basin/sub-basin(s)	Total area (km²)	Recipient	Riparian countries	Lakes in the basin
Amur	1,855,000	Sea of Okhotsk	CN, MN, RU	…
- Argun	164,000	Amur	CN, RU	…
- Ussuri	193,000	Amur	CN, RU	Lake Khanka
Sujfun	*18,300*	*Sea of Japan*	*CN, RU*	…
Tumen	33,800	Sea of Japan	CN, KP, RU	…

[1] The assessment of water bodies in italics was not included in the present publication.

AMUR RIVER BASIN[1]

[1] Based on information provided by the Federal Water Agency, Russian Federation.

China, Mongolia and the Russian Federation share the Amur River basin.

Basin of the Amur River			
Area	**Country**	**Country's share**	
1,855,000 km^2	China	820,000 km^2	44.2%
	Mongolia	32,000 km^2	1.7%
	Russian Federation	1,003,000 km^2	54.1%

Source: Information bulletin on the status of surface waters, water management systems and installations in the area of the Amur River Basin Management Authority, 2005, volume I, analytical description.

Hydrology

The Amur River begins at the confluence of the Argun and Shilki rivers next to the village of Pokrova. Its length is 2,824 km (4,444 km from the source of the Argun) and its discharge at mouth is 11,330 m^3/s (357,3 km^3/a).

The most important tributaries include the Argun (transboundary, see assessment below), Shilka, Zeya, Bureya, Ussuri (transboundary, see assessment below) and Amgun rivers. More than 61,000 lakes are in the basin, including the transboundary Lake Xingkai/Khanka, located in the sub-basin of the Ussuri River (see assessment below).

Discharge characteristics of the Amur River		
Discharge characteristics at the Pashkovo station		
Q_{av}	4,440 m^3/s	1896–1980
Q_{max}	21,000 m^3/s	11–13 September 1897
$Q_{min\ in\ winter}$	80.3 m^3/s	5 March 1922
$Q_{min\ ice\text{-}free\ watercourse}$	1,344 m^3/s	7 November 1921
Discharge characteristics at Khabarovsk		
Q_{av}	8,360 m^3/s	1896–2004
Q_{max}	25,500 m^3/s	6 June 2004
Q_{min}	4,360 m^3/s	11 November 2004
Discharge characteristics at the Bogorodsk station*		
Q_{av}	10,100 m^3/s	1896–2004
Q_{max}	26,300 m^3/s	22 June 2004
Q_{min}	938 m^3/s	23 March 2004

Sources: Information bulletin on the status of surface waters, water management systems and installations in the area of the Amur River Basin Management Authority, 2005, volume I, analytical description.
Long-term data on the regime of surface waters, volume I/19, the Amur and Udy basins, Gidrometizdat, 1986.

* Calculated based on measurements at Khabarovsk.

Pressure factors and transboundary impact

Most critical for the status of the Amur River is the pollution load from the Argun, Sungari/Songhua and Ussuri rivers as described below.

Trends

Improving the ecological and chemical status of the Amur strongly depends on pollution control measures in China.

The Russian Federation has already identified a number of measures to achieve good status of the watercourses in the Amur basin. These measures include: stabilization of the riverbed and decreasing negative consequences of the erosion of riverbanks (for the Amur in Amur Oblast), increasing capacities for wastewater treatment, use of low-waste and non-waste technology, legal measures to respect use restriction in water protection zones, and improving sanitary conditions in cities and other human settlements, including collection and treatment of storm water run-off. There is also a need for a bilateral agreement on joint monitoring of the Ussuri and joint action to achieve the required water quality by decreasing human impact in the sub-basin.

ARGUN RIVER

Hydrology

The 1,620 km long Argun River is shared by China and the Russian Federation. It flows for 669 km in China. 951 km above the mouth, it enters the Russian Federation and forms, more downstream, the border between China and Russia.

Sub-basin of the Argun River			
Area	Country	Country's share	
164,000 km^2	China	114,900 km^2	70%
	Russian Federation	49,100 km^2	30%

Source: Hydrological knowledge, Volume 18, Gidrometizdat, Leningrad, 1966.

At the border between China and the Russian Federation, the Argun River is classified as "polluted" or "very polluted". Apart from regular measurements, field research was carried out in 2005 (April and December), which has shown that for a number of water-quality determinands, the MAC values, which represent the maximum allowable concentration of pollutants for the maintenance of aquatic life, are exceeded by a factor of 2 to 7, and for copper even by a factor of 28.

Regularly, extreme pollution events, mainly caused by industries, occur during wintertime in the section between the villages of Molokanka and Kuti leading to fish kills and the death of animals living close to the river.

Pollution characteristics of the Argun River downstream from the border with China

Determinands	MAC in mg/l	1995	1997	1999	2001	2002	2004	2005
Copper	0.001	0.005	0.004	0.003	0.0025	…	0.011	0.006
Zinc	0.01	0.005	0.015	…	0.014	…	0.033	0.002
Phenols	0.001	0.004	0.014	0.002	0.001	0.002	0.002	0.002
Oil products	0.05	0.18	0.21	0.08	0.22	0.07	0.094	2.48

Source: Information by the Zabaikalsk Branch of the Hydrometeorological Service, Russian Federation.

The flood plain of the Argun is relatively large compared to the river's width (10–12 km, sometimes ever larger) and acts as a natural buffer against human impact on the river. So far, this ecosystem is in a good status, however, the planned water transfer from the Chajlar River, a transboundary watercourse in the sub-basin of the Argun, into Lake Dalajnor may destroy the terrestrial ecosystem of the Argun.

In August 2006, during the ordinary session of the permanent Chinese-Russian working group on the ecology of the Argun River, an agreement has been signed on cooperation related to the protection of water quality and the ecological status of the river, and a plan for joint water-quality monitoring, including the ecological status of the river zones, was approved.

IMPACT FROM THE SUNGARI/SONGHUA RIVER[2]

The waters of the Sungari (Songhua) River, which flows entirely on Chinese territory, are the most significant pollution sources in the middle part of the Amur basin. According to Chinese statistics from the last decade, the river ranks among the five most polluted Chinese watercourses, and its quality continues to deteriorate. Frequent industrial accidents, such that of 13 November 2005 at Harbin, add to the pollution load. Furthermore, hazardous substances enter the river during flood events.

There are more than 20,000 chemical production sites in the basin. Russian experts estimate that more than 15 billion tons of substances, including pesticides and herbicides, and various forms of oil products and derivates, enter the Sungari River. Phenols in the river often exceed the MAC values by a factor of 50.

In 2006, joint measurements to investigate the consequences of the 2005 accident on the aquatic ecosystem of the Amur were carried out, based on an agreement between the riparian Chinese and Russian provinces.

USSURI RIVER

The Ussuri (897 km length), shared by China and Russia, has its source in the southern part of the Sikhote-Alin Mountains, forms part of the Chinese-Russian border and confluences with the Amur at Khabarovsk.

Sub-basin of the Ussuri River			
Area	Country	Country's share	
193,000 km^2	China	57,000 km^2	30%
	Russian Federation	136,000 km^2	70%

Source: Surface water resources of the USSR, Gidrometizdat, 1972.

The river is known for its catastrophic floods. In general, water quality varies between classes 3 and 4.

Water quality of the Ussuri River					
Watercourse	Water-quality class*				
	2001	2002	2003	2004	2005
Ussuri at Novomichailovka	3	3	3	3	4
Ussuri at Kirovkskij	3	3	3	3	5
Ussuri at Lesozavodsk	3	3	3	2	4
Ussuri at Rushino	3	3	2	2	4

Source: Primorskij Service for Hydrometeorology and Environmental Monitoring, Russian Federation.
* There are altogether seven water-quality classes from 1 (clean) to 7 (heavily polluted).

[2] The Sungari/Songhua River is not a transboundary watercourse, but it has been inserted in the assessment due to its impact on the Amur.

LAKE XINGKAI/KHANKA

Lake Xingkai/Khanka is located in the sub-basin of the Ussuri River on the border of China and the Russian Federation. The River Song'acha is the lake's outlet and is connected with the Ussuri River, a transboundary tributary to Amur.

With an area of the lake is 4,190 km^2 (1,160 km^2 in China and 3,030 km^2 in the Russian Federation), the lake is the largest freshwater lake in Northeast Asia. Its recharge basin is 16,890 km^2 (507 km^2 in China and 16,383 km^2 in the Russian Federation).

Lake Xingkai/Khanka is shallow – its mean depth is only 4.5 metres. The total population in the lake basin is 345,000 with a density of more than 20 inhabitants/km^2. The area around the lake is an important wetland habitat and forms a National Nature Reserve on the Chinese side and the Khanka Lake Nature Reserve on the Russian side. It is a remarkable site for nature protection, eco-tourism and scientific research. The Russian Federation has designated the lake as a Ramsar Convention wetland site.

The waters of Lake Xingkai/Khanka are of the carbonate-calcium type. The majority of water input from the Chinese part of the lake basin is from the Muling River floodwater. The overall water quality of the inflow river meets fishery requirements. The Muling River water-quality parameters indicate, however, that the river is suffering from serious organic pollution originating from Mishan City.

In the Russian part, DDT and other groups of pesticides have been found. The data indicate that only the COD value seriously exceeds the accepted standard. Currently, the overall water quality is "suitable for agricultural purposes, tourism and fishing".

During 1985–1992, the overall quality of Lake Xingkai/Khanka's water, based on hydrochemical parameters, improved from "very dirty", "dirty" to "polluted". By 1996–1997, the quality of the lake waters was "moderately polluted" at the Astrakhanka and Sivakovka observation stations (Russian Federation) and "clean" at the Troiskoe and Novoselskoe settlements (Russian Federation).
The average annual concentration of main nutrients indicates that, although nitrogen and phosphorus concentrations decreased during the 1990s, the lake is still eutrophic. But a decreased anthropogenic load and rising lake water levels have slowed the eutrophication process.

TUMEN RIVER BASIN[3]

China, the Democratic People's Republic of Korea and the Russian Federation share the basin of the Tumen River, also known as Tumannaya.

Basin of the Tumen River			
Area	**Country**	**Country's share**	
33,800 km^2	China *	23,660 km^2	70%
	DPR Korea *	10,140 km^2	30%
	Russian Federation	25.8 km^2	<0,01%

Sources: Project on water construction works to stabilize the riverbed in the border region of the Tumen River in order to fortify the State border between the Democratic People's Republic of Korea and the Russian Federation, Vladivostok, 2000.
Surface water resources of the USSR, Gidrometizdat, 1972.

* The figures for China and the Democratic People's Republic of Korea are approximations.

[3] Based on information provided by the Federal Water Agency, Russian Federation and the Russian version of the UNEP/GEF project RAS/98/G31 on the strategic action programme for the Tuman River: Transboundary diagnostic analysis, Vladivostok, 2002.

Hydrology

The Tumen, with a total length of 549 km (16 km in downstream Russia), flows into the Pacific Ocean (Sea of Japan). The discharge at mouth is 10.1 km^3/a.

In its lower part, the river flows through an area with light soils, which are easily washed out and transported away by water, so that the river changes its bed annually. The hydrological regime is still poorly understood; therefore, only preliminary discharge characteristics are available.

Discharge characteristics of the Tumen River at the Kasan gauging station (Russian Federation)		
Q_{av}	320 m^3/s	1934–2000
Q_{max}	11,000 m^3/s	Maximum during 1% of the year
Q_{min}	0.74 m^3/s	Minimum during 95% of the year

Source: Project on water construction works to stabilize the riverbed in the border region of the Tumen River in order to fortify the State border between the Democratic People's Republic of Korea and the Russian Federation, Vladivostok, 2000.

Pressure factors

Industrial wastewaters enter the river mainly from the Democratic People's Republic of Korea. Main pressure factors are iron mining at the Musansk ore deposit; industries at Undoksk (chemical factory, paper production and sugar production) and municipal wastewater from municipalities in the Democratic People's Republic of Korea.

In China, the industrial pollution currently decreased, however, pollution with municipal wastewater is permanently increasing.

In the Russian Federation, there are almost no human activities; the main form of land use is wetlands, which are famous breeding areas for birds.

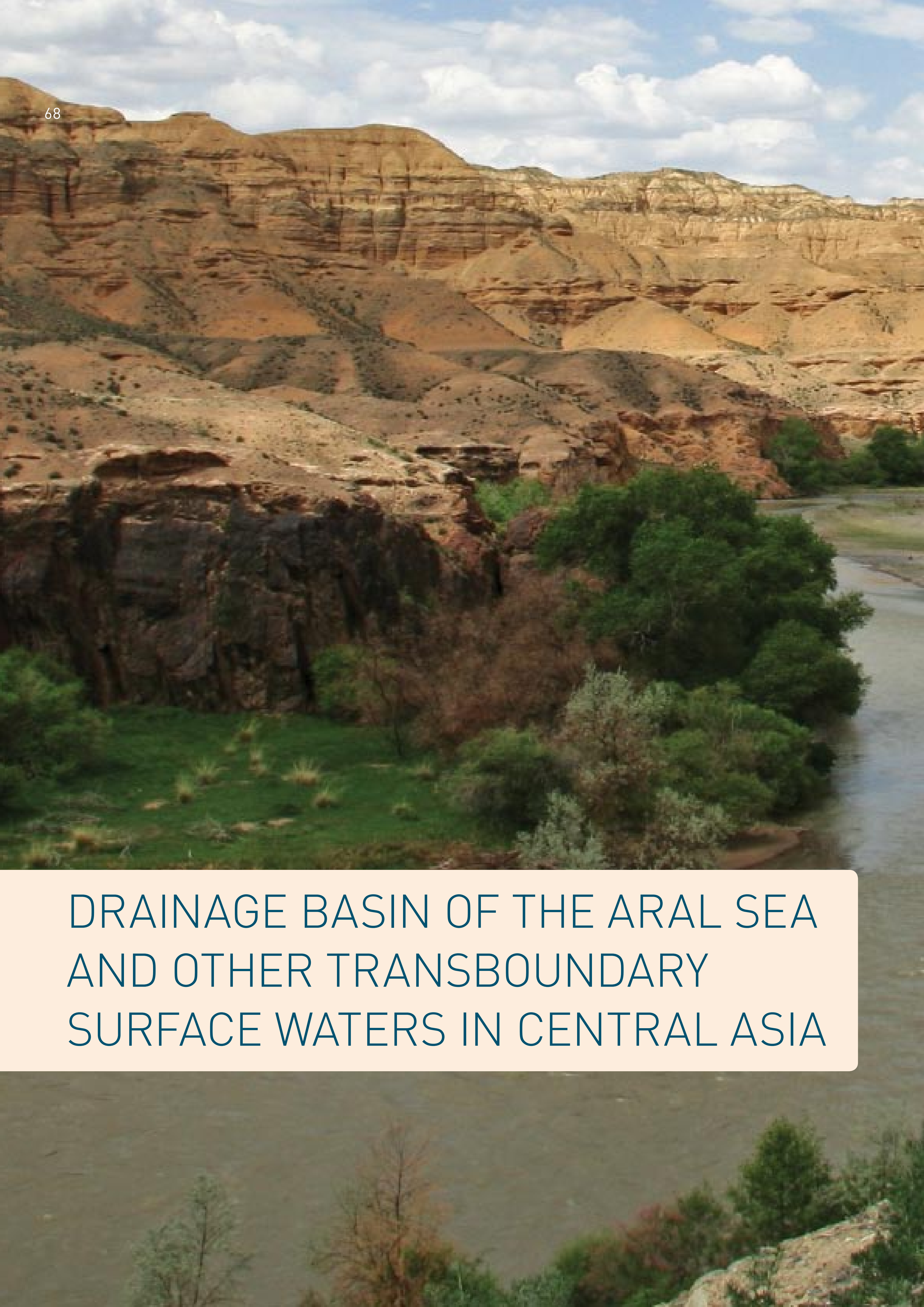
Transboundary impact

Apart from water pollution from China and the Democratic People's Republic of Korea, a major problem is the erosion of the left riverbank and the shift of the riverbed towards the left-hand side in the Russian Federation. This requires water construction work to fortify the riverbank, particularly on the border between the Democratic People's Republic of Korea and the Russian Federation. This works begun in 2004 and will continue until 2008.

Trends

Improving river water quality requires joint activities of all three riparian countries. The drawing up of a multilateral agreement between China, the Democratic People's Republic of Korea and the Russian Federation is of utmost importance. It should provide for joint measures on monitoring and assessment as well as the achievements of water-quality targets in order to decrease the overall human impact on the waters in the Tumen River basin.

The Tumen River basin and adjacent areas in the Democratic People's Republic of Korea are famous breeding areas of birds. Due to urbanization and the destruction of wetlands, these birds lose their breeding grounds and measures to protect and restore wetlands are of great importance.



DRAINAGE BASIN OF THE ARAL SEA AND OTHER TRANSBOUNDARY SURFACE WATERS IN CENTRAL ASIA

This chapter deals with major transboundary rivers in Central Asia which have a desert sink, or discharge either into one of the rivers (or their tributaries) or the Aral Sea or an another enclosed lake. It also includes lakes located within the basin of the Aral Sea. Practically all of the renewable water resources in this area are used predominantly for irrigation, and the national economies are developing under conditions of increasing freshwater shortages.

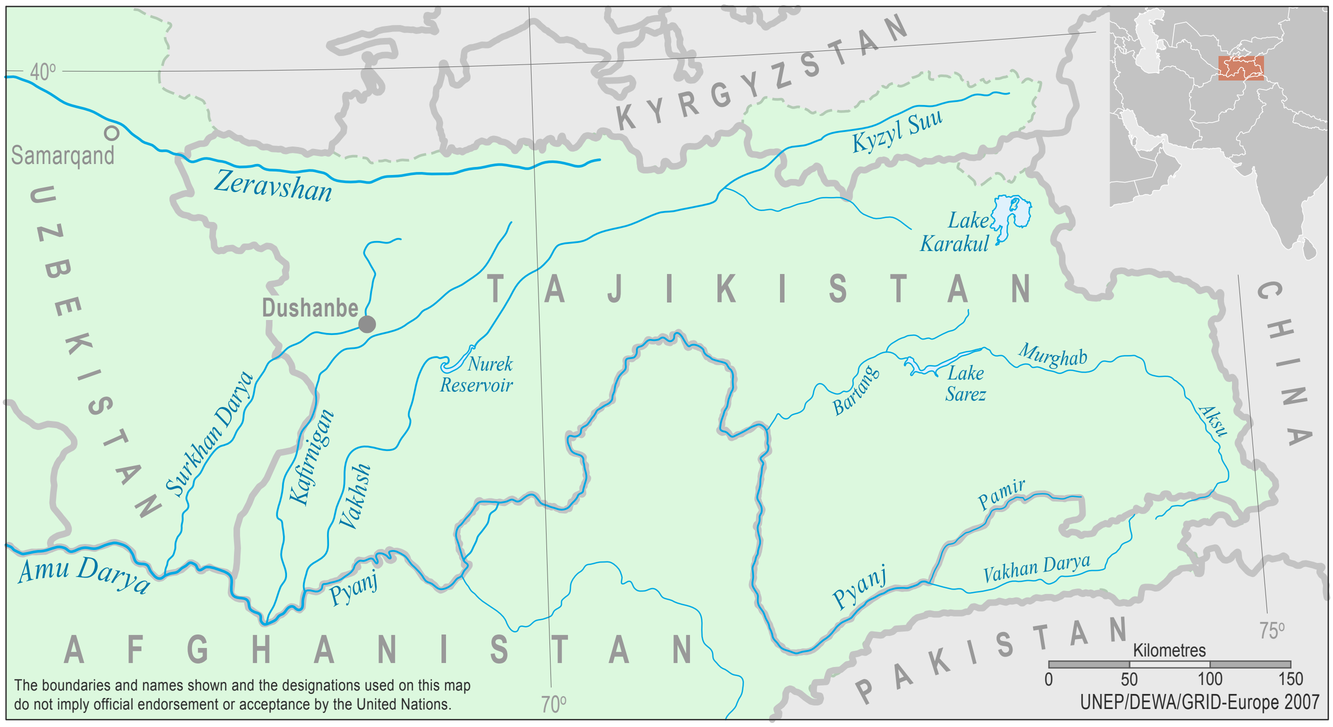
TRANSBOUNDARY WATERS IN THE BASIN OF THE ARAL SEA AND OTHER TRANSBOUNDARY SURFACE WATERS IN CENTRAL ASIA[1]

Basin/sub-basin(s)	Total area (km²)	Recipient	Riparian countries	Lakes in the basin
Amu Darya	…[2]	Aral Sea	AF, KG, TJ, UZ, TM	Aral Sea
- Surkhan Darya	13,500	Amu Darya	TJ, UZ	
- Kafirnigan	11,590	Amu Darya	TJ, UZ	
- Pyanj	113,500	Amu Darya	AF, TJ	
-- Bartang	…	Pyanj	AF, TJ	
-- Pamir	…	Pyanj	AF, TJ	
- Vakhsh	39,100	Amu Darya	KG, TJ	
Zeravshan	…[2]	Desert sink	TJ, UZ	
Syr Darya	…[2]	Aral Sea	KZ, KG, TJ, UZ	
- Naryn	…	Syr Darya	KG, UZ	
- Kara Darya	28,630	Syr Darya	KG, UZ	
- Chirchik	14,240	Syr Darya	KZ, KG, UZ	
-Chatkal	7,110	Chirchik	KG, UZ	
Chu	62,500	Desert sink	KZ, KG	
Talas	52,700	Desert sink	KZ, KG	
Assa	…	*Desert sink*	*KZ, KG*	
Ili	413,000	Lake Balqash	CN, KZ	Lake Balqash
Murgab	46,880	Desert sink	AF, TM	
- Abikajsar	…	*Murgab*	*AF, TM*	
Tejen	70,260	Desert sink	AF, IR, TM	

[1] The assessment of water bodies in italics was not included in the present publication.
[2] The basin area is difficult to determine, see the assessment below.

AMU DARYA RIVER BASIN[1]

Afghanistan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan share the basin of the Amu Darya River. While some literature sources quote a basin area of up to 534,700 km², the water divide can only be correctly established in the mountainous part of the basin; therefore many hydrologists refrain from giving figures for the total basin area.



Hydrology

The confluence of the two transboundary rivers, the Pyanj and the Vakhsh (see the separate assessment below), is taken as the beginning of the Amu Darya.

Of these two, only the Vakhsh is regulated (Nurek reservoir, 10.5 billion m³); therefore, floods often occur between the rivers' confluence and the Tyuyamuyunsk reservoir on the Amu Darya (7,270 million m³). Downstream of this reservoir, the Amu Darya is fully regulated.

Discharge characteristics of the Amu Darya River upstream of the Karakum Canal		
Q_{av}	1,970 m³/s	Average for: 1959–2005
Mean monthly values:		
October – 1,740 m³/s	November – 957 m³/s	December – 898 m³/s
January – 816 m³/s	February – 820 m³/s	March – 979 m³/s
April – 1,670 m³/s	May – 2,670 m³/s	June – 3,800 m³/s
July – 4,500 m³/s	August – 3,470 m³/s	September – 1,950m³/s

Source: Hydrometeorological Service of Uzbekistan.

[1] Based on information provided by the State Agency for Environment Protection and Forestry of Kyrgyzstan, the Ministry of Agriculture and Nature Protection of Tajikistan, the Ministry of Nature Protection of Turkmenistan and the State Committee for Nature Protection of Uzbekistan.

Like other rivers in Central Asia, the Amu Darya is subject to strong hydraulic processes (e.g. deformation of the river bed, meandering, bank erosion).

In addition to the Pyanj and the Vakhsh, a number of other transboundary waters are located in the Amu Darya basin, including the Pamir, Kafirnigan, Surkhan Darya and Zeravshan rivers (assessed separately below).

Pressure factors, transboundary impact and trends

The pressures, transboundary impact and trends for the transboundary rivers in the Amu Darya River basin are described in the following sections. In general, the joint sustainable use and protection of water resources of these transboundary rivers is a particular challenge for this region.

SURKHAN DARYA RIVER[2]

The Surkhan Darya is a transboundary tributary to the Amu Darya and has its source in Tajikistan. The catchment area is 13,500 km²; the major part of this area is located in Uzbekistan.

Hydrology

The natural flow of the river is heavily disturbed by water management activities in the catchment area. Whereas some 120 m^3/s are estimated to originate in the mountain part, the inflow into the Jujnosurkhansk reservoir (Uzbekistan) is only 74.2 m^3/s (see the following table).

Discharge characteristics of the Surkhan Darya (Uzbekistan) (Inflow into the reservoir; summary values for the Shurchi gauging stations on the Surkhan Darya and the gauging station at the river mouth)		
Q_{av}	74.2 m^3/s	Average for 1970–2005
Mean monthly values:		
October – 25.3 m^3/s	November – 34.4 m^3/s	December – 42.01 m^3/s
January – 45.3 m^3/s	February – 47.6 m^3/s	March – 72.8 m^3/s
April – 157 m^3/s	May – 196 m^3/s	June – 166 m^3/s
July – 72.3 m^3/s	August – 17.2 m^3/s	September – 15.3 m^3/s

Source: Hydrometeorological Service of Uzbekistan.

KAFIRNIGAN RIVER[3]

The common border between Tajikistan and Uzbekistan is formed by the Kafirnigan River and it is of some 30 km. Most of the Kafirnigan's catchment area of 11,590 km² belongs to Tajikistan.

Hydrology

The average discharge is on the order of 170 m^3/s. As a rule, the maximum discharge occurs in May (Tartki gauging station, located some 50 km upstream of the river mouth, upstream catchment area some 9,780 km²).

As a consequence of heavy rainfall, mudflow has a considerable impact on the ecological regime and the safe operation of hydrotechnical installations.

[2] Source: Environmental Performance Review of Tajikistan, UNECE, 2004.
[3] Source: Environmental Performance Review of Tajikistan, UNECE, 2004.

Discharge characteristics of the Kafirnigan at Tartki (Tajikistan)		
Q_{av}	169 m^3/s	Average for 1929–2005
Mean monthly values:		
October – 60.0 m^3/s	November – 62.9 m^3/s	December – 63.1 m^3/s
January – 59.6 m^3/s	February – 62.2 m^3/s	March – 187 m^3/s
April – 295 m^3/s	May – 405 m^3/s	June – 389 m^3/s
July – 270 m^3/s	August – 129 m^3/s	September – 70.1 m^3/s

Source: Hydrometeorological Service of Uzbekistan.

PYANJ RIVER[4]

Afghanistan and Tajikistan share the catchment area of the Pyanj River, located in the Amu Darya River basin, as shown in the following table. Of the Pyanj's total catchment area, 107,000 km^2 are in the mountains and the rest (6,500 km^2) in the lowland part of the catchment area.

Sub-basin of the Pyanj River			
Area	**Country**	**Country's share**	
113,500 km^2	Afghanistan	47,670 km^2	42%
	Tajikistan	65,830 km^2	58%

Source: Hydrometeorological Service of Uzbekistan.

Hydrology

The Pyanj and Pamir rivers form the border between Afghanistan and Tajikistan.

Usually the confluence of the rivers Vakhan Darya (Afghanistan) and Pamir (forming the border between Afghanistan and Tajikistan) is considered as the beginning of the River Pyanj. However, hydrologists consider the source of the Vakhan Darya in Afghanistan as the beginning of the River Pyanj, as the Vakhan Darya is the "natural prolongation" of the Pyanj towards the east.

The total length of the Vakhan Darya/Pyanj is 1,137 km; from the confluence of the Vakhan Darya and Pamir, the river is 921 km long.

The lake percentage is 0.42%, based on data for 1987.

[4] Based on information provided by the Hydrometeorological Service of Uzbekistan.

Discharge characteristics of the Pyanj River at Nijniy Pyanj (Tajikistan), 35 km upstream of the confluence with the Vakhsh River		
Q_{av}	1,012 m^3/s	Average for 1965–1992
Mean monthly values:		
October – 643 m^3/s	November – 516 m^3/s	December – 445 m^3/s
January – 389 m^3/s	February – 406 m^3/s	March – 503 m^3/s
April – 828 m^3/s	May – 1,290 m^3/s	June – 2,000 m^3/s
July – 2,300 m^3/s	August – 1,960 m^3/s	September – 1,050 m^3/s

Source: Hydrometeorological Service of Uzbekistan.

Downstream of the confluence of the Vakhan Darya and the Pamir, a number of tributaries join the Pyanj, such as the Gunt, the Bartang, the Jasgulem, the Vanj and the Kyzylsu (right-hand-side tributaries), and the Koktsha (a left-hand-side tributary which flows exclusively through Afghanistan).

Knowledge concerning the hydrological regime of the Pyanj is very limited. Moreover, due to the closure of the Nijniy Pyanj measuring station in 1992, there are no discharge measurements by Tajikistan on the Pyanj River. Currently, only water levels are measured at a number of stations (Ishkashim, Shidz, Shirmandsho); but these stations do not operate regularly. With the exception of Lake Sarez (on the Bartang-Murghab-Oqsu tributary, having its source in Afghanistan, too) and a reservoir on the Gunt River, the flow of the Pyanj is not regulated, which results in severe flooding. June, July and August are the months with peak flow (on average 2,000 m^3/s).

Pressure factors

Besides the general pressure factors in the Amu Darya and Syr Darya basins, the Pyanj catchment area has the following relevant specific features: The Sarez Lake (16.1 km^3), formed by an earthquake in the upper part of the Bartang River, is a potential threat to the population (some 5 million people) living near the middle and lower Amu Darya. In Tajikistan, water use for irrigational agriculture in the Pyanj catchment area is relatively small and mostly limited to the Kyzylsu catchment area.

Transboundary impact

According to the 1946 agreement between the Soviet Union and Afghanistan, Afghanistan is entitled to use up to 9 km^3 a year from the River Pyanj. Afghanistan currently uses about 2 km^3 yearly.

Trends

Full use of Afghanistan's quota for water use from the Pyanj (9 km^3/a), fixed by the 1946 agreement, could radically change the water flow along the Pyanj and would have a significant impact on the downstream flow regime of the Amu Darya.

VAKHSH RIVER[5]

Kyrgyzstan (upstream country) and Tajikistan (downstream country) share the catchment area of the Vakhsh River, which in Kyrgyzstan is called the Kyzyl Suu. Of the total area of 39,100 km^2, 34,010 km^2 are located in the mountainous part.

Sub-basin of the Vakhsh River			
Area	**Country**	**Country's share**	
39,100 km^2	Kyrgyzstan	7,900 km^2	20.2%
	Tajikistan	31,200 km^2	79.8%

Source: Hydrometeorological Service of Uzbekistan.

[5] Based on information provided by the Hydrometeorological Service of Uzbekistan.

Hydrology

The flow regime of the Vakhsh is regulated, mainly due to the Nurek reservoir. Since the Nurek reservoir became operational, the "natural" flow rate of the river has been measured upstream at the station Darband (former Komsomoladad), which was opened in 1976. This value is also taken as the inflow value for the reservoir. The catchment area above the gauging station is 29,190 km².

Pressure factors, transboundary impact and trends

The planned extension of the mining and aluminium processing plant in Tursunzade (Tajikistan) may cause significant transboundary impact.

The Government of Tajikistan is also planning to resume the construction of a big reservoir at Rogun (total volume 12,400 million km³, exploitable volume 8,700 million km³). The future hydro-energy production at this reservoir will be used mainly to satisfy the higher energy demand of the mining and aluminium processing plant in Tursunzade.

Discharge characteristics of the Vakhsh River at Darband (Tajikistan)		
Q_{av}	1,012 m³/s	Average for 1965–1992
Mean monthly values:		
October – 334 m³/s	November – 245 m³/s	December – 205 m³/s
January – 177 m³/s	February – 172 m³/s	March – 213 m³/s
April – 447 m³/s	May – 795 m³/s	June – 1,220 m³/s
July – 1,600 m³/s	August – 1,350 m³/s	September – 697 m³/s

Source: Hydrometeorological Service of Uzbekistan.

ZERAVSHAN RIVER BASIN[6]

Tajikistan (upstream) and Uzbekistan (downstream) are riparian countries to the Zeravshan River. Due the sheer impossibility of determining the size of the catchment area, many hydrologists simply give a figure of 12,200 km² for the mountain part of the catchment area. Currently, the most upstream weir of the irrigation system for the Karakul Oasis is considered the "mouth" of the Zeravshan River.

Hydrology

The Zeravshan River was formerly a tributary to the Amu Darya but lost this function with the development of irrigation in the lowland parts of the catchment area. Some hydrologists therefore consider the Zeravshan an independent river; others still attribute it to the Amu Darya basin.

Discharge characteristics of the Zeravshan River downstream of the confluence of the Magian Darya River		
Q_{av}	161 m³/s	Average for 1997–2005
Mean monthly values:		
October – 91.3 m³/s	November – 63.4 m³/s	December – 49.3 m³/s
January – 42.4 m³/s	February – 39.7 m³/s	March – 38.6 m³/s
April – 57.1 m³/s	May – 150 m³/s	June – 362 m³/s
July – 477 m³/s	August – 370 m³/s	September – 193 m³/s

Source: Hydrometeorological Service of Uzbekistan.

[6] Based on information provided by the Ministry of Agriculture and Nature Protection of Tajikistan and the State Committee for Nature Protection of Uzbekistan.

Pressure factors

Currently some 96% of the water resources are used for irrigation, mainly in Uzbekistan.

Transboundary impact

Based on information supplied by Uzbekistan, Tajikistan is planning to construct a reservoir and hydropower station in the upper reaches of the Zeravshan River which might have an adverse impact on the quantity of water in the downstream part of the river.

Trends

Given the planned construction of a reservoir in Tajikistan, Uzbekistan has voiced the need for an agreement on the joint use of the Zeravshan River responding to the various forms of water use: hydropower generation in Tajikistan and irrigation in Uzbekistan.

SYR DARYA RIVER BASIN[7]

SYR DARYA RIVER

Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan share the basin. Some literature sources quote a basin area of up to 782,600 km^2 (of which 218,400 km^2 is in Kazakhstan). As with the Amu Darya, the water divide can only be correctly established in the mountainous part of the basin. Thus, many hydrologists do not give a figure for the total basin area but state that 142,200 km^2 of the basin area is upstream of the point where the river leaves the Fergana Valley.

Hydrology

The confluence of the transboundary rivers Naryn and Kara Darya (see separate assessments below) in the eastern part of the Fergana Valley is considered the beginning of the Syr Darya. Its total length is 2,137 km.

The river flow is strongly regulated. Major reservoirs include the Kajrakkum reservoir (design capacity 3,400 million m^3) and the Chardarin reservoir in Kazakhstan (design capacity 5,200 million m^3).

The long-term average river discharge is a calculated value of discharges into the Naryn/Syr Darya cascade of reservoirs. This value is seen as the normative-natural flow of the Syr Darya downstream of the run-off formation area in the mountainous part of the basin. The discharge characteristics are as follows:

[7] Based on information provided by the Ministry of Environment Protection, Kazakhstan, the State Agency for Environment Protection and Forestry of Kyrgyzstan, the Ministry of Agriculture and Nature Protection of Tajikistan, and the State Committee for Nature Protection of Uzbekistan.

Discharge characteristics of the Syr Darya, based on discharges into the Naryn/Syr Darya Cascade of reservoirs		
Q_{av}	34.1 km³/a	Average for 1958–2005
Mean monthly values:		
October – 2.25 km³	November – 2.08 km³	December – 2.03 km³
January – 2.10 km³	February – 2.04 km³	March – 2.43 km³
April – 3.03 km³	May – 4.27 km³	June – 4.47 km³
July – 3.97 km³	August – 3.21 km³	September – 2.53 km³

Source: Hydrometeorological Service of Uzbekistan.

In the downstream parts of the Syr Darya, frequent flooding of human settlements, including the town of Kyzylorda, occurs in winter. This is caused by the operation of the Toktogul reservoir in Kyrgyzstan for maximum hydropower production during wintertime.

Pressure factors, transboundary impact and trends

As to specific pressures on the river, Uzbekistan and Tajikistan report water pollution by industrial wastewaters and/or agriculture (return water from irrigational agriculture flowing into the river through a system of channels).

At the Kokbulak monitoring station (in Kazakhstan, on the border with Uzbekistan), the Syr Darya has elevated concentrations of nitrates, manganese, sulphates, iron (2+) and copper. Pollution peaks are observed in autumn.

In Kazakhstan itself, the pollution load of the Syr Darya (and its non-transboundary tributaries, Arys and Keles rivers) is increased by industrial wastewater discharges, emissions from agriculture (discharges from drainage channels) and livestock breeding.

Water pollution characteristics of the Syr Darya River in Kazakhstan (Kokbulak measuring station)					
Year	**Water pollution index[8]**	**Determinands**	**Average concentration in mg/l**	**Factor by which the MAC is exceeded**	**Water quality**
2001	1.26	Manganese	78.120	1.95	Class 3 (moderately polluted)
		Sulphates	662.41	6.63	
		Iron (2+)	0.018	3.6	
		Copper	0.0028	2.8	
2002	1.36	Manganese	58.628	1.47	Class 3 (moderately polluted)
		Sulphates	555.661	5.56	
		Iron (2+)	0.037	7.45	
		Copper	0.0039	3.9	
2003	2.13	Manganese	59.956	1.5	Class 3 (moderately polluted)
		Sulphates	486.012	4.86	
		Iron (2+)	0.036	7.19	
		Copper	0.0042	4.19	
2004	1.92	Manganese	63.768	1.59	Class 3 (moderately polluted)
		Sulphates	515.402	5.15	
		Iron (2+)	0.046	9.2	
		Copper	0.0034	3.38	
2005	2.03	Nitrites-nitrogen	0.04	2.0	Class 3 (moderately polluted)
		Sulphates	469.9	4.7	
		Manganese	53.4	1.3	
		Copper	0.0031	3.1	
2006	2.18	Nitrites-nitrogen	0.045	2.3	Class 3 (moderately polluted)
		Sulphates	507.3	5.1	
		Manganese	51.8	1.3	
		Copper	0.0034	3.4	

Source: Ministry of Environment Protection of Kazakhstan.

The following sections describe the pressure factors, transboundary impact and trends for the transboundary rivers of the Syr Darya River basin. The joint sustainable use and protection of the water resources of these transboundary rivers is a particular challenge for the Central Asian countries.

NARYN RIVER

Kyrgyzstan (upstream) and Uzbekistan (downstream) are riparian countries to the Naryn River. The literature gives various figures for the size of the catchment area, from 58,370 km^2 to 59,900 km^2.

Hydrology

The River Naryn originates in the Tien Shan Mountains in Kyrgyzstan and flows through the Fergana Valley into Uzbekistan. Here it confluences with the Kara Darya River (assessed below) to form the Syr Darya (assessed above).

The river is 807 km long and contains many multipurpose reservoirs, which are particularly important for hydropower generation. The largest one, the Toktogul reservoir, contains some 19.9 km^3 water, which is used for hydropower

[8] The water pollution index is defined on the basis of the ratios of measured values and the maximum allowable concentration of the water-quality determinands.

generation in Kyrgyzstan and for irrigational water supply and protection against floods in Uzbekistan.

Downstream of the Toktogul reservoir, the flow of the river is totally regulated. Therefore, the river discharge figures refer to the inflow into the reservoir as the sum of the discharge of the Naryn at the Uchterek gauging station and the discharge of three smaller rivers directly communicating with the reservoir.

Discharge characteristics of the Naryn River		
Q_{av}	381 m^3/s	Total inflow into reservoir (Naryn plus three smaller rivers). Average for 1950–2005
Q_{av}	342 m^3/s	Discharge of the Naryn at the Uchterek gauging station only. Average for 1959–2005
Mean monthly values (total inflow into the reservoir):		
October – 229 m^3/s	November – 198 m^3/s	December – 164 m^3/s
January – 152 m^3/s	February – 147 m^3/s	March – 159 m^3/s
April – 283 m^3/s	May – 606 m^3/s	June – 942 m^3/s
July – 844 m^3/s	August – 577 m^3/s	September – 324 m^3/s

Source: Hydrometeorological Service of Uzbekistan.

Unfortunately, of the former 15 gauging stations, only three are currently operational in the Kyrgyzstan part of the catchment area; this greatly reduces the accuracy of flood forecasts.

Pressure factors

The main pressure factors include untreated and insufficiently treated wastewater from municipal/domestic sources, discharges from industry and livestock breeding, wastes from ore mining and unauthorized storage of domestic waste from nearby human settlements.

Pollution hot spots are found in the populated lower section of the river, where high concentrations of nitrates (above 3 mg/l), nitrites (0.7 mg/l), oil and grease (0.5 mg/l), phenols (above 0.001 mg/l) and pesticides are still detected.

In the upper stretches, the water quality is assessed as "very good" or "good".

Trends

In addition to direct human impact on water quality and quantity, which will not significantly decrease, there is the growing potential of an adverse impact (mostly on water quantity) from the melting of glaciers due to rising air temperature and pollution of the glaciers.

KARA DARYA RIVER

Kyrgyzstan (upstream) and Uzbekistan (downstream) share the Kara Darya River catchment area of 28,630 km^2. Upstream of the Andijan reservoir, the catchment area is 12,360 km^2.

Hydrology

The river is heavily regulated. In 1978, the Andijan reservoir became operational, which had a significant impact on the river's flow regime (see the following table). Downstream of this reservoir, the much smaller Teshiktash and Kujganya reservoirs also became operational.

Discharge characteristics of the River Kara Darya		
Q_{av}	122 m^3/s	Inflow into the Andishan reservoir for 1978-2005
Q_{av}	136 m^3/s	Discharge at the Uchtepe gauging station at the river mouth for 1978–2005
Mean monthly values (total inflow into the reservoir):		
October – 62.2 m^3/s	November – 67.1 m^3/s	December – 58.9 m^3/s
January – 50.8 m^3/s	February – 49.4 m^3/s	March – 63.1 m^3/s
April – 170 m^3/s	May – 290 m^3/s	June – 324 m^3/s
July – 324 m^3/s	August – 101 m^3/s	September – 61.9 m^3/s
Mean monthly values (river mouth):		
October – 122 m^3/s	November – 147 m^3/s	December – 133 m^3/s
January – 108 m^3/s	February – 102 m^3/s	March – 117 m^3/s
April – 175 m^3/s	May – 210 m^3/s	June – 199 m^3/s
July – 199 m^3/s	August – 124 m^3/s	September – 87.1 m^3/s

Source: Hydrometeorological Service of Uzbekistan.

Pressure factors, transboundary impact and trends

The hydrological regime of the river in the Fergana Valley can be characterized as follows: the river water is used for irrigation purposes (abstraction), and there is considerable water inflow from groundwaters and return waters from irrigational areas (input). Therefore, the main problems are the correct calculation of water abstraction and compliance with the “abstraction norms”.

CHIRCHIK RIVER

Kazakhstan, Kyrgyzstan and Uzbekistan are riparian countries to the Chirchik River. The total catchment area of the Chirchik River is 14,240 km^2, of which 9,690 km^2 are in the mountains (upstream of the Charvads reservoir).

Hydrology

The Chirchik originates in Kyrgyzstan, at the confluence of two rivers, the Chatkal (shared by Kyrgyzstan and Uzbekistan) and the Pskem. Currently both rivers supply the Charvak reservoir.

Downstream of the Charvak reservoir, the Chirchik river is fully regulated. There are two relatively big tributaries, the Ugam on the right and the Aksakata on the left. Further downstream, in the lowland part, the Chirchik is used intensively for irrigational water supply through a comprehensive system of canals. The biggest include- the Zakh, Bozsu and Northern Tashkent canals, which, although artificial, look like real rivers.

Discharge characteristics of the Chirchik River at the Chinaz gauging station		
Q_{av}	104 m^3/s	Average for1923–2005
Mean monthly values (inflow into the reservoir):		
October – 98.1 m^3/s	November – 86.0 m^3/s	December – 72.4 m^3/s
January – 64.2 m^3/s	February – 61.8 m^3/s	March – 82.7 m^3/s
April – 218 m^3/s	May – 417 m^3/s	June – 550 m^3/s
July – 414 m^3/s	August – 232 m^3/s	September – 135 m^3/s

Source: Hydrometeorological Service of Uzbekistan.

Pressure factors

The river is used mainly for irrigation and hydropower generation. From time to time, there is inter-basin water transfer into the catchments of the Keles and Akhangaran rivers.

Major industrial enterprises in the Chirchik basin include the Khodjikent asphalt and concrete plant, the manufacturing firm Electrokhimprom and the Uzbek industrial complex for metal manufacturing. According to recent data, wastewater discharged from Electrochimprom still exceeds MAC values as follows: suspended matters 24 times, ammonia nitrogen up to 10 times, nitrates up to 7 times and oil products 3 times. One can expect a similar picture for the other industrial sites in the Chirchik basin.

In the upper stretches of the lowland part, the Chirchik carries a high sediment load (above 1 t/m^3). To protect the Chirchik-Bozsu Cascade of hydropower stations from this mudflow, a great number of facilities for mud removal and/or its "harmless" passing through the cascade have been built.

Trends

With the ongoing economic development and population growth in the Tashkent Oasis, there is an ever-growing deficit of water for irrigation and hydropower generation.

CHATKAL RIVER

Kyrgyzstan (upstream) and Uzbekistan (downstream) share the catchment area of the Chatkal River (7,110 km^3).

Hydrology

The river has a length of 217 km. There are 106 tributaries to the Chatkal River with a total length of 1434.5 km. None of the three former gauging stations of the Hydrometeorological Service of Kyrgyzstan is currently operational. The gauging station at Khudajdodsaj, operated by the Hydrometeorological Service of Uzbekistan, is functioning properly.

Discharge characteristics of the Chatkal River (Gauging stations at the mouth of the Ters River)		
Q_{av}	66.2 m^3/s	1941–1990
Q_{max}	102.6 m^3/s	1978–1979
Q_{min}	40.7 m^3/s	1981–1982
$Q_{absolute\ max}$	450.0 m^3/s	24 June 1979
$Q_{absolute\ min}$	9.2 m^3/s	9 January 1974

Source: Ministry of Environment of Kyrgyzstan.

Discharge characteristics of the Chatkal River at the Khudajdodsaj gauging station		
Q_{av}	115 m^3/s	Average for 1968–2005
Mean monthly values (inflow into the reservoir):		
October – 54.0 m^3/s	November – 48.7 m^3/s	December – 41.1 m^3/s
January – 36.9 m^3/s	February – 35.6 m^3/s	March – 47.2 m^3/s
April – 134 m^3/s	May – 257 m^3/s	June – 322 m^3/s
July – 217 m^3/s	August – 112 m^3/s	September – 68.0 m^3/s

Source: Hydrometeorological Service of Uzbekistan.

Pressure factors, transboundary impact and trends

There are only eight villages in the basin, two of them with central water supply and only one of them with a wastewater treatment plant (Kanysh-Kiya).

The transboundary impact seems to be limited to organic pollution from the human settlements.

ARAL SEA[9]

The Aral Sea is the biggest lake in Central Asia; it lies between Kazakhstan in the north and Uzbekistan in the south. Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan share the lake basin, which is essentially made up of the basins of the Amu Darya, Zerevshan and Syr Darya.

The recharge basin is characterized by large variations in precipitation. Annual precipitation ranges from 1,500 to 2,500 mm in the glacier belts of the West Tien Shan and West Pamir ranges, 500–600 mm in the foothills, and 150 mm at the latitude of the Aral Sea.

Historically, the Aral Sea has risen and fallen considerably. During the Quaternary period, the lake's showed variations of as much as 36 metres due to natural factors. In the first half of the twentieth century, the variance did not exceed one metre, and the ecological situation was quite stable until the late 1950s. However, since then substantial variations have occurred mainly due to anthropogenic pressure: since the end of the 1950s, the level of the lake has fallen by more than 22 m.

Since the 1960s, the Aral Sea has been shrinking as the rivers that feed it have been intensively used for irrigation. This has created a number of ecological problems both for the lake and for the surrounding area. The lake is badly polluted, largely as a result of former weapons testing, industrial projects and fertilizer runoff before the 1990s.

Another major environmental problem facing the Aral Sea basin is the increasing salinization of irrigated areas, which is reducing their productivity. A significant proportion (about 33,000 km²) of the lake has dried up, and water mineralization has increased. The ecosystem of the Aral Sea has been nearly destroyed, and not least because of the salinization. The receding lake has left huge plains covered with salt and toxic chemicals, which are picked up and carried away by the wind as toxic dust, and thereby spread to the surrounding area. As a result, the land around the Aral Sea became heavily polluted, and the people living in the area are suffering from a lack of fresh water, as well as from a number of health problems, such as certain forms of cancer and lung disease.

[9] Source: Global International Waters Assessment; Aral Sea, GIWA Regional assessment 24, UNEP, 2005.

CHU-TALAS RIVER BASINS [10]

The Chu-Talas basins include the basins of three transboundary rivers: the Chu, the Talas and the Assa. The major part of their basins (73%) is located in desert and semi-desert zones. The Tien Shan Mountains occupy 14% of the basins' total area and the steppe-like hilly part covers 13%.

The Chu-Talas basins also encompass 204 smaller rivers (140 rivers in the Chu basin, 20 in the Talas basin and 64 in the Assa basin), as well as 35 lakes and three large water reservoirs.

Most of the runoff of the Chu, the Talas and the Kukureusu (Assa's main tributary) is formed in Kyrgyzstan. The water resources of the Chu River are estimated at 6.64 km^3 and those of the Talas River at 1.81 km^3. The Chu, Talas and Assa are ultimately regulated.

In Kyrgyzstan, the biggest reservoirs are the Orto-Tokoy reservoir (design capacity of 0.42 km^3) on the Chu and the Kirovsk water reservoir (design capacity of 0.55 km^3) on the Talas. In Kazakhstan, there are the Tasotkel reservoir (total volume 0.62 km^3) on the Chu and the Tersashchibulak reservoir on the Ters River, a tributary to the Talas, with a volume of 158 million m^3. The reservoirs of the Chu-Talas basins are used mainly to supply water for irrigation.

[10] Based on information provided by the Ministry of Environment Protection of Kazakhstan, and the State Agency for Environment Protection and Forestry of Kyrgyzstan.

CHU RIVER

The basin, shared by Kazakhstan (downstream) and Kyrgyzstan (upstream), covers an area of 62,500 km^2; the mountainous part of the basin stretches over an area of 38,400 km^2 (60% of it in Kyrgyzstan).

Hydrology

The Chu River is 1,186 km long; 221 km of this length forms the border between Kyrgyzstan and Kazakhstan. The river is fed mainly by glaciers and melting snow. Rainfall is of secondary importance. Groundwater inflow, particularly in the foothills and lowlands, is particularly important for the formation of the basis flow and the spring flow.

In Kyrgyzstan, only one gauging station on the Chu River is still operational, and the number of groundwater observing wells has fallen by more than 50% since the 1980s. Consequently, the accuracy of runoff forecasts and water balance computations has decreased. Luckily, the number of measuring points for discharge regulation in the irrigation channels has been maintained.

In Kazakhstan, four gauging stations are operational, including one station downstream of the border with Kyrgyzstan at the village of Blagoveshshenskoye.

Pressure factors

The water quality of the Chu River depends on the degree of pollution of its tributaries, lakes in the basin and groundwaters as well as the pollution of glaciers, mainly due to human impact. Apart from irrigated agriculture in both countries, the main pressure factors in Kyrgyzstan arise from untreated municipal and industrial wastewaters, animal husbandry, mining in the mountainous parts and unaut horized storage of wastes next to human settlements. One of the pollution sources is the Gorvodocanal in Bishkek. In the lowlands, runoff regulation has decreased the occurrence of floods and/or their duration, which in turn has adverse effects on riparian vegetation and vegetation in the former flood-prone areas.

Transboundary impact

In Kazakhstan, water quality is measured at the village of Blagoveshshenskoye, downstream of the border with Kyrgyzstan. Water quality falls into classes 3 and 4. Nitrates, phenols and copper play a major role in pollution.

Water pollution characteristics of the Chu River in Kazakhstan (Blagoveshshenskoye village downstream of the border with Kyrgyzstan)					
Year	Water pollution index	Determinands	Mean concentration in mg/l	Factor by which MAC is exceeded	Water quality
2001	1.58	Sulphates	143.45	1.43	Class 3
		Ammonium-nitrogen	0.473	1.21	
		Nitrites-nitrogen	0.053	2.65	
		Iron, total	0.34	3.4	
		Iron (2+)	0.195	39.0	
		Copper	0.0012	11.73	
		Zinc	0.0245	2.45	
		Phenols	0.0013	1.33	
2002	2.87	Sulphates	265.95	2.66	Class 4
		Nitrites-nitrogen	0.043	2.17	
		Iron, total	0.255	2.5	
		Iron (2+)	0.08	16.0	
		Copper	0.0097	9.67	
		Zinc	0.0186	1.86	
		Phenols	0.002	2.0	
2003	1.73	Sulphates	128.95	1.29	Class 3
		Nitrites-nitrogen	0.024	1.19	
		Iron, total	0.36	3.6	
		Copper	0.0048	4.8	
		Phenols	0.0011	1.08	
		Oil products	0.06	1.2	
2004	2.24	Sulphates	129.25	1.29	Class 3
		Nitrites-nitrogen	0.035	1.73	
		Chromium	11.42	1.14	
		Iron, total	0.26	2.6	
		Iron (2+)	0.12	1.2	
		Copper	0.0035	3.48	
		Phenols	0.005	4.91	
		Oil products	0.058	1.15	
2005	1.85	Copper	0.0044	4.4	Class 3
		Nitrites-nitrogen	0.023	1.1	
		Phenols	0.002	2.0	
2006	2.13	Ammonium-nitrogen	0.45	1.2	Class 3
		Nitrites-nitrogen	0.032	1.6	
		Copper	0.0062	6.2	
		Iron, total	0.17	1.7	
		Phenols	0.0014	1.4	

Note: Class 3 – moderately polluted; class 4 – polluted.
Source: Ministry of Environment Protection of Kazakhstan.

Trends

According to an assessment by Kyrgyzstan, the technical status of water construction works, including irrigation channels, and the infrastructure for industrial and municipal water supply is deteriorating, which has adverse effects on the availability and quality of water resources. The pressure on water resources will also increase due to the worsening technical status of water supply and wastewater treatment systems. An additional adverse impact on groundwater quality will be created by increasing contamination caused by the worsening status of water protection zones.

TALAS RIVER

The basin, shared by Kazakhstan (downstream) and Kyrgyzstan (upstream), covers an area of 52,700 km^2 as shown in the following table.

Basin of the Talas River			
Area	**Country**	**Country's share**	
52,700 km^2	Kazakhstan	41,270 km^2	78.3%
	Kyrgyzstan	11, 430 km^2	21.7%

Source: Joint communication by the Ministries of Environment Protection of Kazakhstan and Kyrgyzstan.

Hydrology

The Talas River is formed by the confluence of the Karakol and Uchkosha rivers, which have their sources at the slopes of the Kyrgyz Ridge and the Talas Alatau. The river vanishes into the Moinkum sands without reaching Lake Aydyn. Of the river's total length of 661 km, 453 km flow through in Kazakhstan.

In Kyrgystan, only 13 of 21 former gauging stations are still operational, and the number of groundwater observing wells has decreased, (as it is the case for the Chu basin) by more than 50% compared to the 1980s. Consequently, the accuracy of runoff forecasts and water balance computations has decreased. Luckily, the number of measuring points for discharge regulation in the irrigation channels has been maintained.

Pressure factors

Water resources are used mainly to support grazing and animal husbandry in the mountainous parts of the basin, and irrigated agriculture and animal husbandry in the foothills and lowlands. In Kyrgyzstan some 137,600 ha are irrigated land, and in Kazakhstan 105,000 ha.

Apart from irrigated agriculture in both countries, the main pressure factors in Kyrgyzstan arise from untreated municipal and industrial wastewaters, discharges from livestock breeding, wastes from mining in the mountainous parts, and unauthorized storage of waste next to human settlements. In Kazakhstan, additional pressure on water quality arises from return water from wastewater infiltration fields used by the sugar and alcohol industries.

Transboundary impact

Water quality in the Talas River basin depends on polluting substances, which are discharged from Kyrgyzstan and Kazakhstan into the Talas, as well as on the extent of pollution of its tributaries, lakes in the basin and groundwaters. Major pollutants include ammonium-nitrogen and copper. In the vicinity of the city of Talas, water pollution is higher due to elevated concentrations of iron (total iron and iron-II).

Currently, Kazakhstan assesses the Talas's water quality as "good".

Water pollution characteristics of the Talas River in Kazakhstan (Pokrovka village downstream of the border with Kyrgyzstan)

Year	Water pollution index	Determinands	Mean concentration in mg/l	Factor by which MAC is exceeded	Water quality
2001	1.19	Ammonium-nitrogen	0.492	1.29	Class 3
		Iron, total	0.137	1.37	
		Iron (2+)	0.046	9.2	
		Copper	0.0028	2.76	
2002	0.81	Iron, total	0.155	1.55	Class 2
		Iron (2+)	0.064	12.8	
		Copper	0.0019	1.96	
2003	0.79	Iron, total	0.164	1.64	Class 2
		Iron (2+)	0.071	14.2	
		Copper	0.0015	1.48	
2004	0.88	Iron, total	0.107	1.07	Class 2
		Iron (2+)	0.032	6.4	
		Copper	0.0016	1.57	

Note: Class 2 – slightly polluted; class 3 – moderately polluted.
Source: Ministry of Environment Protection of Kazakhstan.

Trends

As with the Chu basin, Kyrgyzstan finds that the technical status of water construction works, including irrigation channels, and the infrastructure for industrial and municipal water supply is deteriorating, which has adverse effects on the availability and quality of water resources. The pressure on water resources will also increase due to the worsening technical status of water supply and wastewater treatment systems. An additional adverse impact on groundwater quality will be created by increasing contamination caused by the worsening status of water protection zones.

ILI RIVER BASIN[11]

The basin of the Ili River, shared by China (upstream country) and Kazakhstan (downstream country), covers an area of 413,000 km².

Basin of the Ili River			
Area	**Country**	**Country's share**	
413,000 km²	Kazakhstan	353,000 km²	85.4%
	China	60,000 km²	14.6%

Source: Ministry of Environment Protection of Kazakhstan.

ILI RIVER

Hydrology

The Ili River is 1,439 km long, including 815 km in Kazakhstan. Its source is in the eastern Tien Shan at the confluence of the Tekes and Kunes rivers. Before flowing into Lake Balqash, it forms an immense delta with vast regions of lakes, marches and jungle-like vegetation.

In China, there are some 15 reservoirs on the tributaries to the Ili (Kash, Kunes, Tekes); some 40 small reservoirs are in the planning phase. The biggest reservoir in Kazakhstan is the Kapshagan hydropower station on the Ili; a number of smaller hydropower stations are operational on the Ili's tributaries.

Pressure factors

The main pressure factors include agriculture (animal farms and irrigated farming), mining, manufacturing and refinery enterprises, and urbanization.

In China, some 600 million ha are irrigated. The area of irrigated land in Kazakhstan is only 8.18 million ha; 6.53 million ha of this consists of grasslands for grazing of cattle, sheep, goats, horses and camels.

[11] Based on information provided by the Ministry of Environment Protection of Kazakhstan.

In the lowlands, flow regulation by the many reservoirs is another pressure factor and has a direct impact on flood plain vegetation: due to the decreasing number of flood events and a shortening of their duration, the vegetation is deteriorating, which adversely affects animal grazing. In the river delta itself, the opposite is happening in winter: high water discharges from the reservoirs to satisfy peak energy demand lead to complete flooding of the river delta, which adversely affects the riverine ecosystem.

Transboundary impact

The pressure factors described above are causing pollution in both China and Kazakhstan. The main industrial pollutants are copper and zinc (currently, out of 100 samples taken at the border station in Kazakhstan, 72 samples usually exceed the maximum allowable concentration values (MAC) and oil products.

Water pollution characteristics of the Ili River in Kazakhstan
(Dubunj measuring station downstream from the border with China)

Year	Water pollution index	Determinands	Mean concentration in mg/l	Factor by which MAC is exceeded	Water quality
2001	4.01	Iron, total	0.165	1.65	Class 4
		Iron (2+)	0.039	7.89	
		Copper	0.017	19.9	
		Zinc	0.017	1.75	
		Phenols	0.002	2.0	
		Oil products	0.085	1.70	
2002	2.48	Nitrate-nitrogen	0.035	1.74	Class 3
		Iron, total	0.24	2.4	
		Iron (2+)	0.099	19.84	
		Copper	0.009	8.95	
		Zinc	0.016	1.57	
		Oil products	0.056	1.12	
2003	2.46	Nitrate-nitrogen	0.029	1.45	Class 3
		Iron (2+)	0.061	12.21	
		Copper	0.0086	8.63	
		Zinc	0.021	2.06	
		Oil products	0.077	1.54	
2004	2.14	Iron (2+)	0.059	11.8	Class 3
		Copper	0.0072	7.28	
		Zinc	0.015	1.51	
		nganese	0.149	1.49	
		Phenols	0.0015	1.47	

Note: Class 3 – moderately polluted; class 4 – polluted.
Source: Ministry of Environment Protection of Kazakhstan.

Trends

The ever-growing water use, including for irrigation; the attempt to increase the volume of the Kapshagan reservoir to boost hydropower production; the sealing of areas next to reservoirs; and the pollution of water protection zones in mountain rivers will all continue to have adverse effects on the status of aquatic ecosystems.

In addition, there is the potential threat of growing pressure on water resources due to increasing economic activities in China. Of the available 18.1 km^3/year (long-term mean average flow into the Kapshagan reservoir), one third (12.3 km^3/year) is formed in China. With the expected decrease to 8.0 km^3/year, which is very likely due to increasing water use in China, Lake Balqash may – given the same amount of water use in Kazakhstan – share the fate of the Aral Sea.

LAKE BALQASH[12]

Lake Balqash, the largest moderately saline lake of Central Asia, is located in south-eastern Kazakhstan. The total area of the lake is 18,210 km^2. The western half of the lake consists of fresh water, while the eastern half is salt water. The average depth of the lake is only six metres. The lake is fed principally by the Ili River.

Water pollution of the Balqash is growing as agriculture, industrialization and urbanization in the area increase (see the assessment of the Ili River). The lake is also shrinking because of over-utilization of water. The extinction of species in the lake due to over-fishing is occurring at an alarming rate.

MURGAB RIVER BASIN[13]

The basin of the Murgab River, with a total area of 46,880 km^2, is shared by Afghanistan (upstream) and Turkmenistan (downstream). The 852 km long river (350 km in Turkmenistan) rises in Afghanistan at 2,600 m above sea level and ends up in a desert sink (actually, it feeds many irrigation channels in Turkmenistan). The Abikajsar River is its major transboundary tributary.

The long-term mean annual discharge of the river in Turkmenistan is 1,657 million m^3 usually with a clear-cut seasonal distribution: around 55% in summer, 16% in winter, 13% in spring and 17% in autumn.

Since ancient times, irrigated agriculture has been the predominant water user in the basin. Currently, the return waters (surface runoff and groundwater flow) from the irrigated land "do not significantly influence" the river's water quality. According to the 2006 measurements (stations Iolontanj and Takhtabazar, Turkmenistan), the river's mineral salt content was "moderate" and reached 500 mg/l and the maximum concentrations of nitrogen compounds exceeded the MAC values only by a factor of 3. The oxygen regime was "satisfactory". However, water pollution by organic compounds increased over the last couple of years: in 2006, the COD was 65 mg O_2/l and its maximum was 154 mg O_2/l (station Iolotanj).

TEJEN RIVER BASIN[14]

Afghanistan, the Islamic Republic of Iran and Turkmenistan share the Tejen River basin with a total area of 70,260 km^2. The Tejen, also known as Tedshen and Gerirud, has a total lenght of 1,124 km.

Irrigational agriculture is the predominant water user in Afghanistan, the Islamic Republic of Iran and Turkmenistan. However, the river's waters can only satisfy the water demand of 15% of the agricultural land suitable for irrigated agriculture.

To better satisfy agricultural water demand, the Islamic Republic of Iran and Turkmenistan completed in 2005 the construction of the Dostluk dam and reservoir on the Tejen (1,250 million m^3). Following a bilateral agreement between the two countries, the reservoir's water resources are equally shared.

The return waters (surface runoff and groundwater flow) from the irrigated land heavily influence the river's water quality: In 2006, the river's mineral salt content was in the order of 1,900-2,000 mg/l and COD reached 277 mg O_2/l (measurements at Tedshen city).

[12] Based on information provided by the Ministry of Environment Protection of Kazakhstan.
[13] Based on information by the Ministry of Nature Protection of Turkmenistan.
[14] Based on information by Ministry of Nature Protection of Turkmenistan.

DRAINAGE BASIN OF THE CASPIAN SEA

This chapter deals with major transboundary rivers discharging into the Caspian Sea and their major transboundary tributaries. It also includes lakes located within the basin of the Caspian Sea.

TRANSBOUNDARY WATERS IN THE BASIN OF THE CASPIAN SEA[1]

Basin/sub-basin(s)	Total area (km²)	Recipient	Riparian countries	Lakes in the basin
Ural	231,000	Caspian Sea	KZ, RU	…
- Ilek	…	Ural	KZ, RU	…
Atrek	27,300	Caspian Sea	IR, TM	…
Astara Chay	*242*	*Caspian Sea*	*AZ, IR*	…
Kura	188,000	Caspian Sea	AM, AZ, GE, IR, TR	Lake Jandari, *Lake Kartsakhi, Araks Arpachay Baraji reservoir, Araks Govsaghynyn reservoir*
- Iori	5,255	Kura	AZ, GE	
- Alazani	11,455	Kura	AZ, GE	
- Debet	4,100	Kura	AM, GE	
- Agstev	2,500	Kura	AM, GE	
- Potskhovi	1,840	Kura	GE, TR	
- Ktsia-Khrami	8,340	Kura	AM, GE	
- Araks	102,000	Kura	AM, AZ, IR, TR	
-- Akhuryan	9,700	Araks	AM, TR	
-- Arpa	2,630	Araks	AM, AZ	
-- Vorotan (Bargushad)	5,650	Araks	AM, AZ	
-- Voghji	1,175	Araks	AM, AZ	
-- *Kotur (Qotur)*	…	*Araks*	*IR, TR*	
Samur	7,330	Caspian Sea	AZ, RU	…
Sulak	15,200	Caspian Sea	GE, RU	…
- Andis-Koisu	4,810	Sulak	GE, RU	…
Terek	43,200	Caspian Sea	GE, RU	…
Malyi Uzen	13,200	Kamysh-Samarsk Lakes	KZ, RU	*Lakes of Kamysh-Samarsk*
Bolshoy Uzen	14,300	Kamysh-Samarsk Lakes	KZ, RU	

[1] The assessment of water bodies in italics was not included in the present publication.

URAL RIVER BASIN [1]

Hydrology

The Ural River, which forms part of the traditional boundary between Europe and Asia, rises in the South-eastern slopes of the Ural Mountains (Russian Federation). 72% of its total runoff is formed in the Russian part of the basin. There are remarkable water level and water discharge fluctuations throughout the year; the share of spring floods amounts to some 65-70%.

The total length of the river is 2,428 km, from which 1,082 km are in Kazakhstan. In the basin, there are some 240 lakes and one man-made multipurpose reservoir, the Iriklin reservoir, with a total storage capacity of 3,260 km^3 and a surface of 260 km^2.

Pressure factors

On the territory of the Russian Federation, major pollution sources are the industrial enterprises in Magnitogorsk and the Orenburg oblasts. In Kazakhstan, the cities of Uralsk and Atyrau discharge municipal wastewaters with nutrients and organic substances into the Ural River. Other pollution sources include surface water runoff, particularly during flood periods,

URAL RIVER

The Ural River basin is shared by the Russian Federation (upstream country) and Kazakhstan (downstream country).

Basin of the Ural River			
Area	Country	Country's share	
231,000 km^2	Russian Federation	83,200 km^2	36%
	Kazakhstan	147,800 km^2	64%

Source: Ministry of Environment Protection of Kazakhstan.[2]

Discharge characteristics of the Ural River downstream of the border with theRussian Federation	
Q_{av}	2.82 km^3/a
Q_{max}	7.82 km^3/a
Q_{min}	1.0 km^3/a

Source: Ministry of Environment Protection, Kazakhstan.

[1] Based on information provided by the Federal Water Agency, Russian Federation and the Ministry of Environment Protection, Kazakhstan.
[2] Other sources report a size of the basin ranging from 231,000 km^2 to 311,000 km^2.

carrying away pollutants from sewage infiltration fields, as well as seepage from sewage ponds. Surface runoff from the oil extraction sites on the Caspian coast (Tengiz, Prorva, Martyshi, Kalamkas, Karazhmbas) introduces oil products into the Ural river.

Transboundary impact

Phenols, heavy metals and oil products are the principal pollutants in the Ural basin.[3] Data from 1990 to 1999 show that on the Russian-Kazakhstan border (village of Yanvartsevo) the concentration of copper and phenol in the Ural River exceeded the maximum allowable concentration (MAC) by a factor of 10 to 12, whereas the concentrations for hexachlorane and lindan were 1 to 18 times higher than the allowable concentrations. For the same period of time, inputs of phosphorus and lindan from sources in Kazakhstan increased the pollution load by 13% and 30%, respectively, compared to the measurement at the Russian-Kazakhstan border.

Water pollution at the Russian-Kazakhstan border (village of Yanvartsevo)

Determinands and the corresponding MAC in mg/l		1990	1995	1999	2001	2002	2003	2004
Copper	0.001	0.012	0.0006	0.00	…	…	…	…
Zinc	0.01	0.037	0.004	…	0.021	…	…	…
Chromium	0.001	0.0016	0.002	0.00	…	…	…	…
Manganese	0.01	0.009	0.016	0.00	…	…	…	…
Oil products	0.05	0.039	0.071	0.0031	…	…	…	…
Phenols	0.001	0.001	0.001	0.00	0.001	0.002	0.002	0.001

Source: Ministry of Environment Protection, Kazakhstan.

Despite the negative impact of floods (see above), the diluting effects of huge spring floods temporarily decrease water pollution in the river itself and allow for some self-purification of the river system. These effects are particularly visible in the lower parts of the basin and in the delta (see the table below). Nevertheless, data from the second half of the 1990s show a general increase in the content of nitrogen compounds (by 3 times) and boron (by 7 times).

Water pollution index[4] at two stations in Kazakhstan

Measuring station	1994	1995	1996	…	2001	2002	2003	2004
Uralsk (KZ)	1.55	1.68	3.03	…	2.78	1.18	1.21	1.42
Atyrau (KZ)	0.96	1.04	1.01	…	…	…	…	…

Source: Ministry of Environment Protection, Kazakhstan.

Trends

As indicated by the water pollution index, an increase of the overall pollution in the 1990s seems to be followed by a slight decrease of pollution from 2000 onwards and the upgrading from water quality class 4 (polluted) to class 3 (moderately polluted). For individual substance, a trend cannot be detected, as the factor by which the maximum allowable concentration is exceeded considerably changes from year to year.

ILEK RIVER

The river Ilek, also shared by Kazakhstan and the Russian Federation, is a transboundary tributary to the Ural River. The Ilek carries boron and chromium into the Ural River, originating from the tailing ponds of former chemical plants via groundwater. The water-quality class of Ilek River varies between 4 (polluted) to 6 (very polluted).[5]

[3] Environmental Performance Review, Kazakhstan, UNECE, 2000.
[4] The water pollution index is defined on the basis of the ratios of measured values and the maximum allowable concentration of the water-quality determinands.
[5] Water Resources of Kazakhstan in the New Millennium, Water Resources Committee of the Republic of Kazakhstan, 2002.

ATREK RIVER BASIN[6]

Hydrology

The basin of the Atrek River, with a total area of 26,720 km², is shared by the Islamic Republic of Iran and Turkmenistan. The 530 km long river (635 km with its tributaries) rises in the Islamic Republic of Iran, forms for some length the border between the Islamic Republic of Iran and Turkmenistan, and ends up in the Caspian Sea. The Atrek carries high amounts of suspended solids, sometimes 14,000-35,000 mg/l.

The long-term mean annual discharge of the river in Turkmenistan is 100 million m³. Following a bilateral agreement between the riparian countries, the river's water resources are equally shared between the Islamic Republic of Iran and Turkmenistan.

Pressure factors

Irrigated agriculture is the predominant water user in the basin. Of the total area of fertile land in the basin, only 25% can be irrigated due to lacking water resources.

The return waters (surface runoff and groundwater flow) from the irrigated land heavily influence the river's water quality: its mineral salt content reaches 1,800 mg/l. According to the 2006 measurements in Turkmenistan, the oxygen content was "satisfactory" and COD with 20-30 mg O_2/l was "not high". The mean annual concentration of nitrogen compounds did not exceed the MAC values and their maximum values exceeded the MAC values only by a factor of 3. The maximum values for phenols, oil products and sulphates, however, exceeded the MAC values by a factor of 11, 12 and 10, respectively.

KURA RIVER BASIN[7]

[6] Based on information by the Ministry of Nature Protection of Turkmenistan.
[7] Based on information provided by the Ministry of Nature Protection of Armenia, the Ministry of Ecology and Natural Resources of Azerbaijan and the Ministry of Environment Protection and Natural Resources of Georgia.

KURA RIVER

Armenia, Azerbaijan, Georgia, the Islamic Republic of Iran and Turkey share the Kura basin, which has a total area of 188.000 km². The Russian Federation is usually not considered as a basin country, as its territory in the basin is far below 1% of the total basin area.

Basin of the Kura River[8]

Area	Country	Country's share	
188,000 km²	Armenia	29,743 km²	15.8%
	Azerbaijan	57,831 km²	30.7%
	Georgia	29,741 km²	15.8%
	the Islamic Republic of Iran	…	…
	Turkey	…	…

Source: UNECE Environmental Performance Review (EPR) programme; Ministry of Nature Protection of Armenia, Ministry of Ecology and Natural Resources of Azerbaijan and Ministry of Environment Protection and Natural Resources of Georgia.

Hydrology

The Kura, takes off in Turkey on the east slope of the mount Kyzil-Gyadik at the height of 2742 m. The total length of the river is 1364 km (185 km in Turkey, 390 km in Georgia and 789 km in Azerbaijan). The basin includes the whole territory of Armenia, the eastern part of Georgia, some 80% of Azerbaijan as well as parts of Turkey and the Islamic Republic of Iran. In previous times, the Kura was even navigable up to Tbilisi (Georgia); after the construction of dams for hydropower generation, the river became much shallower.

Among the Kura tributaries, there are a number of major transboundary tributaries, including the rivers Araks, Iori, Alazani, Debet, Agstev, Potskhovi and Ktsia-Khrami. Major transboundary tributaries to the Araks River include the rivers Akhuryan, Agstev, Arpa, Kotur, Voghji and Vorotan.

Flash floods are frequent (see also the assessment of the first and second order tributaries below). Reservoir and dam construction also served flood regulation. On the Kura, the Mingechevir reservoir has improved the situation in this respect in the lowlands of the river. Downstream of the confluence of the Araks River, however, floods frequently occur due to a combination of increased water level in the Caspian Sea and sedimentation in the riverbed. Emergency work on the Kura dykes in 2003 mitigated the impact of flooding in the Salyan and Nefchala areas.

[8] There are some differences regarding the total area of the basin (ranging from 188,000 km² to 193,200 km²) and the countries' shares. For example, the 2004 GIWA Regional Assessment 23 "Caspian Sea" gives the following figures: Total basin area 193,200 km² from which 18% in AM, 29% in AZ, 18% in GE, 21% in IR, 14% in TR and <<1% in RU). The figures used here are those reported by the countries under the UNECE Environmental Performance Review programme, supplemented by data from the Water Convention's pilot project on monitoring and assessment of transboundary waters, i.e. the TACIS Project "Joint River Management Programme", 2003. Data on Turkey and on the Islamic Republic of Iran were not gathered under this activity and is therefore not included in the table.

Discharge characteristics of the Kura at gauging stations in Georgia and Azerbaijan		
Khertvisi (Georgia, downstream of the border with Turkey): latitude: 41° 29′; longitude: 43°17′		
Q_{av}	33.0 m^3/s	1936-1990
Q_{max}	56.0 m^3/s	1936-1990
Q_{min}	18.0 m^3/s	1936-1990
$Q_{absolute\ max}$	742 m^3/s	18 April 1968
$Q_{absolute\ min}$	5.5 m^3/s	16 January 1941
Tbilisi city (Georgia): latitude: 41° 44′; longitude: 44° 47′		
Q_{av}	204.0 m^3/s	1936-1990
Q_{max}	325.0 m^3/s	1936-1990
Q_{min}	133.0 m^3/s	1936-1990
$Q_{absolute\ max}$	2450 m^3/s	19 April 1968
$Q_{absolute\ min}$	12 m^3/s	12 February 1961
Kyragkesaman (Azerbaijan, on the border with Georgia): latitude: 41° 00′; longitude: 46° 10′		
Q_{av}	270.0 m^3/s	1953-1958, 1986-2006
Q_{max}	4,460 m^3/s	1953-1958, 1986-2006
Q_{min}	188.0 m^3/s	1953-1958, 1986-2006
$Q_{absolute\ max}$	2,720.0 m^3/s	May 1968
$Q_{absolute\ min}$	47.0 m^3/s	August 2000
Saljany (Azerbaijan): latitude: 48° 59′; longitude: 39° 36′		
Q_{av}	446.0 m^3/s	1953-2006
Q_{max}	6,570 m^3/s	1953-2006
Q_{min}	269.0 m^3/s	1953-2006
$Q_{absolute\ max}$	2,350 m^3/s	11 May 1969
$Q_{absolute\ min}$	82 m^3/s	4 July 1971

Pressure factors

The Kura river system is organically and bacteriologically polluted by the discharge of poorly treated or untreated wastewater from the 11 million people[9] living in the catchment area. Wastewater discharges from households, not connected to sewage systems, into surface waters and groundwaters (particularly on the countryside) which also increases the potential of water-related diseases.

Due to the collapse of many industries in the early 1990s, industrial pollution has decreased considerably. A number of polluting activities, however, still exist, notably mining, metallurgical and chemical industries. The major pollutants are heavy metals (Cu, Zn, Cd) from mining and the leather industry, and ammonia and nitrates from the fertilizer industry. Up to now, concentrations of heavy metals exceed norms up to nine times, phenols up to six times and mineral oil, two to three times. The point source discharges from industries are very irregular (often during night-time) and difficult to detect due to the high speed in most of the rivers. In Georgia, pollution load estimates are therefore based on production figures, rather than measurements.

Irrigated agriculture is another source of pollution. In Azerbaijan alone, some 745,000 ha are used for this purpose, including 300,000 ha in the Azerbaijan part of the Araks sub-basin.

[9] Environmental Performance Review Azerbaijan, UNECE, 2004.

Manure and pesticides (including leakages from old stock of DDT or use of illegally produced or imported products) and viniculture are additional pollution sources. As roads are often close to the riverbanks, there is also a fair impact from oil products, residues and lead, mostly from badly functioning cars.

Deforestation in the upper part of the basin has led to poor soil protection with damaging mud slides as a result. Moreover, deforestation and overgrazing have led to erosion causing high turbidity of river water. The Araks River is claimed to be one of the most turbid in the world, and its high turbidity and pollution load increases the cost of drinking-water production in Azerbaijan.

Transboundary impact

On the territory of Georgia, industrial enterprises discharged in 2004: $9.945 \cdot 10^6$ kg surface active synthetic substances, $2 \cdot 10^3$ kg sulfate, $72 \cdot 10^3$ kg chloride, $46.839 \cdot 10^6$ kg ammonium-nitrogen, $23 \cdot 10^3$ kg nitrate, $159 \cdot 10^3$ kg iron, $37.005 \cdot 10^3$ kg total inorganic nitrogen, $600 \cdot 10^3$ kg BOD and 4,958 t suspended solids.[10] These data are calculated values based on production figures.

Following measurements by Azerbaijan, the maximum allowable concentration (MAC) for a number of substances are exceeded at the Georgian-Azerbaijan border (station Shikhli-2), for example, 8-12 times for phenols, 2-3 times for oil products, 8-14 times for metals, and 1-2 times for sulphates.

There are no significant pollution sources in the section from the Georgian-Azerbaijan border to the Mengechevir reservoir (Azerbaijan); due to self-purification capacity of the Kura, the concentration of polluting substances decreases in this section by 30-55%.

Trends

The Ministry of Environment of Georgia assesses the Kura river's ecological and chemical status (from its source in Turkey until the border between Georgia and Azerbaijan) as moderate. There are no major improvements in water quality to be expected over the next years. Spring floods will continue causing damage in parts of the basin.

IORI RIVER

Georgia (upstream country) and Azerbaijan (downstream country) share the catchment area of the Iori River, a left-hand side (northern) tributary to the Kura, as follows:

Sub-basin of the Iori River[11]			
Area	**Country**	**Country's share**	
5,255 km^2	Georgia	4,645 km^2	88,4 %
	Azerbaijan	610 km^2	11,6 %

Source: Ministry of Environment Protection and Natural Resources of Georgia for the area in Georgia; Ministry of Ecology and Natural Resources of Azerbaijan for the area in Azerbaijan.

Hydrology

The Iori River takes off on the southern slope of the Main Caucasian Range at the height of 2600 m, flows from Georgia to Azerbaijan and falls into the Mingechevir reservoir. The river has a length of 320 km (313 km in Georgia and 7 km in Azerbaijan). In Georgia, the river system is made up of 509 smaller rivers with an overall length of 1,777 km. The density of river network is 0.38 km/km^2.

The hydrological regime of the river is characterized by spring floods, summer/autumn high waters and steady low-water levels in winter. The increase of water levels in the period of spring floods caused by melting of snow and rainfalls usually starts in March (in the second half of February in the lower reaches of the river) and reaches its maximum in May-June. The dropping of water levels continues till the end of July. The summer/autumn season floods, caused by intensive rainfalls, reoccur every year for 3-6 times a season with a duration of 2 to 10 days. By height, water levels often reach the maximums of spring

[10] These data are estimates, based on production figures and not on monitoring.
[11] Both countries gave a different size for the total area.

floods. In winter, variations of low-water levels do not exceed 0.1 m, and in some years the water level even stays on the same mark for 10-30 days.

In Georgia, there are three large irrigation reservoirs on the Iori River, the Sioni reservoir (325 million m³) used for irrigation, hydropower generation and water supply; the Tbilisi reservoir (308 million m³) used for irrigation and water supply; and the Dalimta reservoir (180 million m³) used for irrigation. The construction of the Sioni reservoir in the 1950's also served flow regulation.

Pressure factors
Diffuse pollution from agriculture (94,006 hectares are used for irrigated agriculture) and municipal wastewaters are the main anthropogenic pollution sources in Georgia. In Azerbaijan, 1,522 ha are used for irrigated agriculture.

Transboundary impact
On the territory of Georgia, the following substances were discharged in 2004 into the Iori River: surface active substances $5.85 \cdot 10^6$ kg, oil products 1,000 kg, BOD $111 \cdot 10^3$ kg and suspended solids 176 t. These data are calculated values, based on production figures. The Ministry of Environment of Georgia assesses the river's ecological and chemical status as "good".

Azerbaijan confirms that there is little human impact on the river. Downstream of the Georgian-Azerbaijan border, the maximum allowable concentration (MAC) for phenols and metals are exceeded by a factor of 2-3, the MAC values for oil products and sulphates are exceeded by a factor of two.

Trends
Georgia assesses that the river system's ecological and chemical status will remain in a good status.

ALAZANI RIVER

Georgia (upstream country) and Azerbaijan (downstream country) share the catchment area of the Alazani River. The total length of the river is 391 km (104 km in Georgia, 282 km common border between Georgia and Azerbaijan, 5 km in Azerbaijan).

Sub-basin of the Alazani River			
Area	**Country**	**Country's share**	
11,455 km²	Georgia	6,700 km²	58,5
	Azerbaijan	4,755 km²	41,5%

Source: Ministry of Environment Protection and Natural Resources of Georgia for the area in Georgia; Ministry of Ecology and Natural Resources of Azerbaijan for the area in Azerbaijan.

Hydrology
The Alazani River, the second largest river in Eastern Georgia, is formed at the junction of two mountain rivers, which flow from the southern slopes of the Main Caucasus Mountain Range. The river crosses an inter-mountainous depression, streams along the Georgian-Azerbaijan border and flows into Mingachevir reservoir in Azerbaijan. In Georgia, the river system is made up of 1,803 smaller rivers with an overall length of 6,851 km (1,701 rivers with a length below 10 km).

Spring floods caused by melting of seasonal snows and rainfalls usually starts in March in the upper reaches, and end of February in the lower reaches of the river. Typically, the maximum is achieved in May-June. Caused by rainfalls (from the beginning or middle of April), some sharp but usually low peaks are observed with a duration of 2 to 15 days. The dropping of floods continues till the end of July. At this time, usually 2-3 short rain peaks take place. The rainy days in summer/autumn reoccur typically 2-6 times per season with the duration of 2 to 20 days. They are especially intensive and prolonged in the lower reaches of the river. There, water levels often reach the maximum of spring floods, and in some years even surpass them.

The winter low-water level is nearly steady, the daily range of level fluctuations does not exceed 0.2 m, and in some winters, the same water level persists during 25-30 days.

In several winter seasons, sudden increase of level has occurred caused by rains and thaws.

Discharge characteristics at the Agrichai gauging station (Azerbaijan) latitude: 41° 16′; longitude: 46° 43′		
Q_{av}	110 m^3/s	1950–2006
Q_{max}	192 m^3/s	1950–2006
Q_{min}	69.5 m^3/s	1950–2006
$Q_{absolute\ max}$	742 m^3/s	27 August 1983
$Q_{absolute\ min}$	2.40 m^3/s	8 October 1988

Source: Ministry of Ecology and Natural Resources, Azerbaijan.

Pressure factors

Diffuse pollution from agriculture and viniculture as well as municipal wastewaters are the main anthropogenic pollution sources in Georgia.

Transboundary impact

On the territory of Georgia, the following substances were discharged from industries in 2004: oil products 2,000 kg, BOD 66·10^3 kg and suspended solids 216 t. These data are calculated values based on production figures. There are no data for agricultural and municipal pollution.

The Ministry of Environment of Georgia assesses the river's ecological and chemical status as "good".

Following measurements by Azerbaijan, the MAC values for phenols are exceeded 5-7 times, for metals 6-8 times, and for oil products 2-3 times.

Trends

Georgia assesses that the river system's ecological and chemical status will remain good.

DEBET RIVER

Armenia (upstream country) and Georgia (downstream country) share the catchment area of the Debet River, a right-hand side (southern) tributary to the Kura, as follows:

Sub-basin of the Debet River			
Area	**Country**	**Country's share**	
4,100 km^2	Armenia	3,790 km^2	92.4%
	Georgia	310 km^2	7.6%

Sources: Ministry of Environment Protection and Natural Resources of Georgia and L.A. Chilingarjan et al. "Geography of rivers and lakes in Armenia", Institute of hydro-technology and water problems, Armenia.

Hydrology

The Debet River rises at 2100 m above sea level and flows through a deep valley. From its total length of 176 km, 154 km are in Armenia. There are two reservoirs in the Armenian part of the catchment area, one on the river Dzoraget (0.27 million km^3), which is a (non-transboundary) tributary to the Debet, and the other on the river Tashir (5.4 million km^3), a non-transboundary tributary to the river Dzoraget. The lake percentage is 0.01%.

Discharge characteristics at gauging stations on the Debet River		
Discharge characteristics at the Sadaghlo gauging station at the Georgian-Armenian border		
Q_{av}	29.2 m³/s	1936–1990
Q_{max}	48.5 m³/s	1936–1990
Q_{min}	13.0 m³/s	…
$Q_{absolute\ max}$	479 m³/s	19 May 1959
$Q_{absolute\ min}$	1.56 m³/s	12 July 1961
Discharge characteristics at the Airum gauging station (Armenia) upstream of the border with Georgia		
Q_{av}	38.1 m³/s	Long-term average
Q_{max}	242 m³/s	Long-term average
$Q_{absolute\ max}$	759 m³/s	19 May 1959
Q_{min}	10.6 m³/s	For 95% of time

Source: L.A. Chilingaryan et al. "Geography of rivers and lakes in Armenia", Institute of hydro-technology and water problems, Armenia.

Pressure factors

In the Armenian part of the sub-basin, the Debet experiences background pollution from hydrochemical processes in ore deposits, which leads to increased concentrations of heavy metals (V, Mn, Cu, Fe). These concentrations already exceed in the upper parts of the sub-basin the maximum allowable concentration (MAC)[12] values for aquatic life.

Wastewater from the ore enrichment and processing industry, wastewater from municipal sources (some 110 human settlements in the Armenian part), and diffuse pollution from agriculture (51% of the Armenian agriculture uses water from the sub-basin of the Debet) are the main anthropogenic pollution sources.

Transboundary impact

In the period 2004–2006, the average mineral content at the border between Armenia and Georgia was 392 mg/l and the maximum value was 438 mg/l.

Trends

In Armenia, the closure of the Vanadzorsk chemical factory (1989) and the installations of closed water systems in the Alaverdinsk copper melting factory (2005) and in the Achtalinsk ore processing factory (2006) considerably decreased water pollution.

However, natural background pollution, leakages from a tailing dam that stores wastes from the Achtalinsk factory, and pollution from agriculture will remain as pollution problems. Spring floods will continue causing damage in the lower part of the basin.

Currently, the chemical and ecological status of the water system is not satisfactory for the maintenance of aquatic life, but meets the requirements for municipal, agricultural, industrial and other uses.

[12] In Armenia, water classification is based on MAC values for maintenance of aquatic life, which have been used in former Soviet Union, and which are more stringent than the MAC values for other uses.

AGSTEV RIVER

Armenia (upstream country) and Azerbaijan (downstream country) share the sub-basin of the Agstev River.

Sub-basin of the Agstev River			
Area	**Country**	**Country's share**	
2,500 km^2	Armenia	1,730 km^2	69.2%
	Georgia	770 km^2	30.8%

Sources: Ministry of Environment Protection and Natural Resources of Georgia and L.A. Chilingarjan et al. "Geography of rivers and lakes in Armenia", Institute of hydro-technology and water problems, Armenia.

The Agstev River has its source at 3,000 m above sea level. Its total length is 121 km; 81 km of which are in Armenia. The river has two main transboundary tributaries: the 58 km long Getik River (586 km^2) and the 58 km long Voskepar River (510 km^2).

Discharge characteristics of the Agstev River at the Idshevan gauging station (Armenia) upstream of the border with Azerbaijan		
Q_{av}	9.07 m^3/s	Long-term average
Q_{max}	75.3 m^3/s	Long-term average
$Q_{absolute\ max}$	177 m^3/s	29 August 1990
Q_{min}	1.78 m^3/s	During 95% of the year

Source: L.A. Chilingaryan et al. "Geography of rivers and lakes in Armenia", Institute of hydro-technology and water problems, Armenia.

Pressure factors

The main anthropogenic pollution of the river on Armenian territory stems from household and municipal wastewaters. The high concentration of heavy metals (Fe, Cu, Mn) is mainly due to natural background pollution, which was proved through measurements in the upstream stretches of the river.

Transboundary impact

Following Armenian data, the concentration of heavy metals exceeds the MAC value by a factor of 2–6. Sulphates did never exceed these norms. From 2005 onwards, the measurements of oil products ceased temporarily for technical reasons. In the long run, the phenol concentrations never exceeded the MAC norm. Water pollution, exceeded MAC values for drinking water, was not observed. Unfortunately there were no joint measurements with Azerbaijan at the border section, thus it is difficult to explain differences in measurements by both countries. Following information by Azerbaijan, the maximum allowable concentrations are exceeded for phenols by a factor of 9, for metals by a factor of 5–8, for oil products by a factor of 3–4, and for sulphates by a factor of 2. In the period 2004–2006, the average mineral content at the border was 559 mg/l and the maximum 600 mg/l. Currently, the ecological and chemical status is satisfactory for aquatic life as well as municipal, industrial and other uses.

POTSKHOVI RIVER

Turkey (upstream country) and Georgia (downstream country) share the catchment area of the Potskhovi River, a left-hand side tributary to the Kura.

Sub-basin of the Potskhovi River			
Area	**Country**	**Country's share**	
1,840 km²	Turkey	509 km²	27.7%
	Georgia	1,331 km²	72.3%

Source: Ministry of Environment Protection and Natural Resources of Georgia.

Hydrology

The Potskhovi River originates in Turkey on the southern slope of the Arsiani range 1.2 km east of the mountain Arsian-dag at a height of 2720 m. The length of the river is 64 km, from which 35 km are in Georgia. In the Georgian part of the catchment area, there are 521 rivers with a total length of 1,198 km. Floods mostly occur in the middle or end of March and reach their maximum in April, sometimes in May; the average increase of water levels is in the order of 0.8-1.2 m. There are altogether 11 lakes with a total area of 0.14 km².

Pressure factors, transboundary impact and trends

Above 2000 m, there are alpine meadows utilized as pastures and hayfields. Below, there are mixed forests. Further downhill, the land is used by agriculture. Georgia assesses that the river system's chemical status is moderate.

Discharge characteristics at the gauging station "Skhvilisi" in Georgia (10 km upstream of the river mouth): latitude: 41° 38′; longitude: 42° 56′		
Q_{av}	21.3 m³/s	1936-1990
Q_{av}	13.6 m³/s	During 97% of the year
Q_{max}	31.7 m³/s	1936-1990
Q_{min}	11.7 m³/s	1936-1990
$Q_{absolute\ max}$	581 m³/s	18 April 1968
$Q_{absolute\ min}$	1.0 m³/s	13 August 1955

KTSIA-KHRAMI RIVER

Armenia, Azerbaijan and Georgia share the catchment area of the Ktsia-Khrami River, a right-hand side tributary to the Kura.

Sub-basin of the Ktsia-Khrami River			
Area	**Country**	**Country's share**	
8,340 km²	Armenia	3,790 km²	45.4%
	Georgia	4,470 km²	53.5%
	Azerbaijan	80 km²	1.1%

Source: Ministry of Environment Protection and Natural Resources of Georgia.

Hydrology

The Ktsia-Khrami River takes off from a spring on the southern slope of the Trialeti range 2.4 km eastwards from the mountain Karakaya at the height of 2,422 m, falls into the river Kura from the right bank at 820 km above the river-head. The length of the river is 201 km. There are 2,234 rivers in the catchment area with a total length of 6,471 km.

The hydrological regime is characterized by one significant spring flood. In other periods of the year, the water level is mostly low occasionally disrupted by summer/autumn high waters.

Pressure factors, transboundary impact and trends

Pastures, meadows, forests and agriculture are the main form of land use. Given data from 1980-1993, NH_4, Cu and Zn exceeded the MAC. Georgia assesses that the river system's chemical status will remain in a moderate status.

Discharge characteristics at the transboundary gauging station "Red bridge": latitude: 41° 20′; longitude: 45° 06′

Q_{av}	51.7 m^3/s	1928-1990
Q_{av}	32.5 m^3/s	During 99% of the year
Q_{max}	90.1 m^3/s	1928-1990
Q_{min}	29.3 m^3/s	1928-1990
$Q_{absolute\ max}$	1,260 m^3/s	16 May 1966
$Q_{absolute\ min}$	3.95 m^3/s	26 February 1961

ARAKS RIVER

Hydrology

Armenia, Azerbaijan, the Islamic Republic of Iran and Turkey share the sub-basin of the Araks River with a total area of 102,000 km^2.

The 1,072 km long Araks has its source at 2,200–2,700 m above sea level. The Araks crosses the Armenian border twice: at 364 km and 746 km from its source. In Armenia, the river flows for 192 km and drains an area of 22,560 km^2.

Sub-basin of the Araks River and average discharge for the last 30 year

Country	Area		Discharge	
	In km^2	In %	In km^3	In %
All countries	102,000	100	9.37	100
Armenia	22,560	22	5.01	53.5
Turkey	19,500	19	2.46	26.2
The Islamic Republic of Iran	41,800	41	0.81	8.5
Azerbaijan	18,140	18	1.09	11.7

Source: L.A. Chilingaryan et al. "Geography of rivers and lakes in Armenia", Institute of hydro-technology and water problems, Armenia.

Pressure factors and transboundary impact

The Araks is of particular importance for Armenia, which is the reason for extensive measurements. Following Armenian data, the pollution originates from household waters and municipal wastewaters. The impact of natural hydrochemical processes, which are responsible for the increased concentration of heavy metals in the river water, has also been observed. The concentration of nitrite is 2–4 times above the MAC for aquatic life (MAC = 0.024 mg/l) and 3–6 times above the MAC for heavy metals; which is a general feature for Armenia. On the border between Turkey and Armenia, heavy metals exceed the MAC for aquatic life by a factor of 2–8. However, concentrations exceeding the MAC for drinking water and municipal uses have not been observed.

From 2005 onwards, the measurements of oil products ceased temporarily for technical reasons. In the long run, the phenol concentrations never exceeded the MAC norm; therefore, phenol measurements are not any more carried out.

At the Turkish-Armenian border, the average mineral content for the period 2004–2006 was 368 mg/l with a maximum at 678 mg/l. At the border between Armenia and the Islamic Republic of Iran, joint measurements of both countries showed an average mineral content of 673 mg/l with a maximum at 746 mg/l.

Currently, the ecological and chemical status is satisfactory for aquatic life, municipal and industrial uses, and other uses.

AKHURYAN RIVER

Armenia and Turkey share the sub-basin of the Akhuryan River, a tributary to the Araks.

Sub-basin of the Ahuryan River			
Area	Country	Country's share	
9,700 km²	Armenia	2,784 km²	28.7%
	Turkey	6,916 km²	71.3%

Source: L.A. Chilingarjan et al. "Geography of rivers and lakes in Armenia", Institute of hydro-technology and water problems, Armenia.

Hydrology

The 186 km long river has its source at 2,017 m above sea level; its most important tributary in Armenia is the Karkachun River. There are two reservoirs on the Akhuryan River, the Arpilich reservoir close to the river's source and the Achurnsk reservoir in the middle stretch.

Pressure factors and transboundary impact

Main pressure factors arise from municipal sources and agriculture as well as natural chemical processes.

According to Armenian measurements in the lower part of the sub-basin, the concentration of nitrites exceeds the MAC norms by a factor of 2–6; the concentration of heavy metals is 3–8 times higher than the corresponding MAC. For copper, the concentration exceeds the MAC value for aquatic life (0.001 mg/l) by a factor of 10–18 in the upper part and by a factor of 5–12 in the lower part. However, concentrations exceeding the MAC for drinking water and municipal uses have not been observed.

From 2005 onwards, the measurements of oil products ceased temporarily for technical reasons. In the long run, the phenol concentrations never exceeded the MAC norm; therefore, phenol measurements are not any more carried out.

The average mineral content at the border is 223 mg/l with a maximum at 285 mg/l (period 2004–2006).

Currently, the ecological and chemical status is "satisfactory".

ARPA RIVER

Armenia and Azerbaijan share the sub-basin of the Arpa River, a tributary to the Araks.

Sub-basin of the Arpa River			
Area	Country	Country's share	
2,630 km²	Armenia	2,080 km²	79%
	Azerbaijan	550 km²	21%

Source: L.A. Chilingarjan et al. "Geography of rivers and lakes in Armenia", Institute of hydro-technology and water problems, Armenia.

Hydrology

The total length of the river is 128 km of which 92 km are in Armenia. In the Armenian part, three rivers join the Arpa: the Elegis (47 km long; 526 km^2), the Gerger (28 km; 174 km^2) and the Darb (22 km; 164 km^2).

Discharge characteristics of the Arpa River at the Areni gauging station (Armenia) upstream of the border with Azerbaijan		
Q_{av}	23.2 m^3/s	Long-term average
Q_{max}	146 m^3/s	Long-term average
$Q_{absolute\ max}$	280 m^3/s	12 May 1960
Q_{min}	4.36 m^3/s	During 95% of the year

Source: L.A. Chilingaryan et al. "Geography of rivers and lakes in Armenia", Institute of hydro-technology and water problems, Armenia.

Pressure factors and transboundary impact

The river is very clean. There is almost no human impact; however, natural hydrochemical processes influence the quality of the river's water.

From source to mouth, the concentration of V and Cu is 2–3 times higher than the MAC norms for aquatic life, which is typical for Armenian rivers. The MAC values for other uses are not being exceeded.

The average mineral content on the border is 315 mg/l with a maximum of 439 mg/l (period 2004–2006).

Currently, the ecological and chemical status is "normal and close to natural conditions".

VOROTAN (BARGUSHAD) RIVER

Armenia and Azerbaijan share the sub-basin of the Vorotan River, a tributary to the Araks.

Sub-basin of the Vorotan River			
Area	**Country**	**Country's share**	
5,650 km^2	Armenia	2,030 km^2	36%
	Azerbaijan	3,620 km^2	64%

Source: L.A. Chilingarjan et al. "Geography of rivers and lakes in Armenia", Institute of hydro-technology and water problems, Armenia.

Hydrology

The total length of the river is 178 km. In the Armenian part, two rivers join the Vorotan: the Sisian (33 km long; 395 km^2) and the Gorisget (25 km; 146 km^2).

Discharge characteristics of the Vorotan River at the Vorotan gauging station (Armenia) upstream of the border with Azerbaijan		
Q_{av}	21.8 m^3/s	Long-term average
Q_{max}	101 m^3/s	Long-term average
$Q_{absolute\ max}$	1,140 m^3/s	18 April 1959
Q_{min}	2.82 m^3/s	During 95% of the year

Source: L.A. Chilingaryan et al. "Geography of rivers and lakes in Armenia", Institute of hydro-technology and water problems, Armenia.

Pressure factors and transboundary impact

There is almost no human impact on the river. Natural hydrochemical processes cause an increase of the vanadium concentration.

Given Armenian measurements, an increase in nitrites' concentration (MAC for aquatic life exceeded by a factor of 2) and vanadium concentration (MAC for aquatic life exceeded by a factor of 6, which signals background pollution) appears in the central part of the river's sub-basin. On the border, no measurements of nitrites were carried out. Except for aquatic life, the MAC values for other uses are not exceeded.

The average mineral content at the border is 199 mg/l with a maximum of 260 mg/l (period 2004–2006).

Currently, the ecological and chemical status is "normal and close to natural conditions".

VOGHJI RIVER

Armenia and Azerbaijan share the sub-basin of the Voghji River, a tributary to the Araks.

Sub-basin of the Voghji River			
Area	**Country**	**Country's share**	
1,175 km^2	Armenia	788 km^2	67%
	Azerbaijan	387 km^2	33%

Source: L.A. Chilingarjan et al. "Geography of rivers and lakes in Armenia", Institute of hydro-technology and water problems, Armenia.

Hydrology

Of the river's total length of 82 km, 43 km are in Armenia.
The Gechi is the most important tributary.

Discharge characteristics of the Voghji River at the Kapan gauging station (Armenia) upstream of the border with Azerbaijan		
Q_{av}	11.6 m^3/s	Long-term average
Q_{max}	68.1 m^3/s	Long-term average
$Q_{absolute\ max}$	118 m^3/s	20 May 1976
Q_{min}	2.72 m^3/s	During 95% of the year

Source: L.A. Chilingaryan et al. "Geography of rivers and lakes in Armenia", Institute of hydro-technology and water problems, Armenia.

Pressure factors and transboundary impact

Industrial activities are the main pressure factor. Natural hydrochemical processes in the areas of ore deposits also affect water quality.

According to Armenian data, the concentration of nitrites in the lower area of the sub-basin exceeds the MAC for aquatic life by a factor of 2. The MAC values for metals (Cu, Zn, Mn, Cr, V) are also exceeded, caused by hydrochemical processes in the sub-basin and, partly, by human activity.

In the period 2004–2006, the average mineral content was 296 mg/l with a maximum of 456 mg/l.

Currently, the ecological and chemical status of the river system is "not satisfactory for aquatic life", but appropriate for other uses.

LAKE JANDARI

Lake Jandari covers an area of 12.5 km^2, and the lake basin's area is 102 km^2. Some 67% of the basin is located on Georgian territory and 33% in Azerbaijan. Water comes mainly through the Gardaban water canal from the Kura River. The maximum capacity of the canal is 15 m^3/s.

Pollution originates from various anthropogenic sources. Wastes from industry, residential areas and agriculture pollute water coming into the reservoir from the Kura River. The total population in the lake basin is 14,000–15,000 (some 140–150 inhabitants/km^2). The lake is used for fishing.

In the nineteenth century, the shallow and salty lake often dried out during the summer. Later, in order to provide water for irrigation, an additional water supply canal (the Gardaban canal) was constructed. As a result, the lake was filled and turned into a water reservoir. Another canal, which starts from the Tbilisi (Samgori) water reservoir, also feeds Lake Jandari.

Lake Jandari does not currently have a good ecological or chemical status. Increased pollution from the Kura River and from reservoirs is increasing levels of pollution in the lake. Moreover, expansion of irrigated land in both countries and uncoordinated use of water by various users are decreasing the water level.

SAMUR RIVER BASIN[13]

The basin of the Samur River is shared by the Russian Federation and Azerbaijan, as indicated in the following table.

Basin of the Samur River			
Area*	**Country**	**Country's share**	
7,330 km^2	Azerbaijan	340 km^2	4.6%
	Russian Federation	6,990 km^2	95.4%

Source: Federal Agency for Water Resources (Russian Federation).
* Including the tributary Giolgerykhay.

Hydrology

The river rises in Dagestan (Russian Federation). The common border on the river between the Russian Federation and Azerbaijan is 38 km long. Before flowing into the Caspian Sea, the river divides into several branches, located both in Azerbaijan and the Russian Federation. 96% of the river flow originates on Russian territory.

Pressure factors

Use of the water for irrigation (currently some 90,000 ha in Azerbaijan and 62,000 ha in the Russian Federation)[14] and to supply drinking water to the cities of Baku and Sumgait in Azerbaijan (up to 400 million m^3/a) and settlements in Dagestan (Russian Federation) has led to pressure on water resources.

Transboundary impact

The Russian Federation carries out monitoring close to the mouth of the river.

Average pollution level near to the mouth of the Samur River (Russian Federation)	
Determinands	**Measured concentration, compared to MAC**
BOD_5	0.7–1.7 times MAC
Ammonia	0.4 times MAC
Nitrites	0.6 times MAC
Iron	0.4–3.0 times MAC

[13] Ministry of Ecology and Natural Resources, Azerbaijan and the Federal Water Agency, Russian Federation.
[14] The countries' irrigation inventory indicates 210,000 ha for Azerbaijan and 155,700 ha for the Russian Federation.

Average pollution level near to the mouth of the Samur River (Russian Federation)	
Sulphates	0.4–4.5 times MAC
Copper	0.5–1.2 times MAC
Manganese	Up to 5 times MAC
Oil products	0.2–3.2 times MAC
Phenols	0.03 times MAC

Source: Federal Agency for Water Resources (Russian Federation).

Thus, the river is classified as "moderately polluted".

The total water demand of both countries considerably exceeds the available resources. For six month, there is almost no water flow downstream the hydrotechnical installation at Samursk. The considerable decrease of water flow from source to mouth and the absence of any flow downstream Samursk has caused a drop in the groundwater table, which also has ecological and other consequences for the relic forest in the Samur Valley and nature conservation areas in the delta.

Trends

Over a period of time, pollution problems and adverse impact of overuse will remain. The drawing up of a bilateral agreement is of utmost importance in order to ensure that the transboundary waters of the Samur are used in a reasonable and equitable way and to guarantee the ecological minimum flow in the delta region.

SULAK RIVER BASIN[15]

The basin of the Sulak River is shared by Georgia and the Russian Federation. The total basin area, including all tributaries, is 15,200 km².

Hydrology

The confluence of the Avarsk-Koisu (Russian Federation; 7,660 km²) and Andis-Koisu (transboundary river shared by Georgia and the Russian Federation; 4,810 km²) rivers is taken as the source of the Sulak. The Sulak River itself flows entirely in the Russian Federation.

Sub-basin of the Andis-Koisu River			
Area	**Country**	**Country's share**	
4,810 km²	Georgia	869 km²	18%
	Russian Federation	3,941 km²	82%

Source: Ministry of Environment Protection and Natural Resources (Georgia) and Federal Agency for Water Resources (Russian Federation).

Pressure factors and transboundary impact in the sub-basin of the Andis-Koisu River

Irrigation and human settlements constitute the main pressure factors. The transboundary impact is insignificant. The transboundary Andis-Koisu River is in a good ecological and chemical status.

Trends

There are no pressure factors, which would significantly affect this good status in the near future. However, there are plans to construct a number of hydropower stations in the Russian part of the sub-basin.

[15] Based on information provided by the Ministry of Environment Protection and Natural Resources, Georgia and the Federal Water Agency, Russian Federation.

Measurements at Agvali (Russian Federation, 75 km upstream of the confluence with the Sulak)	
Determinands	**Measured concentration, compared to MAC**
BOD_5	0.9 times MAC
Iron	0.5–2.1 times MAC
Nitrites	0.8–4.6 times MAC
Ammonia	0.2–0.6 times MAC
Oil products	0.2–0.6 times MAC
Mineral content	Does not exceed 300 mg/l

Source: Federal Agency for Water Resources (Russian Federation).

TEREK RIVER BASIN[16]

Georgia (upstream country) and the Russian Federation (downstream country) share the basin of the Terek River. The river is a key natural asset in the Caucasus region.

Basin of the Terek River			
Area	**Country**	**Country's share**	
43,200 km²	Georgia	869 km²	18%
	Russian Federation	3,941 km²	82%

Source: Ministry of Environment Protection and Natural Resources (Georgia) and Federal Agency for Water Resources (Russian Federation).

Discharge characteristics at the Kazbeki gauging station (Georgia): latitude: 44° 38′ 24″; longitude: 42° 39′ 32″		
Q_{av}	24.1 m³/s	1928–1990
Q_{max}	30.4 m³/s	1928–1990
Q_{min}	18.6 m³/s	1928–1990
$Q_{absolute\ max}$	481 m³/s	6 August 1967
$Q_{absolute\ min}$	1.0 m³/s	27 February 1938

Source: Ministry of Environment Protection and Natural Resources of Georgia.

Hydrology

The Terek rises in Georgia on the slopes of Mount Kazbek. After some 61 km, the river crosses the Georgian-Russian border and flows through North Ossetia/Alania, Kabardino-Balkaria, the Stavropol Kraj, Chechnya and Dagestan (Russian Federation).

The river is 623 km long. Usually, inventories quote 43,200 km² as the size of the hydrographic basin. However, the area which is directly and indirectly influenced by the Terek's water management is larger and counts for 90,000 km².

The water resources of the Terek (in the hydrographic basin) are 11.0 km³/a in an average year, 10.1 km³/a in an average dry year and 9.0 km³/a in a dry year (figures for the Stepnoye station). The period of high water levels in spring-summer is very long (end of March to September), which is characteristic for rivers fed by glaciers and rainwater.

Spring floods cause damage, particularly in the Russian part of the basin.

Pressure factors

Irrigational water use and human settlements are the main pressure factors in the Georgian part of the basin. In the Russian part of the basin, pressure arises from irrigation (>700,000 ha), industry, aquaculture/fisheries and human settlements.

[16] Based on information provided by the Ministry of Environment Protection and Natural Resources, Georgia and the Federal Water Agency, Russian Federation.

Transboundary impact

Based on Georgian estimates, 17·10³ kg BOD and 41 t suspended solids were discharged in 2004 into the Georgian part of the basin. Measurements are carried out by the Russian Federation downstream the border (see table below).

Trends

At the border, the river has a good ecological and chemical status. High metal concentrations, exceeding the MAC values, are of natural origin. There are no real threats, which would decrease the status of the river in the near future.

Measurements upstream of the village Lars (Russian Federation, 1 km downstream the border with Georgia, 560 km upstream of mouth)	
Determinands	**Measured concentration, compared to MAC**
BOD_5	0.9 times MAC
Iron	3.2 times MAC
Aluminium	8.9
Manganese	1.8
Copper	Up to 2
Oil products	0.22–0.84 times MAC

Source: Federal Agency for Water Resources (Russian Federation).

MALYI UZEN RIVER BASIN[17]

The Russian Federation (upstream country) and Kazakhstan (downstream country) share the basin of the Malyi Uzen River.

Basin of the Malyi Uzen River			
Area	**Country**	**Country's share**	
13,200 km²	Russian Federation	5,980 km²	45.3%
	Kazakhstan	7,220 km²	54.7%

Source: ТОО «Уралводпроект» «Водохозяйственный баланс бассейнов рек Малый и Большой Узены», заказ № 02.044, Книга 1 (Water management balance of the Malyi and Bolshoy Uzen River basins, TOO Uralvodproject).

Hydrology

The river's source is the Syrt chain of hills (Saratov Oblast, Russian Federation). It discharges into Lake Sorajdyn, which belongs to the Kamysh-Samarsk lakes (Kazakhstan). The river's total length is 638 km (374 km in the Russian Federation, 264 km in Kazakhstan). The mean annual discharge at the Malyi Uzen station is 8.54 m³/s. The population density is 28.4 persons/km².

Pressure factors and transboundary impact

The main pressure on water resources comes from irrigated agriculture. Downstream the border between the Russian Federation and Kazakhstan, irrigated agriculture is the main form of land use. The share of land that requires irrigation strongly depends on the actual river's water availability (depending on hydrometeorological conditions) and varies between 1,961 ha in wet years and 45,979 ha in dry years. The biggest reservoirs on the Russian side are the Upper Perekopnovsk (65.4 million m³), Molouzensk (18.0 million m³) and Varfolomejevsk (26.5 million m³) reservoirs and several artificial lakes (87.33 million m³). Reservoirs in Kazakhstan include: the Kaztalovsk-I (7.20 million m³), the Kaztalovsk-II (3.55 million m³) and the Mamajevsk (3.50 million m³) reservoirs and several artificial lakes (4.83 million m³).

Most recently (2005), water construction works to increase water protection in the basin were carried out in the Russian part of the basin.

Water quality problems are also caused by wastewater discharges, surface run-off from the basin's surface area, sediments and erosion of riverbanks. A significant problem is that economic and other activities in water protection zones next to the water bodies do not respect established environmental standards. Reconstruction works (buildings, installations, communications and other works), which are not approved by the relevant water authorities, have a

[17] Based on information provided by the Ministry of Environment Protection, Kazakhstan and the Federal Water Agency, Russian Federation.

negative effect on surface water quality, and consequently on the drinking water supplied to local populations.

According to the 2005 measurements in the Russian part of the basin, water quality falls into class 3, which means "moderately polluted". It is worth mentioning that both countries have agreed on a schedule for joint sampling of water at the border of the river.

Average water quality characteristics of the Malyi Uzen River in the Russian part of the basin	
Determinands	**Mean values**
Dissolved oxygen	12.24 mg/l
Oxygen saturation	101%
Nitrates	0.194 mg/l
Nitrites	0.033 mg/l
Ammonia	0.25 mg/l
Chlorides	131.8 mg/l
Phosphates	0.236 mg/l
Chromium	0.003 mg/l
Iron	0.18 mg/l
Zinc	0.002 mg/l
COD	30.3 mg/l
Suspended solids	43.0 mg/l
Sulphates	20.0 mg/l
Calcium	56.5 mg/l

Source: Federal Agency for Water Resources (Russian Federation).

Water quality and water quantity at the border between the two countries respect the Agreement between the Russian Federation and Kazakhstan on the joint use and protection of transboundary waters (27 August 1992). Water transfer, including transfer from the Volga basin, is subject to annual agreements between both countries. A minimum of 17.1 million m^3 shall pass the Russian-Kazakhstan border; this amount was increased in 2006 at the request of Kazakhstan (to 19.2 million m^3) following very dry weather conditions and low water flow in the river.

Taking into account that water resources in the Russian part of the basin are mainly used for agricultural purposes and that the population density is relatively small, the status of the watercourses is assessed as "stable".

BOLSHOY UZEN RIVER BASIN[18]

The Russian Federation (upstream country) and Kazakhstan (downstream country) share the basin of the Bolshoy Uzen River.

Basin of the Bolshoy Uzen River			
Area	**Country**	**Country's share**	
14,300 km²	Russian Federation	9,660 km²	67.6%
	Kazakhstan	4,640 km²	32.4%

Source: ТОО «Уралводпроект» «Водохозяйственный баланс бассейнов рек Малый и Большой Узены», заказ № 02.044, Книга 1 (Water management balance of the Malyi and Bolshoy Uzen River basins, TOO Uralvodproject).

Hydrology

The river's source is the Syrt chain of hills (Saratov Oblast, Russian Federation). It discharges into Lake Ajden, which belongs to the Kamysh-Samarsk lakes (Kazakhstan).

[18] Based on information provided by the Ministry of Environment Protection and Natural Resources, Georgia and the Federal Water Agency, Russian Federation.

The river's total length is 650 km (397 km in the Russian Federation, 253 km in Kazakhstan). The mean annual discharge at the Novouzensk station is 11.1 m^3/s.

The population density is 27.9 persons/km^2.

Pressure factors and transboundary impact

The main pressure on water resources comes from irrigated agriculture. Downstream from the border between the Russian Federation and Kazakhstan, irrigated agriculture is the main form of land use. The share of land requiring irrigation depends greatly on the actual hydrometeorological conditions and varies between 1,200 ha in wet years and 27,000 ha in dry years.

The biggest reservoirs on the Russian side are the Nepokojevsk (48.75 million m^3) and Orlovogajsk (5.4 million m^3) reservoirs and several artificial lakes (183.67 million m^3). Three reservoirs are in Kazakhstan: the Sarychganaksk (46.85 million m^3), the Ajdarchansk (52.3 million m^3) and the Rybnyj Sakryl (97 million m^3) reservoirs.

Most recently (2005), water construction works to increase water protection in the basin were carried out in the Russian part of the basin, following decisions of the joint Russian-Kazakhstan Commission for the joint use and protection of transboundary waters.

Water quality problems are also caused by wastewater discharges, surface run-off from the basin's surface area, sediments and erosion of riverbanks. A significant problem is that economic and other activities in water protection zones next to the water bodies do not respect general environmental standards. Reconstruction works (buildings, installations, communications and other works), which are not approved by the relevant water authorities, have a negative effect on surface water quality, and consequently on the drinking water supplied to local populations.

According to the 2005 measurements in the Russian part of the basin, water quality falls into class 3, which means "moderately polluted". It is worth mentioning that both countries have agreed on a schedule for joint sampling of water at the border of the river.

Average water quality characteristics of the Bolshoy Uzen River in the Russian part of the basin

Determinands	Mean values
Dissolved oxygen	10.34 mg/l
Oxygen saturation	83%
Nitrates	0.161 mg/l
Nitrites	0.02 mg/l
Ammonia	0.32 mg/l
Chlorides	369.9 mg/l
Phosphates	0.195 mg/l
Chromium	0.001 mg/l
Iron	0.33 mg/l
COD	39.7 mg/l
Suspended solids	38.0 mg/l
Sulphates	30.3 mg/l
Calcium	84.6 mg/l

Source: Federal Agency for Water Resources (Russian Federation).

Water quality and water quantity at the border between both countries respects the Agreement between the Russian Federation and Kazakhstan on the joint use and protection of transboundary waters (27 August 1992). Water transfer, including transfer from the Volga basin, is subject to annual agreements between both countries. At minimum 17.1 million m^3 shall pass the Russian-Kazakhstan border.

Taking into account that water resources in the Russian part of the basin are mainly used for agricultural purposes and that the population density is relatively small, the status of the watercourses are assessed as "stable".

DRAINAGE BASIN OF THE BLACK SEA

This chapter deals with major transboundary rivers discharging into the Black Sea and some of their transboundary tributaries. It also includes lakes located within the basin of the Black Sea.

TRANSBOUNDARY WATERS IN THE BASIN OF THE BLACK SEA[1]

Basin/sub-basin(s)	Total area (km²)	Recipient	Riparian countries	Lakes in the basin
Rezvaya	740	Black Sea	BG, TR	…
Danube	801,463	Black Sea	AL, AT, BA, BG, CH, CZ, DE, HU, HR, MD, ME, MK, IT, PL, RO, RS, SK, SI, UA	Lake Iron Gates I and II, Lake Neusiedl
- *Lech*	*4,125*	*Danube*	*AT, DE*	…
- *Inn*	*26,130*	*Danube*	*AT, CH, DE, IT*	…
- *Morava*	*26, 578*	*Danube*	*AT, CZ, PL, SK*	…
- *Raab/Raba*	*10,113*	*Danube*	*AU, HU*	…
- *Vah*	*19,661*	*Danube*	*PL, SK*	…
- Ipel/Ipoly	5,151	Danube	HU, SK	…
- *Drava and Mura*	*41,238*	*Danube*	*AT, HU, HR, IT, SI*	…
- Tisza	157,186	Danube	HU, RO, RS, SK, UA	…
- Somes/Szamos	16,046	Tisza	HU, RO	…
- Mures/Maros	30,195	Tisza	HU, RO	…
- Sava	95,713	Danube	AL, BA, HR, ME, RS, SI	…
- Velika Morava	37,444	Danube	BG, ME, MK, RS	…
- Timok	4,630	Danube	BG, RS	…
- Siret	47,610	Danube	RO, UA	…
- Prut	27,820	Danube	MD, RO, UA	Stanca-Costesti Reservoir
Kahul	…	Lake Kahul	MD, UA	*Lake Kahul*
Yalpuh	…	Lake Yalpuh	MD, UA	*Lake Yalpuh*
Cogilnik	6,100	Black Sea	MD, UA	…
Dniester	72,100	Black Sea	UA, MD	…
- *Yahorlyk*	…	*Dniester*	*UA, MD*	…
- Kuchurhan	…	Dniester	UA, MD	…
Dnieper	504,000	Black Sea	BY, RU, UA	…
- Pripyat	114,300	Dnieper	BY, UA	…

Elancik	*900*	*Black Sea*	*RU, UA*	…
Mius	*6,680*	*Black Sea*	*RU, UA*	…
Don	422,000	Black Sea	RU, UA	…
- Siversky Donets	98,900	Don	RU, UA	…
Psou	421	Black Sea	RU, GE	…
Chorokhi/Coruh	22,100	Black Sea	GE, TR	…
- Machakhelisckali	369	Chorokhi/Coruh	GE, TR	…

[1] The assessment of water bodies in italics was not included in the present publication.

REZVAYA RIVER BASIN[1]

The basin of the Rezvaya River, also known as Rezovska, is shared by Bulgaria and Greece. The basin covers an area of approximately 740 km². The river with a total length of 112 km springs from the Turkish part of the Strandja Mountain, where it is known under the name Passpalderessi. For almost its entire length, it forms the border between Bulgaria and Turkey. The river runs into the Black Sea near the village of Rezovo, district of Bourgas (Bulgaria).

The upper part of the river is in "natural conditions" and most of its downstream parts are in a "good ecological and chemical status".

DANUBE RIVER BASIN

Following provisions of the Water Framework Directive, watercourses in the Danube River basin, watercourses in the Romanian Black Sea river basins as well as Romanian-Ukrainian Black Sea coastal waters have been combined in the Danube River Basin District (RBD)[2]. The transboundary rivers and lakes included in this chapter belong to the Danube RBD, although hydrologist regard some of them as separate first-order rivers discharging directly into a final recipient of water.

[1] Based on information by the Ministry of Environment and Water, Bulgaria.
[2] Following the Water Framework Directive, a River Basin District means the area of land and sea, made up of one or more neighboring river basins together with their associated groundwaters and coastal waters, which is identified under Article 3 (1) as the main unit for management of river basins.

DANUBE RIVER [3]

Nineteen countries (Albania, Austria, Bosnia and Herzegovina, Bulgaria, Croatia, the Czech Republic, Germany, Hungary, Italy, Moldova, Montenegro, Poland, Romania, Serbia, Slovakia, Slovenia, Switzerland, The former Yugoslav Republic of Macedonia and Ukraine) share the basin of the Danube River, with a total area of 801,463 km^2.

Due to its geologic and geographic conditions, the Danube River basin is divided into three main parts:

- The *Upper Danube* that covers the area from the Black Forest Mountains to the Gate of Devín (east of Vienna), where the foothills of the Alps, the Small Carpathians and the Leitha Mountains meet;
- The *Middle Danube* that covers a large area reaching from the Gate of Devín to the impressive gorge of the Danube at the Iron Gate, which divides the Southern Carpathian Mountains to the north and the Balkan Mountains to the south;
- The *Lower Danube* that covers the Romanian-Bulgarian Danube sub-basin downstream of the Cazane Gorge and the sub-basins of the rivers Siret and Prut.

Basin of the Danube River			
Area	Country	Country's share	
801,463 km^2	Albania	126 km^2	<0.1 %
	Austria	80,423 km^2	10.0 %
	Bosnia and Herzegovina	36,636 km^2	4.6 %
	Bulgaria	47,413 km^2	5.9 %
	Croatia	34,965 km^2	4.4 %
	Czech Republic	21,688 km^2	2.9 %
	Germany	56,184 km^2	7.0 %
	Hungary	93,030 km^2	11.6 %
	Italy	565 km^2	<0.1 %
	Moldova	12,834 km^2	1.6 %
	Poland	430 km^2	<0.1 %
	Romania	232,193 km^2	29.0 %
	Serbia and Montenegro*	88,635 km^2	11.1 %
	Slovakia	47,084 km^2	5.9 %
	Slovenia	16,422 km^2	2.0 %
	Switzerland	1,809 km^2	0.2 %
	The former Yugoslav Republic of Macedonia	109 km^2	<0.1 %
	Ukraine	30,520 km^2	3.8 %

Source: The Danube River Basin District - River basin characteristics, impact of human activities and economic analysis required under Article 5, Annex II and Annex III, and inventory of protected areas required under Article 6, Annex IV of the Water Framework Directive (2000/60/EC), Part A – Basin-wide overview. International Commission for the Protection of the Danube River, Vienna, 18 March 2005. This publication is hereinafter referred to with its short title: "Danube Basin Analysis (WFD Roof Report 2004)".
* At the date of publication of the Danube Basin Analysis (WFD Roof Report 2004), Serbia and Montenegro still belonged to the same State.

[3] If not otherwise specified, information on the Danube River and its major tributaries, as well as the Danube delta, is based on information submitted by the International Commission for the Protection of the Danube River.

Hydrology

The confluence of two small rivers – the Brigach and the Breg – at Donaueschingen (Germany) is considered to be the beginning of the Danube. The river flows south-eastward for a distance of some 2,780 km before it empties into the Black Sea via the Danube delta in Romania.

The long-term average discharge of the Danube River is about 6,550 m^3/s (207 km^3/a).[4] The annual discharge in dry years is 4,600 m^3/s (95 % probability, one-in-20 dry years) and in wet years 8,820 m^3/s (5 % probability, one-in-20 wet years).[5]

Approximate distribution of Danube River basin runoff by country/group of countries

Country/group of countries	Annual volume of runoff (km^3/a)	Mean annual runoff (m^3/s)	Share of Danube water resources (%)	Ratio of outflow minus inflow ÷ outflow (%)
Austria	48.44	1,536	22.34	63.77
Bulgaria	7.32	232	3.99	7.35
Czech Republic	3.43	110	1.93	n.a.
Germany	25.26	801	11.65	90.71
Hungary	5.58	176	2.57	4.97
Romania	37.16	1,177	17.00	17.35
Slovakia	12.91	407	7.21	23.0
Bosnia and Herzegovina, Croatia and Slovenia	40.16	1,274	16.84	n.a.
Moldova and Ukraine	10.41	330	4.78	9.52
Montenegro and Serbia	23.5	746	10.70	13.19
Switzerland	1.40	44	0.64	86.67
Italy	0.54	17	0.25	100.00
Poland	0.10	3	0.04	100.00
Albania	0.13	4	0.06	100.00
Total	216.34	6,857	100.00	

Source: Danube Pollution Reduction Programme - Transboundary Analysis Report. International Commission for the Protection of the Danube River, June 1999.

Extremely high floods have hit certain areas of the Danube River basin in recent years. Floods in the Morava and Tisza sub-basins and in the Danube River itself have had severe impact on property and human health and safety. Changes in morphological characteristics and in river dynamics can also take place during large floods. After severe floods, dikes need to be reconstructed, which is often costly. The damage inflicted by large floods may influence the way flood-endangered areas are used.

Pressure factors

The activities of over 81 million people living in the Danube River basin greatly affect the natural environment of the basin, causing pressures on water quality, water quantity and biodiversity.

The most significant pressures fall into the following categories: organic pollution, nutrient pollution, pollution by hazardous substances, and hydromorphological alterations.

[4] Danube Basin Analysis (WFD Roof Report 2004).
[5] Danube Pollution Reduction Programme – Transboundary Analysis Report. International Commission for the Protection of the Danube River, June 1999

Significant point sources of pollution in the Danube River Basin District[6]													
Item	Countries along the main watercourse and tributaries*												
	DE	AT	CZ	SK	HU	SI	HR	BA	CS*	BG	RO	MD	UA
Municipal point sources: Wastewater treatment plants	2	5	1	9	11	3	10	3	4	6	45	0	1
Municipal point sources: Untreated wastewater	0	0	0	2	1	3	16	15	14	31	14	0	0
Industrial point sources	5	10	10	6	24	2	10	5	14	4	49	0	5
Agricultural point sources	0	0	0	0	0	1	0	0	0	0	17	0	0
Total	**7**	**15**	**11**	**17**	**36**	**9**	**36**	**23**	**32**	**41**	**125**	**0**	**6**

* CS was the ISO country code assigned to Serbia and Montenegro until its split in 2006.
Source: Danube Basin Analysis (WFD Roof Report 2004).

Insufficient treatment of wastewater from major municipalities is a significant cause of organic pollution. In parts of the Middle and Lower Danube, wastewater treatment plants are missing or the treatment is insufficient. Therefore, the building of wastewater treatment plants is a prime focus of the programme of measures which needs to be developed under the Water Framework Directive's river basin management plan by the end of 2009. Organic pollution (expressed as BOD_5 and COD_{Cr}) reaches its maximum-between Danube-Dunafoldvar (river kilometre 1,560 below Budapest) and Danube-Pristol/Novo Selo (river kilometre 834, just below the border of Serbia and Bulgaria). The most polluted tributaries from the point of view of degradable organic matter are the rivers Russenski Lom, Sio and Siret.[7] COD_{Cr}, ammonium-nitrogen and ortho-phosphate phosphorus reach the highest values in the Lower Danube.

[6] The Danube River Basin District with an area of 807,827 km² includes the basin of the Danube River (801,463 km²), Romanian Black Sea river basins (5,122 km²) and Romanian-Ukrainian Black Sea coastal waters (1,242 km²).
[7] Following more recent information by Romania, the Siret River (RO 10 – confluence Danube Sendreni, year 2005) was in class 2 for dissolved oxygen and BOD_5 and only for COD_{Cr}, in class 4.

The chemical, food, and pulp and paper industries are prominent industrial polluters, and wastewaters from these plants raise the levels of nutrients, heavy metals and organic micro-pollutants in the river network. Pollution loads of hazardous substances can be significant, although the International Commission for the Protection of the Danube River has not yet evaluated the full extent. Currently, there is little data available for such hazardous substances as heavy metals and pesticides.

Cadmium and lead can be considered as the most serious inorganic microcontaminants in the Danube River basin. Especially critical is cadmium, for which the target value under the TNMN [8, 9] is substantially exceeded in many locations downstream of river kilometre 1,071 (values are in many cases 2-10 times higher than the target value). The pollution of the Lower Danube by cadmium and lead can be regarded as a significant problem.

Agriculture has long been a major source of income for many people, and it has also been a source of pollution by fertilizers and pesticides. Many tributaries, such as the rivers Prut, Arges, Russenski Lom, Iskar, Jantra, Sio and Dyje, are considered as rather polluted by nitrogen compounds. Most of these are in the lower part of the Danube.

There are indications that the Middle Danube (from river kilometre 1,600 to 1,200) may be sensitive to eutrophication. Other sections of the Danube and its tributaries are apparently flowing too fast, and are too deep or too turbid to develop eutrophication problems. Like many large rivers, the impact of the high transboundary river nutrient loads in the Danube river basin is the most critical in the receiving coastal waters of the Black Sea; however, pressures from the coastal river basins directly affecting the coastal waters of the Danube RBD also need to be considered.

A substance of special concern in the lower Danube is p,p'-DDT. Here, the very low target values of the TNMN are often exceeded in the order of two magnitudes. This means that, despite a high analytical uncertainty, the level of p,p'-DDT is significant and gives a strong indication of potential risk of failure to reach the good status. For lindane, the results of the TNMN classification are not so alarming.[10] Some tributaries (the Sió, the Sajó and the Sava) show random occurrence of high concentrations of atrazine.

Transboundary impact

In the Danube basin, there are areas in "high and good status", but there are also stretches of river which fall under "heavily modified water bodies" and have been assessed as "polluted". As analysed in the above section, cadmium, lead, mercury, DDT, lindane and atrazine are among the most serious pollutants.

The Upper Danube, where chains of hydropower plants exist, is mainly impacted by hydromorphological alterations, and many water bodies have also been provisionally identified as "heavily modified water bodies".

The Middle Danube is classified as "possibly at risk" due to hazardous substances. The section of the Danube shared by Slovakia and Hungary is classified as "at risk" due to hydromorphological alterations. The section shared by Croatia and Serbia is "possibly at risk" in all categories, since not enough data is available for a sure assessment.

The Lower Danube is "at risk" due to nutrient pollution and hazardous substances, and in large parts due to hydromorphological alterations. It is "possibly at risk" due to organic pollution.

Trends

The water quality in the Danube basin has improved significantly during the last decade, hand-in-hand with improvements of the general environmental conditions in the Danube basin.

Improvements in water quality can be seen at several TNMN locations. A decrease of biodegradable organic pollution is visible in the Austrian-Slovakian section of the Danube and in a lower section downstream at Chiciu/Silistra. The tributaries Inn, Salzach, Dyje, Vah, Drava, Tisza (at Tiszasziget) and Arges show the same tendency.

[8] The Transnational Monitoring Network (TNMN) constitutes the main data source on water quality of the Danube and its major tributaries. The main objective of the TNMN is to provide an overall view of pollution and long-term trends in water quality and pollution loads in the major rivers of the Danube River basin. Currently, the network consists of 78 water-quality monitoring sites with a minimum sampling frequency of 12 times per year for chemical determinands in water. The TNMN includes biological determinands with a minimum sampling frequency of twice a year. There are 23 sampling stations in the TNMN load assessment programme with a minimum sampling frequency of 24 times per year.

[9] The "target values" have been purposely developed for the presentation of results of the TNMN; in some way, the choices were made with arbitrariness and they do not represent any threshold-, limit- or standard values, which may be required by national law or EU legislation for the characterization of water bodies.

[10] At the time of writing, the International Commission for the Protection of the Danube River had not yet assessed the consequences of the newly set environmental-quality standards.

As for nutrients, ammonium-nitrogen decreases are evident in locations of the upper part of Danube down to Hercegszanto (TNMN site H05), in tributaries of the upper section (Inn, Salzach, Morava, Dyje, Vah) as well as in the Drava, Tisza (at Tiszasziget), Sava and Arges. A significant decrease of ammonium-nitrogen is also apparent in the Danube at Silistra/Chiciu (TNMN site BG05), but is not supported by Romanian data at the same monitoring location. Nitrate-nitrogen decreases in several locations of the German-Austrian part of the Danube River, at Danube-Dunafoldvar and in some locations of the Lower Danube, such as Danubeus, Iskar-Bajkal and Danube/us.Arges. Nitrate-nitrogen decreases have also been seen in the tributaries Morava, Dyje, Vah and Drava, and in the Sava River at the confluence with the Una River at Jasenovac.

A decrease of ortho-phosphate phosphorus has been observed at Slovak monitoring locations, at Danube Szob, and at most downstream locations on the Danube River starting from the Reni Chilia/Kilia arm. An improvement can also be seen in the tributaries to the upper part of the river, and further in the rivers Drava, Siret and at the monitoring site Sava/Una rivers at Jasenovac.

Despite the achievements of the last 10 years, water and water-related ecosystems in the Danube River basin continue to be at risk from pollution and other negative factors. A period of more intensive farming, especially in the fertile areas of the new EU member States in the basin, may increase agricultural pollution. This calls for the development of a long-term strategy to address the problems of pollution, and especially diffuse pollution from agriculture.

As is the case in other basins, the frequency of serious flood events due to climatic changes could increase, which, in combination with unsustainable human practices, may cause substantial economic, social and environmental damage.

LAKE IRON GATE I[11]

Iron Gate is a gorge between the Carpathian and Balkan mountains on the Danube River on the border between Romania and Serbia. Earlier, it was an obstacle for shipping.

Iron Gate I (upstream of Turnu Severin) has one of Europe's largest hydroelectric power dams. The dam was built by Romania and the former Yugoslavia between 1970 and 1972.

The total area of the lake is 260 km^2 and the total volume 2.4 km^3. The lake is relatively shallow, the mean depth being 25 m and the deepest point being 40 m. The lake has been monitored for a number of physical, chemical, biological, microbiological and radiological determinands. The riparian countries consider that there are no major water-quality problems in Iron Gate I.

[11] Based on the Background document for the Guidelines on Monitoring and Assessment of Transboundary and International Lakes.

LAKE IRON GATE II[12]

Iron Gate II downstream of Turnu Severin is smaller ($78 km^2$) than Iron Gate I; the total volume of the lake ($0.8 km^3$) is one third of that of Iron Gate I. The lake is even shallower than Iron Gate I, the mean depth being 10 m and the deepest point being 25 m. The lake is also monitored similarly to Iron Gate I. The riparian countries consider that Iron Gate II has no serious water-quality or water-quantity problems.

LECH RIVER[13]

The Lech (254 km) is a left-hand tributary of the Danube. Its sub-basin ($4,125 km^2$) covers parts of Austria and Germany. Its discharge at mouth is 115 m^3/s (1982-2000).

INN RIVER[14]

The Inn (515 km) is the third largest by discharge and the seventh longest Danube tributary. At its mouth in Passau (Germany), it brings more water into the Danube (735 m^3/s, 1921–1998) than the Danube itself although its sub-basin of 26,130 km^2 (shared by Austria, Germany, Italy and Switzerland) is only half as big as the Danube's basin at this point. The main tributary of the Inn is the Salzach River, shared by Austria and Germany.

MORAVA RIVER[15]

The Morava (329 km) is a left-hand tributary of the Danube. Its sub-basin of 26,578 km^2 covers parts of the Czech Republic, Slovakia and Austria. Its discharge at mouth is 111 m^3/s (1961–2000).

RAAB/RABA RIVER[16]

The 311-km-long Raab/Raba is shared by Austria and Hungary (total area of the sub-basin 10,113 km2). Various rivers flowing from the Fischbacher Alps in Austria feed it. Its discharge at mouth is 88 m^3/s (1901–2000).

VAH RIVER[17]

The Vah (398 km) is a right-hand tributary of the Danube. Its sub-basin of 19,661 km^2 covers parts of Poland and Slovakia. Its discharge at mouth is 194 m^3/s (1961–2000).

[12] Based on the Background document for the Guidelines on Monitoring and Assessment of Transboundary and International Lakes.
[13] Source: Danube Basin Analysis (WFD Roof Report 2004).
[14] Source: Danube Basin Analysis (WFD Roof Report 2004).
[15] Based on information by the Ministry of the Environment of the Slovak Republic. The figures are based on country information and deviate from the Danube Basin Analysis (WFD Roof Report 2004).
[16] Source: Danube Basin Analysis (WFD Roof Report 2004).
[17] Based on information by the Ministry of the Environment of the Slovak Republic. The figures are based on country information and deviate from the Danube Basin Analysis (WFD Roof Report 2004).

IPEL/IPOLY RIVER[18]

Slovakia (upstream country) and Hungary (downstream country) share the sub-basin of the Ipel/Ipoly River, with a total area of 5,151 km².

Sub-basin of the Ipel/Ipoly River			
Area	**Country**	**Country's share**	
5,151 km²	Slovakia	3,649 km²	70.8%
	Hungary	1,502 km²	29.2%

Source: Ministry of Environment and Water, Hungary, and Ministry of the Environment of the Slovak Republic. These figures deviate from the Danube Basin Analysis (WFD Roof Report 2004).

Hydrology

The 232-km-long Ipel/Ipoly[19] has its source in the Slovak Ore Mountains in central Slovakia. It flows south to the Hungarian border, and then southwest, west and again south along the border between Slovakia and Hungary until it flows into the Danube near Szob. Major cities along its course are Šahy (Slovakia) and Balassagyarmat (Hungary). Its discharge at mouth is 22 m³/s (1931–1980).

There are 14 reservoirs on the river.

The most serious water-quantity problems are flooding and temporary water scarcity.

Pressure factors

Diffuse pollution mainly stems from agriculture, but also from settlements that are not connected to sewer systems. The estimated total amount of nitrogen and phosphorus reaching surface waters in the Ipel/Ipoly sub-basin is 1,650 tons nitrogen/year and 62 tons phosphorus/year.
The most important and problematic pressure factor is inappropriate wastewater treatment. Point sources of pollution, which are mostly municipal wastewater treatment plants, discharge organic pollutants, nutrients and heavy metals into the river and its tributaries.

Pollution in the sub-basin of the Ipel/Ipoly River in 2000		
Determinands	**Discharges in the Slovak part [tons/year]**	**Discharges in the Hungarian part [tons/year]**
BOD_5	514.9	27.1
COD_{Cr}	1,283.5	98.4
Dissolved solids	6,507.1	2,017
Suspended solids	515.5	117
NH_4-N	159.9	7.5
Nitrate-N	…	145
Total discharged wastewater	**12,882,000 m³/year**	**1,959,000 m³ /year**

Source: Ministry of Environment and Water, Hungary, and Ministry of the Environment of the Slovak Republic.

Transboundary impact

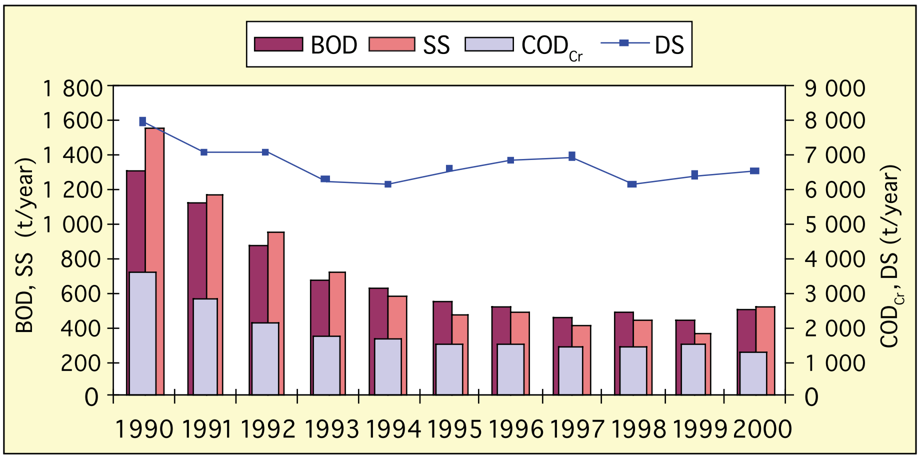
The most serious water-quality problems are eutrophication, organic pollution, bacterial pollution, and pollution by hazardous substances.

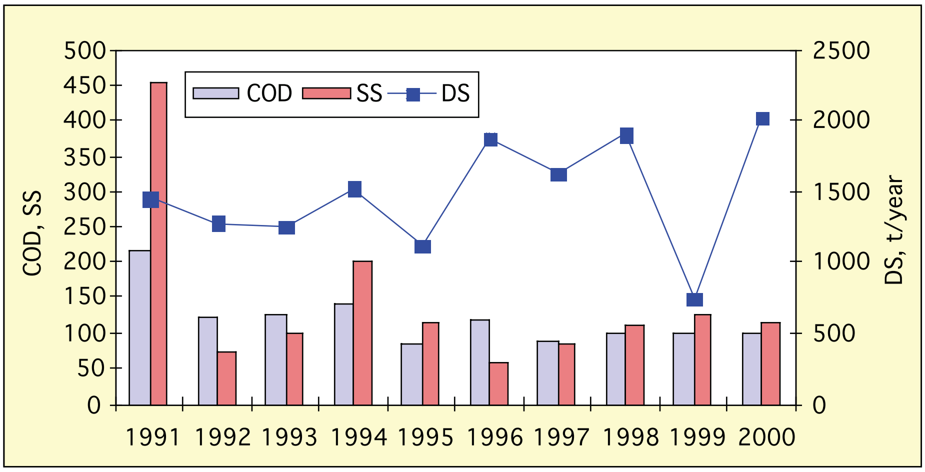
Owing to inappropriate wastewater treatment and agricultural practices, the content of nutrients in the waters of the transboundary section of the river is rather high and gives rise to the excessive growth of algae.

[18] Based on information by the Ministry of Environment and Water, Hungary, and the Ministry of Environment, Slovakia.
[19] Source: The Danube Basin Analysis (WFD Roof Report 2004) quotes a length of 197 km.

Organic pollution can have a negative impact on the ecosystem, irrigation, fishing and drinking-water quality. The BOD_5 values in the Ipel/Ipoly River sometimes exceed the limits of the water-quality criteria for drinking water and aquatic life. The primary sources of the biodegradable organic pollutants are wastewater discharges. Coliform bacteria, faecal coliforms and faecal streptococcus counts in the river also exceed the water-quality criteria for drinking water and bathing; the bacterial pollution, therefore, threatens these uses. Recreational use is directly affected, as compliance with bacteriological limit values is a prerequisite for bathing. Abstraction for drinking water is indirectly affected because flexible treatment technologies can eliminate a wide range of bacteria. The main sources of bacterial pollution are municipal wastewater discharges.

The occurrence of hazardous substances in waters presents a risk to biota and can affect almost all uses as well as the ecological functions of the river. Some specific pollutants – cadmium, petroleum hydrocarbons and phenols – were identified at concentrations exceeding those for drinking-water abstraction and irrigation.





Loads of selected determinands (BOD – biochemical oxygen demand; COD – chemical oxygen demand; SS – suspended solids; DS – dissolved solids) discharged into the Ipel/Ipoly River from the Slovak part (upper figure) and the Hungarian part (lower figure).

Trends

The Hungarian national sewerage collection and wastewater treatment plan for settlements envisages the construction or upgrading of sewerage systems and treatment plants in order to implement the requirements of the Council Directive of 21 May 1991 concerning urban wastewater treatment (91/271/EEC) by the year 2010. In Slovakia, implementation of the Council Directive is required by 2010 for wastewater treatment plants with more than 10,000 population equivalents (p.e.) and by 2015 for those with 2,000 to 10,000 p.e.

Thus, organic pollution and pollution by dangerous substances will substantially decrease. The trend of nutrient pollution from agriculture is still uncertain.

DRAVA AND MURA RIVER[20]

The transboundary river Drava (893 km) is the fourth largest and fourth longest Danube tributary. It rises in the Southern Alps in Italy, but is the dominant river of southern Austria, eastern Slovenia, southern Hungary and Croatia. The sub-basin covers an area of 41,238 km². One of the main transboundary tributaries is the Mura, with its mouth at the Croatian-Hungarian border. The discharge of the Drava at its mouth is 577 m^3/s (1946–1991).

TISZA RIVER[21]

Hungary, Romania, Slovakia, Serbia and Ukraine share the sub-basin of the Tisza, also known as Tysa and the Tisa. The sub-basin of the Tisza is the largest sub-basin of the Danube River basin.

Sub-basin of the Tisza River			
Area	**Country**	**Country's share**	
157,186 km^2	Ukraine	12,732 km^2	8.1
	Romania	72,620 km^2	46.2
	Slovakia	15,247 km^2	9.7
	Hungary	46,213 km^2	29.4
	Serbia	10,374 km^2	6.6

Source: Ministry of Environment and Water, Hungary.

Hydrology

The Tisza sub-basin has both a pronounced mountain and lowland character as it stretches over the Carpathians and the Great Hungarian lowland. The drainage basins of the tributaries of the Tisza River are rather different from each other in topography, soil composition, land use and hydrological characteristics. The 1,800-2,500 m high ridge of the Carpathian Mountains create in a half circle the northern, eastern and south-eastern boundary of the Tisza sub-basin. The western – south-western reach of the sub-basin is comparatively low, in some places – on its Hungarian and Serbian reaches – it is almost flat.

The sub-basin of the Tisza River can be divided into two main parts: the mountainous catchments of the Tisza and the tributaries in Ukraine, Romania and Eastern-Slovakia, and the lowland parts mainly in Hungary and in Serbia.

The Tisza River itself can be divided into three parts, the Upper-Tisza upstream the confluence of the Somes/Szamos River, the Middle-Tisza between the mouth of the Somes/Szamos and the Mures/Maros rivers, and the Lower-Tisza downstream the confluence of the Mures/Maros River.

Europe's largest flood defence system was created in the basin. It encompasses regulation of rivers, construction of flood embankments and flood walls, systems of drainage canals, pumping stations and designated flood detention reservoirs (polders).

Floods in the sub-basin are formed at any season and can be of rainstorm, snow or rain origin. Long observations of water levels and maximum flow provide evidence that the distribution of extremely high and severe floods in the sub-basin is different along the Upper-, Middle- and Lower-Tisza and its tributaries. Not every high flood in the upstream part causes severe floods along the Middle- or Lower-Tisza. On the other hand, multi-peak floods caused by repeated rainfall in the upstream parts due to the extremely mild slope of the river bed of the Middle- and Lower-Tisza may superimpose and result in high floods of long duration in April and May.

[20] Source: Danube Basin Analysis (WFD Roof Report 2004).
[21] Based on information by the Ministry of Environment and Water, Hungary, Ministry of the Environment of the Slovak Republic and Slovak Hydrometeorological Institute.

Discharge characteristics of the Tisza River at the gauging station Szeged (Hungary)		
Q_{av}	863 m^3/s	Average for: 1960-2000
Q_{max}	~ 4,000 m^3/s	1931
Q_{min}	57.8 m^3/s	1990
Mean monthly values:		
October: 504 m^3/s	November: 641 m^3/s	December: 762 m^3/s
January: 775 m^3/s	February: 908 m^3/s	March: 1,218 m^3/s
April: 1,574 m^3/s	May: 1,259 m^3/s	June: 956 m^3/s
July: 756 m^3/s	August: 531 m^3/s	September: 473 m^3/s

Source: Ministry of Environment and Water, Hungary.

In the Tisza sub-basin, there are a great number of lakes, reservoirs, forests, wetlands and protected areas. Within the most important water-related protected areas for species and habitats in the upper Tisza, there are two Slovakian protected areas: a medium size (<50,000 ha) protected area (karst) in the Slana/Sajo River, partially shared with Hungary, and a small size (<10,000 ha) protected wetland on the Latorytsya River (upper Bodrog River), near the Ukrainian border.

In Romania, biosphere, nature reserves and national parks in the upper sub-basin represent a total surface of 194,271 ha. In these areas, many protected flora and fauna species mentioned in the national Red Book are found. In addition, there are plans to create a new protected area in the Upper Tisza sub-basin - the Maramures Mountains National Park.

In Ukraine, protected areas occupy 1,600 km^2 (more than 12 % of the Zakarpatska Oblast area) and there are plans to expand the network of nature conservation areas. The most prominent reserve is the Carpathian Biosphere Reserve, which covers a surface of 57,889 ha.

Five National Parks and several protected areas are located in the middle Tisza in Hungary. The National Parks Hortobagyi, Koros-Maros, Bukk, Kiskunsagi (with oxbow lakes), and Aggtelek contain numerous important environmentally sensitive areas of the country. In addition, a mosaic of Ramsar sites, important bird and landscape protection areas, and biosphere reserves can be found along the wetlands of the middle and lower Tisza River. The Ecsedi Lap Complex (Ukraine, Slovakia, Romania and Hungary) forms a river eco-corridor, which is 400 km long and has a size of 140,000 ha. There are also Ramsar sites within both the Hortobagy (23,121 ha) and Kiskunsag (3,903 ha) National Parks. In the lower Tisza, the Pusztaszer (Hungary) and Stari Begej (at the confluence of the Begej and the Tisza Rivers in Serbia) Ramsar sites are among the most valuable wetlands.

On Serbian territory, protected (or planned to be) areas are Selevenj-PalicLudas complex (including Selevenj steppe, Palic lake, Ludas lake – Ramsar site), Zobnatica forest, Rusanda pool, Titelski Breg hill, Jegricka swamp, Pastures of large Bustard near Mokrin, as well as Ramsar sites of Slano Kopovo marshes and Stari Begej (Old Bega) – Carska Bara.

Pressure factors

Land in the sub-basin is mainly used for agriculture, forestry, pastures (grassland), nature reserves, as well as urbanized areas (buildings, yards, roads, railroads). As a result of intensive agricultural development over the past decades, many natural ecosystems, particularly the Tisza floodplains, have been transformed into arable lands and pastures. In the upper part of the sub-basin, notably in Ukraine and Slovakia, deforestation in mountain areas is responsible for changes of the flow regime and typical habitats. In addition, extensive use of fertilisers and agro-chemicals led to soil and water contamination with heavy metals and POPs, and river and lake eutrophication from organic materials and biogenic substances. Main pressures arise from the sewerage, as the Urban Waste Water Treatment Directive has not yet been fully implemented in Hungary, Romania and Slovakia. Furthermore, industrial activities as metallurgy and mining activities including solid waste disposals, can contribute to the water resources deterioration in the Tisza sub-basin. Large storage tanks of chemicals and fuels are potential accidental risk spots in the area, as well.

Transboundary impact

Accidental pollution from the industrial sites is one issue causing transboundary impact in the Tisza River sub-basin. For example, the cyanide accident on 30 January 2000 proved that inadequate precautionary measures at the disposal sites could lead to massive harmful effects to humans as well as to the environment. Consequences of such events lead to significant economic impacts on entire region. The floods of August 2002 highlighted the problem of inundation of landfills, dump sites and storage facilities where harmful substances are deposited. Transfer of both pathogens and toxic substances into the water may occur posing an additional threat to the environment.

Thermal pollution by industry or power generation processes can cause deterioration of water quality or alterations of the sedimentary environment and water clarity. These can lead to increased growth of microalgae and other nuisance flora.

Water pollution from navigation is linked to several diffuse sources. These include poorly flushed waterways, boat maintenance, discharge of sewage from boats, storm water runoff from parking lots, and the physical alteration of shoreline, wetlands, and aquatic habitat during construction and operation.

The implementation of the WFD and other related directives are decisive steps to significantly improve the status of the Tisza and its tributaries in Hungary, Romania and Slovakia.

Trends

There were no significant changes in recent years (2000–2005). The implementation of the Urban Wastewater Treatment Directive[22] and the implementation of Nitrate Directive[23] are decisive steps to significantly improve the status of the Tisza in Hungary and its tributaries in Slovakia and Romania.

[22] Council Directive 91/271/EEC of 21 May 1991 concerning urban waste-water treatment.
[23] Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources.

SOMES/SZAMOS[24]

The sub-basin of the river Somes/Szamos is shared by Romania (upstream) and Hungary (downstream).

Sub-basin of the Somes/Szamos River			
Area	**Country**	**Country's share**	
16,046 km²	Romania	15,740 km²	98%
	Hungary	306 km²	2%

Source: Ministry of Environment and Water, Hungary.

Hydrology

The Somes/Szamos has its source in the Rodnei Mountains in Romania and ends up in the Tisza. The sub-basin has an average elevation of about 534 m above sea level.

Discharge characteristics of the Somes/Szamos River at the gauging station Satu Mare (Romania)		
Q_{av}	126 m³/s	Average for: 1950-2005
Q_{max}	3342 m³/s	15 May 1970
Q_{min}	4.90 m³/s	18 December 1961
Mean monthly values:		
October: 59.5 m³/s	November: 84.2 m³/s	December: 110 m³/s
January: 99.4 m³/s	February: 152 m³/s	March: 224 m³/s
April: 240 m³/s	May: 169 m³/s	June: 139 m³/s
July: 107 m³/s	August: 68.7 m³/s	September: 56.3 m³/s

Source: National Administration "Apele Romane", Romania.

Reservoirs in the Romanian part include the Fantanele, Tarnita, Somes Cald, Gilau, Colibita and Stramtori-Firiza reservoirs. Fish ponds are numerous. There are two natural water bodies: the lakes Stiucilor and Bodi-Mogosa.

Pressure factors

In the Romania part of the sub-basin, the population density is 86 persons/km². Water use by sector is as follows: agriculture – 0.5%, urban uses – 0.5%, industrial uses – 0.2%, and energy production – 98.8%.

As concerns animal production, domestic animals have a density below the Danube basin average. In the rural areas, the most important diffuse pollution sources are situated in localities delineated as vulnerable areas.

In Romania, the most significant point pollution sources are the mining units located in the middle part of the sub-basin, which cause a degradation of downstream water quality due to heavy metals. Tailing dams for mining are an additional pollution source and generate diffuse pollution in the areas with developed mining activity. There is a potential risk of industrial accidents, especially in mining areas.

Discharges from manufacturing are insignificant, mainly due to a decrease in industrial production in the last decade.

There is still an environmental problem related to untreated or insufficiently treated urban wastewater, which increases the nitrogen concentration in the river. Uncontrolled waste dumpsites, especially located in rural areas, are an additional significant source of diffuse nutrient inputs into the watercourses.

As in other parts of the UNECE region, there is also a "natural pressure" due to hydrochemical processes in areas with mining activities.

[24] Based on information by the National Administration "Apele Romane", Romania.

Transboundary impact and trends

Nutrient species and heavy metals (Cu, Zn, Pb) cause transboundary impact.

Improving the status of the river requires investments in wastewater treatment technology and sewer systems. In urban areas, investments to expand capacity and/or rehabilitate sewerage treatment facilities are necessary. In rural areas, the connection rate to these facilities, which is very low, and should be increased.

Improving the status of the river also requires measures against pollution in mining areas. At the national level, there is already a step-by-step programme for closure of the mines and for the ecological rehabilitation of the affected areas.

MURES/MAROS RIVER[25]

The sub-basin of the Mures/Maros River is shared by Romania (upstream country) and Hungary (downstream country). The river ends up in the Tizsa.

Sub-basin of the Mures/Maros River			
Area	**Country**	**Country's share**	
30,195 km^2	Hungary	1,885 km^2	6.2%
	Romania	28,310 km^2	93.8%

Source: National Administration "Apele Romane", Romania.

Hydrology

The basin has a pronounced hilly and mountainous character with an average elevation of about 600 m above sea level. A major transboundary tributary to the Mures/Maros is the river Ier with its source in Romania.

Discharge characteristics of the Mures/Maros River at Arad (Romania)		
Discharge characteristics	**Discharge, m^3/s**	**Period of time or date**
Q_{av}	182	1950-2006
Q_{max}	2,320	1950-2006
Q_{min}	15.5	1950-2006

Source: National Administration "Apele Romane", Romania. The station has been in operation since 1861.

There are many man-made water bodies, but also natural water bodies, in the Romanian part of the sub-basin.

Pressure factors, transboundary impact and trends

In Romania, the dominant water user is the energy sector (75.1%). The share of other users is as follows: agriculture – 4%, urban uses – 10.9%, and industrial water use – 10.0%. Pressure factors of local significance include mining, manufacturing and sewerage as well as waste management and storage. Electricity supply generates thermal pollution, but this is only of local significance. It is possible that accidental water pollution by heavy metals can have a transboundary impact. With local exceptions, the Mures/Maros is being characterized as a river with a "medium to good status". Its trend is "stable".

In the Hungarian part of the sub-basin, the dominant water user is the agricultural sector, mainly for irrigational water use. The river is characterized as "at risk" due to hydromorphological alterations.

[25] Based on information by the National Administration "Apele Romane", Romania, and the Ministry of Environment and Water, Hungary.

SAVA RIVER[26]

The sub-basin of the Sava River covers considerable parts of Slovenia, Croatia, Bosnia and Herzegovina, northern Serbia, northern Montenegro and a small part of Albania.

Sub-basin of the Sava River			
Area	**Country**	**Country's share**	
97,713.2 km^2	Slovenia	11,734.8 km^2	12.0 %
	Croatia	25,373.5 km^2	26.0 %
	Bosnia and Herzegovina	38,349.10 km^2	39.2 %
	Serbia	15,147.0 km^2	15.5 %
	Montenegro	6,929.8 km^2	7.1 %
	Albania	179.0 km^2	0.2 %

Source: International Sava River Basin Commission; Regional Sava CARDS Project.

The Sava is the third longest tributary and the largest by discharge tributary of the Danube. The length of the river from its main source in the mountains of western Slovenia to the river mouth at Belgrade is about 944 km. The average discharge at the mouth is 1,564 m^3/s (for the period 1946–1991).

The Sava is nowadays navigable for large vessel up to Slavonski Brod (river kilometre 377) and for small vessels up to Sisak (river kilometre 583). The Sava's main tributaries include the rivers Ljubljanica, Savinja, Krka, Sotla, Krapina, Kupa, Lonja, Ilova, Una, Vrbas, Orljava, Ukrina, Bosna, Tinja, Drina, Bosut and Kolubara.

The Sava sub-basin is known for its outstanding biological and landscape diversity. It hosts the largest complex of alluvial wetlands in the Danube basin (Posavina - Central Sava basin) and large lowland forest complexes. The Sava is a unique example of a river, where some of the floodplains are still intact, supporting both mitigation of floods and biodiversity. Four Ramsar sites, namely Cerkniško Jezero in Slovenia, Lonjsko Polje in Croatia, Bardača in Bosnia and Herzegovina, and Obedska Bara in Serbia have been designated and numerous other areas to protect birds and plants have been established at the national level and as NATURA 2000 sites.

Key water management issues in the Sava sub-basin include organic pollution, nutrient pollution, pollution by hazardous substances, and hydromorphological alterations. Additional issues for transboundary water cooperation are floods, water-demand management and drinking-water supply as well as sediment management (quality and quantity). Prevention of accidental pollution and emergency preparedness are further tasks for international cooperation. Morphological alterations due to dams and hydropower plants, and hydrological alterations due to water abstractions for agricultural and industrial purposes and hydropower operation, must also be dealt with. Invasive species are also of concern.

Unregulated disposal of municipal and mining waste remains as a major pressure factor. The development of hydro-engineering structures, including those for navigation, is expected to become an additional pressure factor.

[26] Based on information by the International Sava River Basin Commission. The figures on the size of the basin are those given by the Commission and slightly deviate from the Danube Basin Analysis (WFD Roof Report 2004).

VELIKA MORAVA[27]

The river Velika Morava (430 km) with a sub-basin of 37,444 km^2 is the last significant right-bank tributary before the Iron Gate (average discharge 232 m^3/s for 1946-1991). It is formed by the confluence of two tributaries, the Juzna Morava, draining the south-eastern part of the sub-basin, and the Zapadna Morava, draining the south-western part.

Sub-basin of the Velika Morava			
Area	**Country**	**Country's share**	
37,444 km^2	Bulgaria	1,237 km^2	3,3%
	Serbia and Montenegro*	36,163 km^2	96,6%
	The former Yugoslav Republic of Macedonia	44 km^2	0,1%

Source: The Danube River Basin District. Part B: report 2004, Serbia and Montenegro. International Commission for the Protection of the Danube River, Vienna.
* At the date of publication of the above report, Serbia and Montenegro were still belonging to the same State.

The mouth of the Velika Morava is critically polluted. The most significant transboundary tributary of the Juzna Morava is the 218 km long Nishava River (4,068 km^2 total area, from which 1,058 km^2 in Bulgaria). The Nishava rises on the southern side of the Stara Planina Mountain in Bulgaria. A tributary of Nishava River, the 74 km long river Erma/Jerma, is in south-eastern Serbia and western Bulgaria. It twice passes the Serbian-Bulgarian border.

Sub-basin of the Nishava River			
Area	**Country**	**Country's share**	
4,068 km^2	Serbia and Montenegro*	3,010 km^2	74%
	Bulgaria	1,058 km^2	26%

Source: The Danube River Basin District. Part B: report 2004, Serbia and Montenegro. International Commission for the Protection of the Danube River, Vienna.
* At the date of publication of the above report, Serbia and Montenegro were still belonging to the same State.

TIMOK RIVER[28]

The Timok River (180 km) is a right-bank tributary of Danube. Its area of 4,630 km^2 is shared by Serbia (98%) and Bulgaria (2%). On its most downstream part, the river forms for 17.5 km the border between Serbia and Bulgaria. At its mouth, the river discharge amounts to 31 m^3/s (1946-1991). Pollution by arsenic, cadmium, copper, nickel, zinc and lead is significant.

[27] Based on information from the publication: The Danube River Basin District. Part B: report 2004, Serbia and Montenegro. International Commission for the Protection of the Danube River, Vienna.
[28] Based on information from the publication: The Danube River Basin District. Part B: report 2004, Serbia and Montenegro. International Commission for the Protection of the Danube River, Vienna.

SIRET RIVER[29]

Ukraine (upstream country) and Romania (downstream country) share the sub-basin of the Siret River.

Sub-basin of the Siret River			
Area	Country	Country's share	
47, 610 km²	Romania	42,890 km²	90.1%
	Ukraine	4,720 km²	9.9%

Source: National Administration "Apele Romane", Romania.

Hydrology

Among the Danube tributaries, the 559-km-long Siret has the third largest sub-basin area, which is situated to the east of the Carpathians. The Siret's source lies in Ukraine and it flows through the territory of Ukraine and Romania.

The sub-basin has a pronounced lowland character.

Its main tributaries are the rivers Suceava, Moldova, Bistritsa, Trotus, Barlad and Buzau.

Discharge characteristics of the Siret River at the gauging station Lungoci (Romania)		
Q_{av}	210 m³/s	Average for 1950-2005
Q_{max}	4,650 m³/s	14 July 2005
Q_{min}	14.2 m³/s	27 December 1996
Mean monthly values:		
October – 136 m³/s	November – 128 m³/s	December – 124 m³/s
January – 110 m³/s	February – 135 m³/s	March – 217 m³/s
April – 375 m³/s	May – 337 m³/s	June – 332 m³/s
July – 256 m³/s	August – 215 m³/s	September – 178 m³/s

Source: National Administration "Apele Romane", Romania.

There are over 30 man-made lakes in the catchment area. Natural lakes in Romania include the Rosu, Lala, Balatau, Cuejdel, Vintileasca and Carpanoaia Lakes.

Hydropower is generated at over 25 sites along the river.

Pressure factors

In Romania, the main water users are agriculture (13%), urban uses (47%), industry (32%), and thermal power production (8%).

The mining industry is one of the most significant pressure factors, with copper, zinc and lead mining, coal mining and uranium mining in Romania. There are a number of storage facilities (including tailing dams for mining and industrial wastes) in the Siret sub-basin.

Manufacturing includes light industry, and the paper, wood, chemical and food industries.

Thermal power stations are located at Suceava, Bacau and Borzesti; but only the thermal power station at Borzesti contributes to thermal pollution.

Transboundary impact and trends

According to an earlier assessment[30], the Siret was among the most polluted Danube tributaries in terms of degradable organic matter. Following water classifications for 2005, the Siret (RO 10 - confluence Danube Sendreni) was in class 2 for dissolved oxygen and BOD_5 and only for COD_{Cr} in class 4. The river Râmnicu Sărat, a right-hand tributary of the Siret, has a high natural background pollution by salts (class 5) along its entire length of 136 km. The table below includes these new data and shows an increase in river kilometres that fall into class 2.

[29] Based on information by the National Administration "Apele Romane", Romania.
[30] Source: Danube Basin Analysis (WFD Roof Report 2004).

Classification of the Siret River in Romania			
Class/year	**2003**	**2004**	**2005**
Class 1	1245 km (45%)	1332 km (48.2%)	920 km (31.8%)
Class 2	628 km (22.7%)	921 km (33.3%)	1168 km (40.3%)
Class 3	641 km (23.2%)	297 km (10.7%)	555 km (19.2%)
Class 4	111 km (4%)	15 km (0.5%)	109 km (3.8%)
Class 5	139 km (5%)	199 km (7.2%)	145 km (5.0%)
Total length classified	**2,764 km**	**2,764 km**	**2,897 km**

Source: National Administration "Apele Romane", Romania.

PRUT RIVER[31]

Moldova, Romania and Ukraine share the Prut sub-basin.

Sub-basin of the Prut River			
Area	**Country**	**Country's share**	
27,820 km^2	Ukraine	8,840 km^2	31.8%
	Romania	10,990 km^2	39.5%
	Moldova	7,990 km^2	28.7%

Source: Ministry of Environment and Natural Resources, Moldova, and National Administration "Apele Romane", Romania. Figures for Ukraine are estimates. The Danube Basin Analysis (WFD Roof Report 2004) quotes an area of 27,540 km^2.

Hydrology

The Prut is the second longest (967 km) tributary of the Danube, with its mouth just upstream of the Danube delta. Its source is in the Ukrainian Carpathians. Later, the Prut forms the border between Romania and Moldova.

Discharge characteristics of the Prut River at the monitoring site Sirauti (Moldova)	
Q_{av}	1,060 m^3/s
Q_{max}	3,130 m^3/s
Q_{min}	3,73 m^3/s

Source: Ministry of Environment and Natural Resources, Moldova.

The rivers Lapatnic, Drageste and Racovet are transboundary tributaries in the Prut sub-basin; they cross the Ukrainian-Moldavan border. The Prut River's major national tributaries are the rivers Cheremosh and Derelui, (Ukraine), Jijia, Elanu and Liscov (Romania) and Ciugur, Camenca, Lapusna, Sarata[32] and Larga (Moldova). Most are regulated by reservoirs.

The biggest reservoir on the Prut is the hydropower station of Stanca-Costesti (total length – 70 km, maximal depth – 34 m, surface – 59 km^2, usable volume – 450 million m^3, total volume 735 million m^3), which is jointly operated by Romania and Moldova.

[31] Based on information by the Ministry of Environment and Natural Resources of Moldova.
[32] The above mentioned Sarata river is distinct from the transboundary river shared by Moldova and Ukraine also called Sarata.

Pressure factors

Agriculture, supported by large irrigation systems, is one of the most important economic activities in the sub-basin. The rate of soil erosion is high and nearly 50% of the land used in agriculture suffer from erosion, thus polluting the surface water by nutrients.

Environmental problems include insufficient treated municipal wastewater, discharged mostly from medium-sized and smaller treatment facilities, which require substantial rehabilitation, as well as wastewater discharges from industries, many of them with outdated modes of production.

In Moldova, in particular the standards for organic pollution, heavy metals, oil products, phenols and copper are exceeded. One should note, however, that these standards are more stringent than the standards usually applied in EU countries. During the warm season, a deficit of dissolved oxygen and increased BOD_5 levels also occur. Microbiological pollution is also of concern.

In general, there is "moderate pollution" in the upper and middle sections of the Prut; the lower part is "substantially polluted". All tributaries are also "substantially polluted".

Hydrochemical characteristics of the Prut River at the monitoring site Kahul (Moldova), located 78 km upstream of the river mouth

Determinands	MAC[33]	End of 1980s	End of 1990s	September 2001	April 2002	September 2002	March 2003
$N\text{-}NH_4$, mg/l	0.39	1.78	0.69	0.09	0.63	0.33	0.77
$N\text{-}NO_2$, mg/l	0.02	0.08	0.04	0.01	0.03	0.01	0.04
$N\text{-}NO_3$, mg/l	9.00	1.54	1.79	1.03	0.91	0.79	2.46
N mineral, mg/l	…	3.40	2.43	2.13	1.88	1.32	3.70
$P\text{-}PO_4$, mg/l	…	0.05	0.06	0.04	0.05	0.04	0.09
Cu, µg/l	1.0	3.78	5.00	<3.00	<3.00	4.60	3.51
Zn, µg/l	10.0	15.95	29.90	5.00	<3.00	<3.00	<3.00
DDT, µg/l	Absence	0.37	0.28	<0.05	<0.05	<0.05	<0.05
HCH, µg/l	Absence	0.07	…	<0.01	0.01	0.00	0.00

Source: Moldova Water Quality Monitoring Program 2001-2004.[34]

Transboundary impact

Apart from water pollution, flooding remains a problem, despite water regulation by the many reservoirs.

The large wetland floodplain in downstream Moldova has been drained in favour of agriculture, but nowadays the pumping stations and dykes are poorly maintained, thus productive agricultural land is subject to becoming waterlogged. Due to flow regulation and water abstractions, the water level in downstream river sections in southern Moldova, particularly in dry years, is low and the water flow to the natural floodplain lakes, including lakes designated as a Ramsar site, is often interrupted.

In case of significant increase of the Danube water level, flooding of downstream flood plains in Moldova can become a problem. Oil abstraction fields and oil installations located near Lake Beleu may thus be flooded and oil products may contaminate the Ramsar site.

Trends[35]

Following measurements by Moldova, there is a decreasing pollution level for almost all determinands, except for nitrogen compounds, copper containing substances, and zinc. The decrease of pollution is particularly obvious in the lower part of the river.

Despite the improvement of water quality in the last decade, mostly due to decreasing industrial production, significant water-quality problems remain. However, water-quality improvements in terms of nitrogen, microbiological pollution and the general chemical status are likely.

[33] The maximum allowable concentration of chemical determinands, except oxygen where it stands for the minimum oxygen content, needed to support aquatic life. This term is only used in EECCA countries. Other countries use the term "water-quality criteria".
[34] C. Mihailescu, M. A. Latif, A Overcenco: USAID/CNFA-Moldova Environmental Programs - Water Quality Monitoring 2001-2004. Chisinau, Moldova, 2006.
[35] Based on information by the Ministry of Environment and Natural Resources, Moldova.

STANCA-COSTESTI RESERVOIR[36]

The Stanca-Costesti Reservoir is a transboundary lake shared by Moldova and Romania. It is part of the sub-basin of the Prut, a transboundary tributary to the Danube. The reservoir was built for hydropower purposes during 1973 - 1978.

Constructed on the Prut approximately 580 km upstream of its confluence with the Danube, the dam (47 m high and 3,000 m long) retains a volume of 735 million m^3 at the normal water level. The discharge is 82.9 m^3/s (2.6 km^3 per annum). The area of the river basin upstream of the reservoir is 12,000 km^2. The surface area of the reservoir is 59 km^2, the mean depth 24 m and the deepest site 41.5 m. Water level changes are about 8 m between the normal and lowest levels. The theoretical retention time is 30 days during the spring floods and about 180 days during the rest of the year. The area in the vicinity of the reservoir is covered by arable lands (70%), perennial crops (17 %), forests and urban areas.

The Stanca-Costesti Reservoir has been monitored since 1984. Sampling sites are located near the dam (at surface and 10 m depth), in the middle of the reservoir (at surface and 5 m depth) and the end of the backwater. The sampling frequency is four times a year. Besides chemical and biological sampling of the water, the sediment is also sampled for a variety of determinands, especially hazardous substances.

Due to the high volume of water in the reservoir, the aquatic ecosystem has a substantial self-purification capacity and the reservoir can annihilate loadings of certain pollutants.

The main hydromorphological pressure due to the dam is discontinuity of flow and flow regulation.

Diffuse pollution by nutrients and accumulation of heavy metals are the most serious pressure factors. However, the overall water quality (for the majority of indicators) of the reservoir is classified as "1st category" under the Romanian water-quality classification system.

KAHUL RIVER[37]

The Kahul River originates in Moldova and flows in Ukraine into the Lake Kahul, a Danube lake shared by both countries. Usually, the river is considered as a separate first-order river. It has become, however, part of the Danube River Basin District.

The table below shows the river's hydrochemical regime and developments since the end of the 1980s. Compared to the 1980s, the concentration of water pollutants has fallen considerably.

Hydrochemical characteristics of the Kahul River at the monitoring site Vulcanesti (Moldova), located 15 km upstream of the lake

Determinands	MAC	End of 1980s	End of 1990s	September 2001	April 2002	September 2002	March 2003
N-NH_4, mg/l	0.39	8.90	…	0.70	1.64	0.77	0.47
N-NO_2, mg/l	0.02	0.82	…	0.19	0.04	0.07	0.09
N-NO_3, mg/l	9.00	6.49	…	4.33	0.30	4.07	5.08
N mineral, mg/l	…	16.21	…	5.70	2.24	5.47	6.39
P-PO_4, mg/l	…	0.33	…	0.13	0.03	0.03	0.04
Cu, µg/l	1.0	8.50	…	3.60	3.20	7.00	<3.00
Zn, µg/l	10.0	12.40	…	6.40	3.00	9.20	<3.00
DDT, µg/l	Absence	0.16	…	<0.05	<0.05	<0.05	<0.05
HCH, µg/l	Absence	0.08	…	0.01	0.02	0.02	<0.01

Source: Moldova Water Quality Monitoring Program 2001–2004.

[36] Based on information by the Ministry of Environment and Water Management, Romania.
[37] Based on information by the Ministry of Environment and Natural Resources, Moldova.

YALPUH RIVER[38]

The Yalpuh River originates in Moldova and flows into Ukraine's Lake Yalpuh, one of the Danube lakes. Usually, the river is considered as a separate first-order river. It has become, however, part of the Danube River Basin District.

The table below shows the river's hydrochemical regime and its developments since the end of the 1980s. Compared to the 1980s, the concentration of water pollutants has fallen considerably.

Hydrochemical characteristics of the Yalpuh River at the monitoring site Aluat (Moldova), located 12 km upstream of the lake

Determinands	MAC	End of 1980s	End of 1990s	September 2001	April 2002	September 2002	March 2003
$N\text{-}NH_4$, mg/l	0.39	1.17	…	0.12	1.50	0.60	0.20
$N\text{-}NO_2$, mg/l	0.02	0.25	…	0.00	0.05	0.00	0.01
$N\text{-}NO_3$, mg/l	9.00	4.31	…	0.59	3.23	0.94	1.75
N mineral, mg/l	…	5.74	…	1.32	5.26	4.15	2.35
$P\text{-}PO_4$, mg/l	…	0.15	…	0.07	0.02	0.04	0.02
Cu, µg/l	1.0	7.10	…	3.00	<3.00	3.00	<3.00
Zn, µg/l	10.0	23.20	…	<3.00	<3.00	<3.00	<3.00
DDT, µg/l	Absence	0.02	…	<0.05	<0.05	<0.05	<.0.5
HCH, µg/l	Absence	0.06	…	<0.01	0.02	<0.01	<0.01

Source: Moldova Water Quality Monitoring Program 2001-2004.

DANUBE DELTA[39]

The Danube delta is largely situated in Romania, with parts in Ukraine. It is a protected area, which covers 679,000 ha including floodplains and marine areas. The core of the reserve (312,400 ha) was established as a "World Nature Heritage" in 1991. There are 668 natural lakes larger than one hectare, covering 9.28 % of the delta's surface. The Delta is an environmental buffer between the Danube River and the Black Sea, filtering out pollutants and enabling both water quality conditions and natural habitats for fish in the delta and in the environmentally vulnerable shallow waters of the north-western Black Sea. Moreover, it is Europe's largest remaining natural wetland – a unique ecosystem.

LAKE NEUSIEDL

Lake Neusiedl (also known as Neusiedler See and Fertö-tó) is located in the east of Austria and shared with Hungary. It belongs to the Danube River Basin District.

The lake has an average surface area of 315 km² (depending on water fluctuations), of which 240 km² are located in Austria and 75 km² in Hungary. A fluctuation in the water level of the lake of +/- 1.0 cm changes the lake surface by up to 3 km². More than half of its total area consists of reed belts; in certain parts the reed belt is 3 to 5 km wide. In the past, the lake had no outflow and therefore extremely large fluctuations of its surface area were recorded. Later, the Hanság Main Canal was built as a lake outlet.

Lake Neusiedl has an average natural depth of 1.1 m; its maximal water depth is 1.8 m. In its history, it has dried out completely several times.

Since 1965, the water level is stabilized by the outlet sluice based on the 1965 agreement of the Hungarian-Austrian Water Commission (water level in April-August: 115.80 m above sea level; October-February: 115.70 m above sea

[38] Based on information by the Ministry of Environment and Natural Resources, Moldova.
[39] Source: Danube Basin Analysis (WFD Roof Report 2004).

level, transition period (March and September): 115.75 m above sea level). The main surface water input is through precipitation on the lake surface, as well as the Wulka River, Rákos Creek and other smaller tributaries. Groundwater inflow is insignificant. Due to its low depth, the lake is quickly mixed by wind action, and is therefore naturally turbid. The lake water has "a high salt concentration".

COGILNIC RIVER BASIN[40]

Moldova (upstream county) and Ukraine (downstream country) share the basin of the Cogilnic River.

Basin of the Cogilnic River			
Area	**Country**	**Country's share**	
6,100 km^2	Moldova	3,600 km^2	57.8%
	Ukraine	2,600 km^2	42.2%

Source: The United Nations World Water Development Report, 2003.

The Cogilnic has several small transboundary tributaries, including the Schinosa and the Ceaga.

Discharge characteristics of the Cogilnic River in Moldova upstream of the border with Ukraine	
Q_{av}	8.32 m^3/s
Q_{max}	18.0 m^3/s
Q_{min}	1.53 m^3/s

Source: Ministry of Environment and Natural Resources, Moldova.

Over the observation period, the level of ammonium is permanently over the MAC and tends to grow. Concentrations of nitrogen have increased over the last years. Compared to the end of the 1980s and 1990s, concentrations of phosphorus increased considerably.

Hydrochemical characteristics of the Cogilnic River at the monitoring site Cimislia (Moldova)

Determinands	MAC	End of 1980s	End of 1990s	September 2001	April 2002	September 2002	March 2003
N-NH_4, mg/l	0.39	3.22	…	0.50	2.06	10.00	6.90
N-NO_2, mg/l	0.02	0.64	…	0.24	0.10	0.24	0.38
N-NO_3, mg/l	9.00	3.54	…	3.46	0.60	3.38	6.42
N mineral, mg/l	…	7.40	…	5.88	3.12	14.78	15.24
P-PO_4, mg/l	…	0.38	…	0.15	0.67	1.39	1.89
Cu, µg/l	1.0	7.40	…	11.80	4.10	<3.00	3.43
Zn, µg/l	10.0	12.00	…	49.10	31.50	215.50	<3.00
DDT, µg/l	Absence	…	…	<0.05	<0.05	0.01	<0,05
HCH, µg/l	Absence	0.01	…	0.01	0.03	<0.01	<0.01

Source: Moldova Water Quality Monitoring Program 2001-2004.

[40] Based on information by the Ministry of Environment and Natural Resources, Moldova.

DNIESTER RIVER BASIN

DNIESTER RIVER[41]

Ukraine and Moldova are usually considered as the basin countries as Poland's share of the basin is very small.

Basin of the Dniester River			
Area	**Country**	**Country's share**	
72,100 km²	Ukraine	52,700 km²	73.1%
	Moldova	19,400 km²	26.9%
	Poland	Poland's share is very small	

Source: Ministry of Environment and Natural Resources, Moldova.

Hydrology

The River Dniester, with a length of 1,362 km, has its source in the Ukrainian Carpathians; it flows through Moldova and reaches Ukraine again near the Black Sea coast.

At the river mouth, the discharge characteristics are as follows: 10.7 billion m³ (during 50% of the year); 8.6 billion m³ (during 75% of the year); and 6.6 billion m³ (during 95% of the year). There is a significant, long-term trend of decreasing river flow, possibly due to climatic changes. The maximum water flow at the gauging stations Zaleshshiki and Bendery was observed in 1980 with 429 m³/s and 610 m³/s, respectively; and the minimum flow at Zaleshshiki (1961) was 97,6 m³/s and at Bendery (1904) 142 m³/s.

Flooding is common; up to five flood events occur each year with water levels rises of 3-4 meters, sometimes even more.

[41] Based on information by the Ministry of Environment and Natural Resources of Moldova.

Pressure factors

The Dniester flows through densely populated areas with highly developed industry (mining, wood-processing and food industry). Aquaculture, discharges of municipal wastewaters and diffuse pollution from agriculture are the other main pressure factors. Nitrogen compounds, heavy metals, oil products, phenols and copper are the main pollutants. During the warm season, a deficit of dissolved oxygen and increased BOD_5 levels occur additionally. Microbiological pollution is also of concern.

Petrol mining and chemical industry (e.g. oil refining) cause water pollution by phenols and oil products. Their main sources are in the upper part of the basin, where petroleum mining takes place and oil-refineries are located. Due to the high migration ability of phenols and oil-products, elevated concentration are also found in the Middle Dniester.

Hydrochemical characteristics of the Dniester River near the Mereseuca village (600 km upstream of the river mouth)

Determinands	MAC	End of 1980s	End of 1990s	September 2001	April 2002	September 2002	March 2003
$N\text{-}NH_4$, mg/l	0.39	0.56	0.21	0.18	0.12	0.09	0.17
$N\text{-}NO_2$, mg/l	0.02	0.05	0.01	0.01	0.05	0.01	0.01
$N\text{-}NO_3$, mg/l	9.00	1.71	2.50	1.17	2.21	1.35	2.25
N mineral, mg/l	…	2.32	2.72	1.91	2.76	2.02	2.58
$P\text{-}PO_4$, mg/l	…	0.07	0.00	0.06	0.01	0.06	0.05
Cu, µg/l	1.0	6.00	9.00	<3.00	<3.00	<3.00	<3.00
Zn, µg/l	10.0	10.00	10.00	15.00	3.20	<3.00	<3.00
DDT, µg/l	Absence	0.34	…	<0.05	<0.05	<0.05	<0.05
HCH, µg/l	Absence	0.15	…	<0.01	<0.01	<0.01	<0.01

Source: Moldova Water Quality Monitoring Program 2001–2004.[42]

Hydrochemical characteristics of the Dniester River near the Rascaieti village (70 km upstream of the river mouth)

Determinands	MAC	End of 1980s	End of 1990s	September 2001	April 2002	September 2002	March 2003
$N\text{-}NH_4$, mg/l	0.39	0.83	0.36	<0.01	0.09	0.33	1.27
$N\text{-}NO_2$, mg/l	0.02	0.06	0.03	0.02	0.05	0.02	0.02
$N\text{-}NO_3$, mg/l	9.00	1.15	3.85	1.10	2.73	1.18	1.92
N mineral, mg/l	…	2.04	4.24	1.76	3.30	2.02	3.21
$P\text{-}PO_4$, mg/l	…	0.11	0.12	0.15	0.03	0.12	0.11
Cu, µg/l	1.0	20.00	10.00	<3.00	<3.00	4.20	4.00
Zn, µg/l	10.0	60.00	0.00	22.10	8.40	4.40	10.00
DDT, µg/l	Absence	0.37	…	<0.05	<0.05	<0.05	<0.05
HCH, µg/l	Absence	0.27	…	<0.05	<0.05	<0.05	<0.05

Source: Moldova Water Quality Monitoring Program 2001–2004.

[42] C. Mihailescu, M. A. Latif, A Overcenco: USAID/CNFA-Moldova Environmental Programs - Water Quality Monitoring 2001-2004. Chisinau, Moldova, 2006.

Transboundary impact

Moldova assesses that the upper and middle Dniester basin are moderately polluted, whereas the Lower Dniester and the Dniester tributaries are assessed as substantially polluted.

In recent years, the technical status of wastewater treatment plants in Moldova substantially decreased. Although wastewater treatment plants in cities continue to work with decreasing efficiency, most of the other treatment plants are out of order. For some cities (e.g. Soroki), new treatment plants are to be constructed. In addition, there is the great challenge to plan, create and correctly manage water protection zones in Moldova, including the abolishment of non-licensed dumpsites in rural areas.

Trends

Although there was an improvement of water quality over the last decade, mainly due to the decrease in economic activities, the water quality problems remain to be significant. A further decrease of water quality related to nitrogen and phosphorus compounds as well as the microbiological and the chemical status is to be expected.

In both countries, the construction of wastewater treatment plants and the enforcement of measures related to water protection zones are of utmost importance.

KUCHURHAN RIVER[43]

The Kuchurhan River originates in Ukraine, forms for some length the Ukrainian-Moldavian border and flows through the Kuchurhan reservoir, and empties into the Dniester on the territory of Ukraine.

Sampling at the Kuchurhan reservoir under a specific programme was conducted in autumn 2003, spring 2004 and autumn 2004. Compared to the samples taken in autumn 2003 and in spring 2004, the autumn 2004 samples showed an increase of nitrites (from MAC 0.4 to 1.7), no significant changes of ammonium, a decrease of detergent’s concentrations, and a decrease of oil products (from MAC 1.6 to 0.4).

[43] C. Mihailescu, M. A. Latif, A Overcenco: USAID/CNFA-Moldova Environmental Programs - Water Quality Monitoring 2001–2004. Chisinau, Moldova, 2006.

DNIEPER RIVER BASIN

DNIEPER RIVER[44]

The Russian Federation, Belarus and Ukraine share the Dnieper basin as follows:

Basin of the Dnieper River			
Area	**Country**	**Country's share**	
504,000 km^2	Russian Federation	90,700 km^2	18%
	Belarus	121,000 km^2	24%
	Ukraine	292,300 km^2	58%

Source: UNDP-GEF Dnipro Basin Environment Programme.

Hydrology

The River Dnieper flows from the Russian Federation through Belarus and then Ukraine. It is the third largest in Europe (after the River Volga and the River Danube). Its length is 2,200 km, of which 115 km form the border between Belarus and Ukraine.

Over the last 800 km of the river, there is a chain of consecutive reservoirs. The Dnieper is connected with the Bug River through the Dnieper-Bug Canal.

Discharge characteristics of the Dnieper River at the gauging station Dnieper Hydropower Plant (observation period 1952-1984)	
Q_{av}	1,484 m^3/s
Q_{max}	8,080 m^3/s
Q_{min}	362 m^3/s

Source: UNDP-GEF Dnipro Basin Environment Programme.

At the river mouth, the discharge amounts to 1,670 m^3/s (52.7 km^3/a).

After the Chernobyl catastrophe, a large amount of radioactive caesium was deposited in reservoir sediment.

Pressure factors

In all three riparian countries, a great number of domestic waste dumps and industrial waste storage facilities are located in the Dnieper basin.

Following estimates in 2001, some 8.5 billion tonnes of industrial waste is accumulated in waste storage facilities (up to 50 % of these waste products are accumulated in the territory of Ukraine, up to 10 % in the territory of Belarus, and about 40 % in the territory of the Russian Federation). There is an estimated annual increase in accumulated industrial waste of 8 to 10 %.

The storage facilities contain up to 40 % of especially hazardous industrial waste, including salts of heavy and non-ferrous metals (lead, cadmium, nickel, chromium, etc.) as well as oil products (up to 2.5 %).

Transboundary impact

Discharges of insufficiently treated municipal and industrial wastewaters as well as pollution from waste disposal sites and from agriculture have an adverse impact on the water quality of the Dnieper River as well as its major transboundary tributaries.

Trends

Hydropower stations, nuclear power stations and manufacturing industries have caused ecological damage at a sub-regional scale. The environmental and human health problems both in the Dnieper river basin and the Black Sea region as a whole are worsened by large-scale development of timberland, and draining of waterlogged lands for agriculture, and the intensive growth of cities where sewage treatment is insufficient.

[44] Source: UNDP-GEF Dnipro Basin Environment Programme.

PRIPYAT RIVER

The River Pripyat (approximately 710 km length) rises in Ukraine in the region of the Shatsk Lakes. It flows into Belarus before re-entering Ukraine upstream of Chernobyl. A large number of smaller transboundary rivers are part of Pripyat's catchment area. There are some 50 dams in the Pripyat catchment area.

Sub-basin of the Pripyat River			
Area	Country	Country's share	
114,300 km^2	Ukraine	65,151 km^2	57%
	Belarus	49,149 km^2	43%

Source: Ministry for Environmental Protection of Ukraine.

Hydrology

The average flow of the River Pripyat at the gauging station "Mosyr" for the period 1881 to 2001 was 390 m^3/s (12.3 km^3/a). Little damage is being caused by the snow-melt flood, but occasional floods that are the result of spring or summer rainfall can be destructive.

Average flow characteristics at the station "Mosyr" on the Pripyat River

Pressure factors

The Pripyat is a largely rural basin, with little industrial development. However, there are a number of significant sources of pollution, including municipal sewage treatment works that are no longer working efficiently. This is most significant in the upper catchments of the Pripyat tributaries, especially in Ukraine, where larger settlements are located towards the edge of the basin.

Pollution by oil products in the lower catchment area from the oil processing plant at Mosyr and pollution from a salt pit and a fertilizer plant at Salihorsk are issues of concern.

Radioactive contamination following the accident at Chernobyl in 1986 remains a serious issue as the fallout was heaviest over the lower Pripyat catchment area, which is special "exclusion zone". Run-off from this area is still radioactive, and will be for many decades.

There are also a number of other anthropogenic causes of pollution sources, such as the use of agricultural chemicals (although the use of pesticides has considerably reduced in the last decade) as well as the drainage of water from peat areas.

Transboundary impact

The major issue in the lower Pripyat arises from the fall-out from the nuclear accident at Chernobyl in 1986, which contaminated much of the lower catchment, and radioactive material continues to work its way through the runoff processes into the river.

There is a threat of potential contamination by the nuclear power station at Rivno on the Styr River, a transboundary tributary, which is based on the same technology as the plant at Chernobyl.

Eutrophication of surface waters in the Pripyat river basin is caused by various factors, such as use of agrochemicals, lack of treatment of domestic wastewater and soil erosion.

Trends

Water-quality problems will continue to exist; they stem from poor natural water quality (high natural organic content, high acidity and colour), especially in areas where the density of peat and mires is highest, as well as from insufficient municipal wastewater treatment, and occasionally, industrial waste disposal and spillage problems.

DON RIVER BASIN

Hydrology

The River Siversky Donets / Severskiy Donets originates in the central Russian upland, north of Belgorod, flows south-east through Ukraine (traversing the oblasts of Kharkiv, Donetsk and Luhansk) and then again into the Russian Federation to join the River Don in the Rostov oblast below Konstantinovsk, about 100 km from the Sea of Azov. Its length is 1,053 km. The average density of the river network is 0.21 km/km^2.

The maximum registered discharge of the Siversky Donets (gauging station Lisichansk) was 3,310 m^3/s. The minimum average discharges during the summer/autumn low-flow period are 2.9 m^3/s in the upper reaches (gauging station Chuguev), 14.0 m^3/s in the middle segment (Lisichansk town), and 15.8 m^3/s in the lower reaches (gauging station Belaya Kalitva).

SIVERSKY DONETS[45]

The Russian Federation and Ukraine share the Siversky Donets basin as follows:

Sub-basin of the Siversky Donets River			
Area	Country	Country's share	
98,900 km^2	Russian Federation	44,500 km^2	45%
	Ukraine	54,400 km^2	55%

Source: Joint River Management Programme Severski-Donez Basin Report.

Pressure factors

In the Russian Federation, the main pollution sources of the Siversky Donets and its tributaries on the territory of the Belgorod Oblast are domestic wastewaters and wastewaters from municipal sources, metal extraction and processing, the chemical industry and from the processing of agricultural products. On the territory of Rostov Oblast, the main pollution sources include coal mining, metallurgical and machine building plants, chemical enterprises,

[45] Source: Joint River Management Programme Severski-Donez Basin Report.

communal municipal services and enterprises for agricultural products' processing. In the Rostov Oblast, the river also passes through an area of well-developed agriculture.

In Ukraine (town of Volchansk and Kharkiv Oblast), the main pollution sources are municipal wastewater treatment plants, which increase the polluting load by BOD, ammonium and phosphates. Only some 20 % of wastewater discharges comply with the permit conditions. In the Donetsk and Lugansk oblasts, municipal wastewater treatment plants and a large number of chemical plants discharge into the river. Certain enterprises store liquid waste and release it during periods of flooding. Around 80 % of the Ukrainian part of the catchment is agricultural land.

Transboundary impact

The following table gives an overview on the chemical status of the river at the Ukrainian monitoring station "Ogurtsovo village" at the Ukrainian-Russian border (2001) in comparison with the Ukrainian MAC values. From the determinands monitored, total iron, manganese, copper, nitrites, sulphates, phenols, zinc, oil products, chromium (6+) and BOD_5 are of particular concern.

Chemical status of the Siversky Donets at the Ukrainian monitoring station "Ogurtsovo village" at the Ukrainian/Russian border in 2001 [46]

Determinands	Maximum concentration in mg/l	Minimum concentration in mg/l	Average concentration in mg/l	MAC for fish in mg/l	MAC for drinking water in mg/l
Ammonia	0.42	0.06	0.22	0.5	…
Iron, total	0.26	0	0.16	0.1	0.3
Manganese	45	14.6	23.0	40	…
Copper	0.01	0	0.003	0.001	1
Nitrates	11.3	0.09	3.55	40	45
Nitrites	0.195	0.016	0.109	0.08	3
Surfactants	0.081	0.009	0.031	0.3	0.5
Sulphates	144.1	86.5	106.9	100	500
Phenols	0.001	0	0.0002	0.001	0.25
Chlorides	47.9	28.4	38.7	300	350
Zinc	0.127	0.003	0.020	0.001	0.25
Calcium	112.2	80.2	95.5	180	…
Oil products	0.5	0	0.2	0.05	0.1
Dry residues	598	452	517	…	1000-1500
Phosphates	1.84	0.51	1.02	…	3.5
Chromium 6+	0.006	0	0.001	0.001	0.1
DDE	0	0	0	…	…
DDT	0	0	0	…	…
BOD_5	3.56	1.4	2.69	2	…
Suspended solids	26.7	4.7	8.6	…	…

Trends

The industrial decline since 1992 makes it very difficult for many industries to invest in pollution control measures.

In recent years, low flows in the river reduced dilution for pollutants.

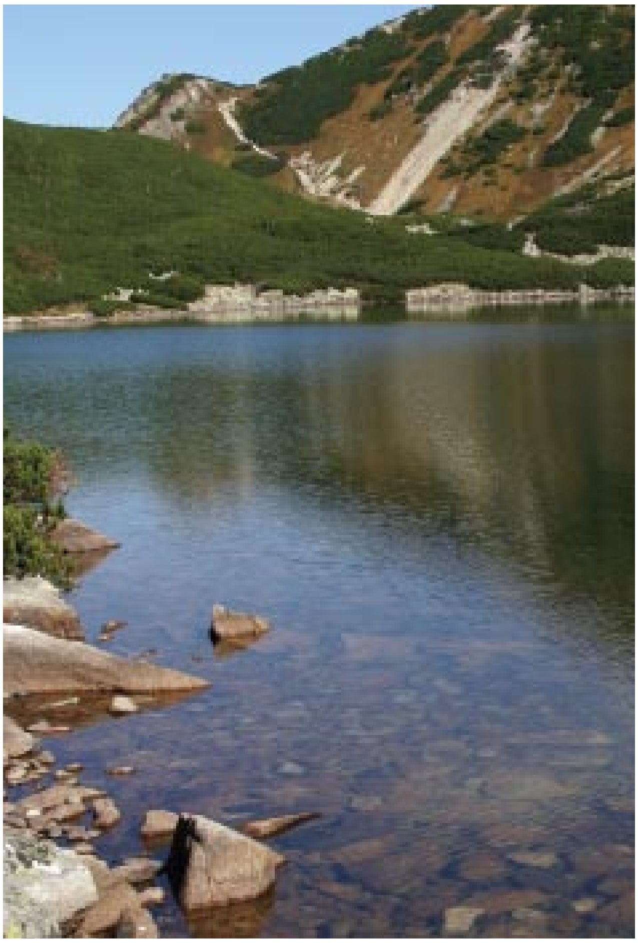
[46] Source: Joint River Management Programme Severski-Donez Basin Report.

PSOU RIVER BASIN[47]

The Russian Federation and Georgia share the Psou River basin.

Basin of the Psou River			
Area	**Country**	**Country's share**	
421 km²	Georgia	232 km²	55.1%
	Russian Federation	189 km²	44.9%

Source: Ministry of Environment Protection and Natural Resources of Georgia.



The Psou River originates on the Mountain Aigba at a height of 2,517 m. It flows along the Georgian-Russian border and discharges into the Black Sea. The river length is 53 km and the average elevation of the basin is 1,110 m.

There are no transboundary tributaries to the Psou River. Its main left-hand side tributaries are the Besh (11 km long) and Pkhista (13 km long), both in Georgia. Altogether, 158 other very small tributaries have been identified.

The Psou River's flow velocity varies between 0.7 m/s and 2 m/s and its depth between 0.6 m and 2.1 m. The river is fed by snow, rainwater and groundwater. The river is characterized by spring floods, with a peak in May. In summer, a shortage of water often occurs.

The average temperature of the river water in January varies between 3.7 °C and 6.7 °C and in August between 14.8 °C and 21.7 °C.

A hydrological station on the Psou River, located at Leselidze (Georgia) 1.5 km upstream of the river mouth, was operational from 1913 to 1955.

Discharge characteristics of the Psou River at the gauging station at Leselidze (Georgia) (1.5 km upstream of the river mouth)

Discharge characteristics	Discharge	Period of time or date
Q_{av}	17.3 m³/s	1913–1955
$Q_{absolute\ max}$	327 m³/s	18 May 1932
$Q_{absolute\ min}$	2.6 m³/s	6 February 1931; 26–27 September 1935

Sources: Ministry of Environment Protection and Natural Resources of Georgia.

[47] Based on information by the Ministry of Environment Protection and Natural Resources of Georgia.

CHOROKHI/CORUH RIVER BASIN[48]

CHOROKHI/CORUH RIVER

Turkey (upstream country) and Georgia (downstream country) share the basin of the Chorokhi River, also known as Coruh River, which has a total length of 438 km (412 km in Turkey; 26 km in Georgia).

Basin of the Chorokhi/Coruh River			
Area	Countries	Countries' share	
22,100 km^2	Turkey	19,910 km^2	90.5%
	Georgia	2,090 km^2	9.5%

Source: Ministry of Environment Protection and Natural Resources of Georgia.

Hydrology[49]

The Chorokhi/Coruh is one of the most important rivers of the eastern coast of the Black Sea. It originates in Turkey at a height of 2,700 m. The river is 438 km long. Its depth varies between 1.5 and 4.8 m and its flow velocity between 0.7 m/s and 2.5 m/s. Floods often occur in spring and autumn. The relief of the basin is mainly mountainous.

From the former five gauging stations in Georgia, only one station (Mirveti) is currently operational and provides data on water levels, water temperature, water discharges (weekly or monthly) as well as suspended sediments. Hydrochemical and hydrobiological determinands are not measured.

Discharge characteristics of the Chorokhi/Coruh River at the Erge gauging station (Georgia)[50] (15 km upstream of the river mouth; latitude: 41° 33′; longitude: 41° 42′)		
Q_{av}	278 m^3/s	1930–1992
Q_{max}	409 m^3/s	1930–1992
Q_{min}	159 m^3/s	1930–1992
$Q_{absolute\ max}$	3,840 m^3/s	8 May 1942
$Q_{absolute\ min}$	44.4 m^3/s	12 August 1955

Source: Ministry of Environment Protection and Natural Resources of Georgia.

Pressure factors in Georgia[51]

In Georgia, the river basin is covered by forests (oak, chestnut, fir) and used for agriculture. Due to lacking data, the impact of these forms of land use on the quality of the river and its biological characteristics is unknown.

Pressure factors in Turkey[52]

The rivers in the Turkish part of the Chorokhi/Coruh River basin have irregular flow regimes with a large variation in run-off parameters. This part of the river basin is also prone to floods. The Turkish Government has therefore decided to build 10 dams on the main watercourse in order to protect the residents of this area from the threats of floods with risk to their lives and material loss. The Yusufeli Dam and Hydroelectric Power Plant (HEPP) and the Deriner dam are two of the biggest projects among these 10 dams. The Yusufeli Dam and HEPP is planned to be built on the Chorokhi/Coruh River, about 40 km southwest of the Artvin city centre. The main purpose of the project is to produce electric power. The dam and HEPP also regulate the flow of the river and make downstream development projects in Turkey viable and more economical. An Environ-

[48] Based on information by the Ministry of Environment Protection and Natural Resources of Georgia and the Ministry of Foreign Affairs of Turkey.
[49] Based on information by the Ministry of Environment Protection and Natural Resources of Georgia.
[50] The gauging station ceased operation in 1992.
[51] Communication by the Ministry of Environment Protection and Natural Resources of Georgia.
[52] Communication by the Ministry of Foreign Affairs of Turkey.

mental Impact Assessment (EIA) report on the Yusufeli dam and HEPP was finalized (see below).

In Turkey, sediment transport is monitored twice a year. By 2006, altogether 15 sets of measurements were carried out, whose results were communicated to Georgia through diplomatic channels.

Transboundary impact[53]

Georgian authorities estimate that about half of the sediments transported by the Chorokhi/Coruh River form the sandy beaches at the Black Sea coast. The maintenance of the sediment transport is vital for tourism, which is of prime importance to Georgia's earnings.

Studies show that the development and the forming of the Black Sea coastal zone in Ajara (Georgia) depends on the quantity and quality characteristics of the alluvial deposit brought into the sea by the Chorokhi/Coruh River. The alluvial deposit is then moved to the north and takes part in the formation process of the beach in the Batumi sea front. It is estimated that the Chorokhi/Coruh carries 4.92 million m^3 solid sediment to the river mouth, whereby 2.31 million m^3 contribute to the formation of the coastal zone and the underground slope, and 2.61 million m^3 form sea sediments. In spite of the huge volume of the coastal sediments, the coastal zone near the river mouth has been experiencing a "washing away" problem. This problem may become worse due to the expected decreasing amount of sediment transport linked to the construction of the dams on Turkish territory.

The EIA report on the Yusufeli Dam and HEPP predicts that trapping of 83% of the suspended sediments in the cascade of dams would create changes in the river mouth. Due to a reduced amount of sediments arriving at the mouth, morphological changes would occur and, with all likelihood, the mouth of the Chorokhi/Coruh may gradually become estuary-shaped.

Conclusions

On the above issues meetings between both countries started as early as 1998 and joint work on the assessment of the consequences is ongoing. Georgia and Turkey are committed to further bilateral cooperation. Turkey communicated to the UNECE secretariat its commitment to take the EIA report and its recommendations into consideration during the construction and operation of the Yusufeli Dam and HEPP. Moreover, monitoring stations are being set up in the basin.

MACHAKHELISCKALI RIVER[54]

The Machakheliscкali River, a transboundary tributary to the Chorokhi/Coruh, has its source in Turkey at a height of 2,285 m. The length of the river is 37 km (Turkey – 16 km, Georgia – 21 km). The basin area is 369 km^2 (Turkey – 181 km^2, Georgia – 188 km^2).

The only hydrological station on the Machakhelisckali River at the village of Sindieti (Georgia) was in operation from 1940 to 1995. The station was located 2.2 km upstream of the mouth of Chorokhi/Coruh.

Discharge characteristics of the Machakhelisckali River at the Sindieti gauging station (2.2 km upstream of the Chorokhi/Coruh river's mouth)		
Q_{av}	20.6 m^3/s	1940–1995
Q_{max}	30.4 m^3/s	1940–1995
Q_{min}	9.12 m^3/s	1940–1995
$Q_{absolute\ max}$	430 m^3/s	12 September 1962
$Q_{absolute\ min}$	1.50 m^3/s	31 January – 10 February 1950

Source: Ministry of Environment Protection and Natural Resources of Georgia.

[53] Based on information by Georgia and Turkey and the Environment Impact Assessment for the construction of the Yusufeli Dam and HEPP Project, Turkish Environmental Consultancy Company "Encon".
[54] Based on information by the Ministry of Environment Protection and Natural Resources of Georgia.

DRAINAGE BASIN OF THE MEDITERRANEAN SEA

This chapter deals with major transboundary rivers discharging into the Mediterranean Sea and some of their transboundary tributaries. It also includes lakes located within the basin of the Mediterranean Sea.

TRANSBOUNDARY WATERS IN THE BASIN OF THE MEDITERRANEAN SEA[1]

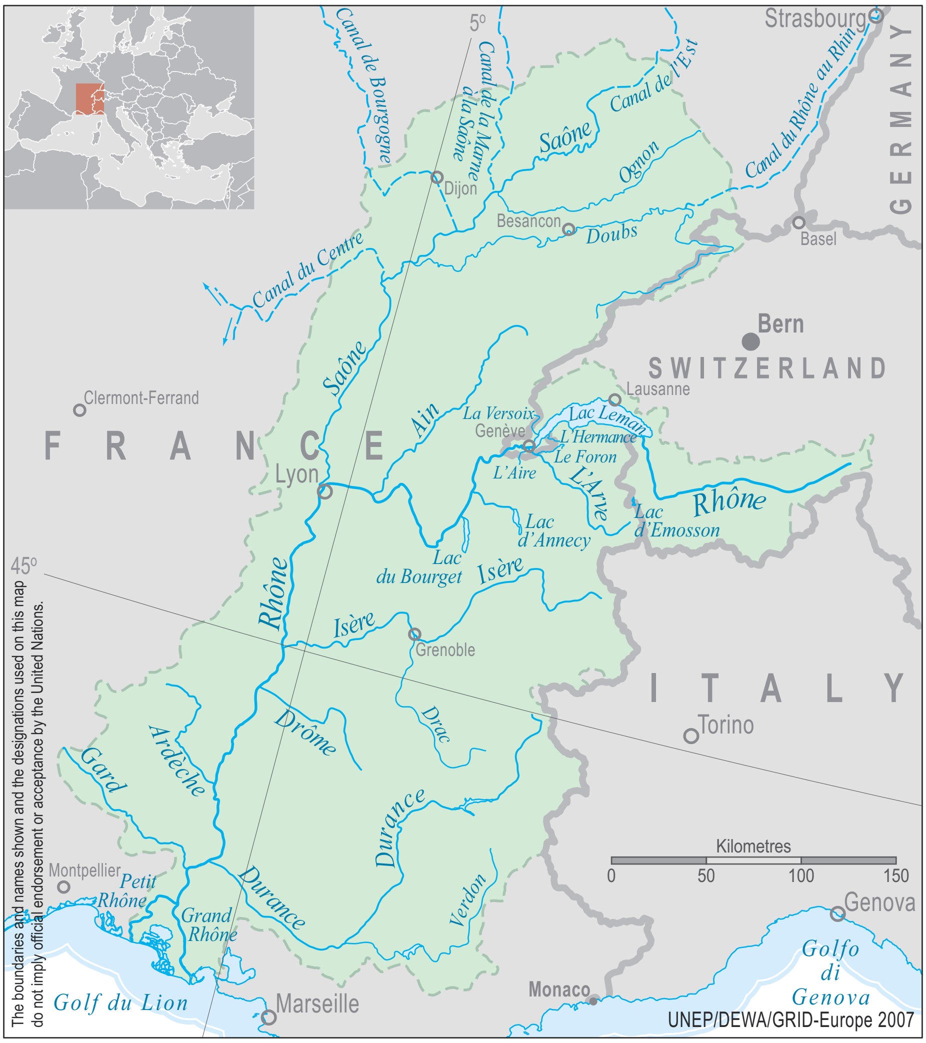
Basin/sub-basin(s)	Total area (km²)	Recipient	Riparian countries	Lakes in the basin
Ebro	85,800	Mediter. Sea	AD, ES, FR	…
Rhone	98,000	Mediter. Sea	CH, FR, IT	Lake Emosson, Lake Geneva
Roia	*600*	*Mediter. Sea*	*FR, IT*	…
Po	74,000	Mediter. Sea	AT, CH, FR, IT	Lake Maggiore, Lake Lugano
Isonzo	3,400	Mediter. Sea	IT, SI	
Krka	2,500	Mediter. Sea	BA, HR	
Neretva	8,100	Mediter. Sea	BA, HR	
Drin	17,900	Mediter. Sea	AL, GR, ME, MK, RS	Lake Ohrid, Lake Prespa, Lake Skadar
Vijose	6,519	Mediter. Sea	AL, GR	
Vardar	23,750	Mediter. Sea	GR, MK	Lake Dojran
Struma	18,079	Mediter. Sea	BG, GR, MK, RS	
Nestos	5,613	Mediter. Sea	BG, GR	
Maritza	52,600	Mediter. Sea	BG, GR, TR	
- Arda	…	Maritza	BG, GR	
- Tundja	…	Maritza	BG, TR	

[1] The assessment of water bodies in italics was not included in the present publication.

EBRO RIVER BASIN[1]

The Ebro River rises near the Atlantic coast in the Cantabrian Mountains in northern Spain, drains an area of 86,000 km² between the Pyrenees and the Iberian mountains, and empties through a wide delta into the Mediterranean Sea. Andorra, France and Spain are the riparian countries. Due to the very small share of Andorra and France in the total basin area (86,000 km²), the assessment of the status of the Ebro was not included in the present publication.

RHONE RIVER BASIN[2]



Switzerland (upstream country) and France (downstream country) share the Rhone River basin; the Italian part of the basin is negligible.

Lake Geneva and Lake Emosson (see assessments below) are transboundary lakes in the basin. Lake Emosson (located in the Swiss part of the Rhone basin) is formed by a dam, which is jointly operated by France and Switzerland for hydropower generation.

Basin of the Rhone River			
Area	**Country**	**Country's share**	
98,00 km²	France	90,000 km²	92%
	Italy	50 km²	…
	Switzerland	8,000 km²	8%

Source: Freshwater in Europe – Facts, Figures and Maps. UNEP/DEWA-Europe, 2004.

[1] Information based on the publication of the United Nations Environment Programme Division of Early Warning and Assessment, Office for Europe titled Freshwater in Europe – Facts, Figures and Maps. (UNEP/DEWA-Europe, 2004).
[2] Information based on publications of the International Commission for the Protection of Lake Geneva.

RHONE RIVER

Hydrology

The river rises from the Rhone glacier at an altitude of 1,765 m. Major transboundary rivers in the basin include the Arve, which joins the Rhone downstream from Lake Geneva, and the Doubs (a transboundary tributary of the Saône); a number of small transboundary rivers end up in Lake Geneva.

Other main tributaries of the Rhone, completely located in France, include the Ain, Saône, Ardèche, Gard, Isère, Drôme and Durance.

The average annual discharge from Lake Geneva is 570 m^3/s and at Beaucaire, upstream Arles (France) near the end of the river course, it is 2,300 m^3/s.

Typically, the Rhone develops floods in spring and autumn. Flood peaks of 13,000 m^3/s were recorded in autumn of 2003. The river also has a relatively high gradient (0.625°/°°). These characteristics help explain why the Rhone has been known for its poor navigability, but good hydroelectric potential.

Pressure factors[3]

Today, the flow regime of the Rhone is regulated by several large storage reservoirs (7 billion m^3, which represent about 7.3 % of the annual runoff of 96 billion m^3). Nearly 80% of this storage capacity is located downstream of Geneva and is provided by such dams as the Vouglans dam on the Upper Ain River, several dams on Isère River (which together account for 30% of total storage capacity) and the Serre-Ponçon dam on the Durance River. The Serre-Ponçon dam is one of the largest in Europe and it provides 43% of the basin's storage capacity.

The Rhone basin is a densely populated, industrialized and agricultural area with some 15 million inhabitants in France and Switzerland (more than 2.5 million inhabitants in the "river corridor" in France). The Rhone has contributed to the economic prosperity of the riverside cities and their inhabitants.

In ecological terms, the effects of change in physical habitat have been particularly considerable: the morphology of the river channel has changed from braided to straight and canalized, often eroded and incised; the level of the groundwater has been lowered; several natural biotopes disappeared; the riparian forest evolved to hardwood forest due to groundwater depletion; and dams block the migration of amphibiotic fish (shads, eel, lampreys), where numerous lateral communications with tributaries or side channels have been modified, sometimes cut off. Overall the biodiversity of the river has been reduced. There is scarcity of species whose life histories are linked to a dynamic fluvial system. Rheophilic species have declined and communities shifted to more limnophilic habitat species.

The Rhone delta is known as the Camargue with a surface area of 800 km^2. This region is one of the major wildlife areas of Europe.

LAKE GENEVA/LAC LEMAN[4]

Lake Geneva is a transboundary lake (580 km^2) shared between Switzerland (345.3 km^2) and France (234.8 km^2). It is the largest lake of Western Europe and a vast drinking-water reservoir. Lake Geneva is a deep lake; the mean depth is 152.7 m and the maximum depth 309.7 m. It represents a privileged habitat and recreation area. The anthropogenic impact is strong on both sides of the lake. Only 3% of the lakeshores are still natural.

As 20% of the lake basin (total area 7,975 km^2), which is mostly located in Switzerland, consists of cultivated land; agriculture is clearly one of the pressure factors. The others are industries and urbanization.

In 1957, concerned by the growing pollution in Lake Geneva, a group of scientists introduced systematic monitoring of the water quality. Subsequently, the Governments of France and Switzerland founded the International Commission for the Protection of Lake Geneva (CIPEL), following an agreement signed in 1962. Today, CIPEL's efforts include not only the protection of the lake water but also the renaturation of the rivers in the lake basin, whose biodiversity is threatened.

[3] Based on the IUCN publication by Yves Souchon: "The Rhone river: hydromorphological and ecological rehabilitation of a heavily man-used hydrosystem".
[4] Based on information by the International Commission for the Protection of Lake Geneva (CIPEL).

Eutrophication and industrial pesticides are the most serious water-quality problems. The lake has a good ecological status. Due to the long retention time (11.4 years), the restoration of the lake is slow, making it vulnerable to alteration.

LAKE EMOSSON[5]

Lake Emosson (located in the Swiss part of the Rhone basin) is formed by a dam, which is jointly operated by France and Switzerland (Electricité d'Emosson SA) for hydropower generation. The company collects water from the Mont Blanc Massif, which it channels into the reservoir located at an altitude of 1930 meters.

The water comes from the high valleys of the river Arve and Eau Noire (France) and from the Ferret and Trient valleys (Switzerland). Through collectors located on the French side, the water is routed to the reservoir by gravity. The water from the Swiss side must be pumped into the reservoir.

The two stations of the scheme - Châtelard-Vallorcine (France, 189 MW) and La Bâtiaz (Martigny, Switzerland, 162 MW) - annually generate 612 GWh of energy, of which 94 % in the winter. The energy used for pumping represents 110 GWh per year.

[5] Based on information by Electricité d'Emosson SA .

PO RIVER BASIN[6]

France, Italy and Switzerland share the basin of the Po River.

Basin of the Po River			
Area	**Country**	**Country's share**	
≈ 74,000 km²	France	230 km²	0.4%
	Italy	70,000 km²	94.4%
	Switzerland	3,900 km²	5.2%

Source: Po River Basin Authority, Italy.

The Po River rises from Mount Monviso at 2,022 m above sea level and flows towards the Adriatic Sea, where its delta represents a habitat of precious environmental and landscape value.

The Po basin is divided into three areas: an Alpine sector, prevalently of crystalline metamorphic origin; an Apennine sector, mostly of sedimentary origin with a high clay content (as a consequence, several areas are affected by erosion and landslides); and a central alluvial area, including the Padanian Plain and the Adriatic lowlands.

The transboundary rivers and lakes in the Po basin are located in the Alpine sector. The most prominent transboundary river, the Ticino River, as well as Lake Maggiore and Lake Lugano, are shared by Italy and Switzerland. In general, watercourses in the Alpine sector and their sub-basins have "glacio-nival and lacustrine environments": they are able to regulate flows, have a considerable size of plain reaches, and a moderate transport of solids (compared to the watercourses in the Appenine sector). The glacial regime of the Alpine rivers is characterized by maximum flows from late spring to early autumn and low flows in winter.

The surface water data available in the entire Po hydrographic system cover a period of roughly 30 years. All the water resources of the basin are exposed to a high level of anhropogenic pressure, generating an organic load equivalent to that produced by 100 million inhabitants (although only 17 million people live in the basin), approximately 15% of which can be attributed to municipal sources, 52% to industrial wastewaters, and 33 % to agriculture and animal husbandry. The combined effect of polluting agents makes many rivers unsuitable for bathing, prevents the development of a balanced aquatic life, and requires deep water purification before drinking-water supply.

LAKE LUGANO[7]

Lake Lugano, a transboundary lake shared by Italy and Switzerland, belongs to the Po River basin. The lake is a popular place for recreation activities.

The lake has a surface of 48.9 km² and basin area of 565 km². Lake Lugano is divided into two main parts, the northern part being deep and the southern part relatively shallow. The volume of the lake is 6.5 km³ and its theoretical retention time is approximately 8.2 years (11.9 years in the northern part and 2.3 years in the southern part).

In the 1960s, the lake was heavily polluted by anthropogenic sources and became eutrophic. The period was characterized by high phosphorus concentration and oxygen deficiency in the bottom water layers. Since the 1970s, the lake has recovered substantially, mainly due to eight wastewater treatment plants that gradually came into operation and use mechanical, chemical and biological treatments. In 1986, Italy and Switzerland began to eliminate the phosphorus in detergents and cleaning products. Since 1995, the main sewage treatment plants have improved their efficiency by introducing phosphorus post-precipitation, denitrification and filtration treatments. During the last 20 years, recovery measures have reduced the external phosphorus load from about 250 to 70-80 tons/year. The improved water status is also visible in the Secchi-disk transparency, which has increased from 3.5 to 5.5 m. Currently, the external nutrient load derives from anthropogenic (85%), industrial (10%) and agricultural (5%) sources.

[6] Based on information by the Po River Basin Authority, Italy.
[7] Based on Monitoring of International Lakes - Background document for the Guidelines on Monitoring and Assessment of Transboundary and International Lakes, UNECE, 2002.

LAKE MAGGIORE[8]

Lake Maggiore (Lago Maggiore) is a large pre-Alpine lake situated west of Lake Lugano on the border between Italy and Switzerland. It offers good possibilities for fisheries, navigation, tourism and recreation (swimming, sportfishing, yachting). The lake belongs to the sub-basin of the Ticino River, a tributary of the Po River.

Lake Maggiore has a relatively large drainage basin (6,600 km^2) covered, inter alia, by woody vegetation (20 %), rocky outcrops and depris (20 %), permanent snow, and glaciers and lakes. The lake is 65 km long and 2–4.5 km wide and has a surface area of 213 km^2. The total volume of this deep lake (mean depth 177 m, maximum depth 372 m) is 37.5 km^3, and its theoretical retention time is 4 years.

Lake Maggiore underwent a process of eutrophication in the course of the 1960s and 1970s due to phosphorus inputs from municipal sewage, changing its status from oligotrophic to meso-eutrophic. Starting from the late 1970s, the phosphorus load has been gradually reduced; the total phosphorus in-lake concentration is currently below 10 µg/l (at winter mixing), compared to a maximum value of 30 µg/l in 1978.

ISONZO RIVER BASIN[9]

Slovenia (upstream country) and Italy (downstream country) share the Isonzo basin

Basin of the Isonzo River			
Area	**Country**	**Country's share**	
3,400 km^2	Italy	1,150 km^2	34%
	Slovenia	2,250km^2	66%

Source: Ministry of the Environment, Land and Sea, Italy.

The river Isonzo, in Slovenia known as the Soča, has its source in Slovenia and empties into the Adriatic Sea. The basin has a pronounced mountainous character with an average elevation of about 599 m above sea level.

Major transboundary tributaries include the rivers Natisone, Vipoacco and Iudrio.

Discharge characteristics of the Isonzo River at the gauging station Pieris		
Discharge characteristics	**Discharge**	**Period of time or date**
Q_{av}	172 m^3/s	…
Q_{max}	4,400 m^3/s	1925-1953
Q_{min}	12.1 m^3/s	3 August 1904
Discharge characteristics of the Isonzo River at the gauging station Ponte Piuma (Italy)		
Q_{av}	21 m^3/s	…
Mean monthly values		
October: 18 m^3/s	November: 22 m^3/s	December: 20 m^3/s
January: 14 m^3/s	February: 13 m^3/s	March: 18 m^3/s
April: 21 m^3/s	May: 24 m^3/s	June: 23 m^3/s
July: 21 m^3/s	August: 17 m^3/s	September: 15 m^3/s

Source: Ministry of the Environment, Land and Sea, Italy.

[8] Based on Monitoring of International Lakes - Background document for the Guidelines on Monitoring and Assessment of Transboundary and International Lakes, UNECE, 2002.
[9] Based on information submitted by the Ministry of the Environment, Land and Sea, Italy.

Dams include the Salcano, Sottosella and Canale Dams in Slovenia and the Crosis Dam in Italy. The lakes Doberdò amd Pietrarossa are natural water bodies in Italy.

In the Italian part of the basin, the main forms of land use are forests (40%), cropland (45%) and grassland (6%). 227 km^2 are protected areas.

Organic matter from wastewater discharges and heavy metals cause a transboundary impact and affect the water quality in the Adriatic.

According to recent Italian data,[10] eight monitoring stations show a "good status" of surface waters, and one station an "elevated status".

Water use in the Italian part of the Isonzo River basin (%)			
Agriculture	**Urban**	**Industry**	**Energy**
64	5	4	27

Source: Ministry of the Environment, Land and Sea, Italy.

KRKA RIVER BASIN[11]

Croatia and Bosnia and Herzegovina are the two riparian countries in the Krka River basin.

[10] Source: Ministry of the Environment, Land and Sea, Italy. Database "Quality Data D.Lgs. 152/99".
[11] Based on information provided by the Croatian Waters/Water Management Department (Split, Croatia) on behalf of both Croatia and Bosnia and Herzegovina.

Basin of the Krka River			
Area	**Country**	**Country's share**	
2,500 km^2	Bosnia and Herzegovina	300 km^2	12%
	Croatia	2,200 km^2	88%

Source: Croatian Waters/Water Management Department (Split, Croatia).

Hydrology

The river has its source in Croatia and ends up in the Adriatic Sea in Croatia. The basin has a pronounced mountainous character with an average elevation of about 100 m above sea level. Major lakes are Lake Brljan (man-made), Lake Golubić (man-made), Lake Visovac (natural) and Lake Prokljan (natural). The National Park "Krka" covers 4.5% of the basin area.

A major transboundary tributary is the river Butišnica.

There are three hydropower stations located on the Krka, and two located on the tributaries Butišnica and Krčić.

Discharge characteristics of the Krka River at the gauging station Marjanovići (Croatia)		
Discharge characteristics	**Discharge**	**Period of time or date**
Q_{av}	21.2 m^3/s	1963–1990
Q_{av}	18.4 m^3/s	1979–1991
Q_{max}	125 m^3/s	1961–1990
Q_{min}	3.3 m^3/s	1961–1990
Mean monthly values		
October: 11.8 m^3/s	November: 17.9 m^3/s	December: 24.3 m^3/s
January: 22.0 m^3/s	February: 23.8 m^3/s	March: 25.0 m^3/s
April: 28.2 m^3/s	May: 24.6 m^3/s	June: 17.6 m^3/s
July: 11.7 m^3/s	August: 8.06 m^3/s	September: 8.67 m^3/s

Source: Croatian Waters/Water Management Department (Split, Croatia).

Pressure factors

The main forms of land use include grasslands (44%), forests (30%) and cropland (15%). In Croatia, the population density is 34 persons/km^2. No data were available from Bosnia and Herzegovina.

Industry uses 27% of the water from the public water supply systems, and the urban sector, 73%.

The pressure from agriculture is insignificant due to the still low agricultural production of fruits, vegetables and olives as well as a very low animal production (sheep, pigs, poultry). However, the production is slowly increasing, which in turn may lead to increasing pressure and transboundary impact.

There are 18 small sites for stone and alabaster excavations. The intensity of exploitation and the number of sites are slowly increasing.

Intensive aluminum production and shipyards are located in the coastal area in Croatia. Other industry sectors are less intensive and not recovered after the war. They are mostly connected to the sewer systems. The number of industrial zones is rapidly increasing, but they are all required by law to have adequate wastewater treatment or to be connected to municipal wastewater treatment plants.

There are still unfinished sewerage systems and untreated urban wastewaters from the towns Knin (40,000 p.e.) and Drniš (10,000 p.e.).[12] The three controlled dumping sites

[12] The abbreviation "p.e." means population equivalent.

do not cause significant impact; however, there are also several small illegal dumpsites.

Storm waters from highways are treated by oil-separators and disposed into underground or discharged into the rivers. However, the treated waters cannot be disposed of into the underground in the vicinity of water abstraction sites (sanitary protection zones).

Minimum, maximum and mean values of water-quality determinands at the water-quality station Lake Visovac

Year	Values	Determinands						
		COD_{Mn} mgO_2/l	BOD_5 mgO_2/l	Ammonia mgN/l	Nitrite mgN/l	Nitrate mgN/l	Total N mgN/l	Total P mgP/l
2001	Min	0.9000	1.1000	0.0000	0.0000	0.1420	0.3800	0.0000
	Max	6.0000	4.3000	0.1100	0.0420	1.0340	1.2370	0.0920
	Mean	2.9000	2.7909	0.0285	0.0079	0.4951	0.8729	0.0373
2002	Min	1.1000	0.5000	0.0000	0.0000	0.0440	0.2780	0.0110
	Max	2.8000	5.3000	0.0750	0.0170	0.6960	1.1180	0.1340
	Mean	1.9833	2.3917	0.0298	0.0053	0.4307	0.7558	0.0364
2003	Min	0.8000	0.9000	0.0100	0.0050	0.1700	0.4400	0.0100
	Max	6.0000	5.0000	0.0800	0.0190	1.0300	1.3250	0.0800
	Mean	2.5500	2.4273	0.0317	0.0085	0.4750	0.8285	0.0375
2004	Min	0.6000	0.4300	0.0100	0.0030	0.1000	0.2720	0.0100
	Max	2.4000	2.6000	0.0700	0.0130	0.7300	1.0500	0.0450

Source: Croatian Waters/Water Management Department (Split, Croatia).

The water bodies have mostly a “good ecological status”. The surface waters in the National Park “Krka” have a “moderate status” because of the ecological requirements of the National Park for high water quality and the untreated urban wastewater discharges from the towns Drniš and Knin, which are located upstream.

NERETVA RIVER BASIN[13]

Bosnia and Herzegovina and Croatia are the riparian countries in the Neretva River basin

Basin of the Neretva River			
Area	Country	Country's share	
8,100 km²	Bosnia and Herzegovina	7,900 km²	97.5%
	Croatia	200 km²	2.5%

Source: Ministry of Foreign Trade and Economic Relations, Bosnia and Herzegovina, and Croatian Waters/Water Management Department (Split, Croatia).

Hydrology

The river has its source in the Jabuka Mountains and empties into the Adriatic Sea. The basin has a pronounced mountainous character in its upper part and a lowland character further downstream.

Major transboundary tributaries include the rivers Ljuta, Rama, Drežanjka, Rdaobolja, Jasenica, Buna, Bregava, Trebižat, Krupa, Bistrica, Žabljak, Sturba and Trebišnjica.

Discharge characteristics of the Neretva River at the gauging station Mostar		
Discharge characteristics	Discharge	Period of time or date
Q_{av}	180 m³/s	…
Q_{max}	1,900 m³/s	…
Q_{min}	50 m³/s	…

Source: Croatian Waters/Water Management Department (Split, Croatia).

Dams and reservoirs include those of Jablanica, Grabovica, Salakovac and Mostar.

Pressure factors

Pressures on water resources result from aluminum production, untreated municipal wastewaters and uncontrolled dumpsites, both for municipal and industrial wastes.

[13] Based on information provided by the Ministry of Foreign Trade and Economic Relations, Bosnia and Herzegovina, and Croatian Waters/Water Management Department (Split, Croatia).

Minimum, maximum and mean values for water-quality determinands at the station Rogotin/Croatia						
Determinands	**2001**			**2002**		
	Min.	**Max.**	**Mean**	**Min.**	**Max.**	**Mean**
BOD_5, mgO_2/l	0.3	5.4	2.245	0.3	4.9	2.9
COD, mgO_2/l	1.7	5.1	3.04	1.4	4.1	2.3
Ammonium, mgN/l	0	0.08	0.038	0	0.107	0.03
Nitrites, mg/l	0	0.025	0.011	0	0.017	0.01
Nitrates, mgN/l	0.339	0.733	0.515	0.16	0.89	0.524
Total Kjehldal nitrogen, mgN/l	0.703	1.229	0.896	0.601	1.217	0.95
Total phosphorus, mgP/l	0	0.116	0.034	0.01	0.152	0.068
Mineral oils, mg/l	0	0.04	0.0136	0	0.039	0.0175
Phenols, mg/l	0	0.004	0.001	0	0.09	0.008
Chlorides, mg/l	16	2,100	983	10	1,350	604
Determinands	**2005**			**2006**		
	Min.	**Max.**	**Mean**	**Min.**	**Max.**	**Mean**
BOD_5, mgO_2/l	1.5	4.4	1.84	1.5	1.5	1.5
COD, mgO_2/l	1.5	3.1	1.97	1.5	3.9	2.19
Ammonium, mgN/l	0.01	0.13	0.032	0.01	0.07	0.02
Nitrites, mg/l	0.005	0.005	0.005	0.005	0.005	0.005
Nitrates, mgN/l	0,32	0.96	0.64	0.33	0.9	0.57
Total Kjehldal nitrogen, mgN/l	0.46	1.28	0.92	0.44	1.19	0.82
Total phosphorus, mgP/l	0.01	0.04	0.022	0.005	0.073	0.03
Mineral oils, mg/l	0.001	0.009	0.003	0.001	0.025	0.009
Phenols, mg/l	0.001	0.004	0.001	0.001	0.004	0.001
Chlorides, mg/l	13	1,600	525	13	1,330	403

Source: Croatian Waters/Water Management Department (Split, Croatia).

Bosnia and Herzegovina reported that water pollution by pesticides, heavy metals and industrial organic compounds, as well as salinization, are issues of great concern.

DRIN RIVER BASIN[14]

The Drin starts at the confluence of its two headwaters, the transboundary river Black Drin (Crn Drim) and the transboundary river White Drin (Beli Drim) at Kukës in Albania.

The interconnected hydrological system of the Drin River basin comprises three major transboundary sub-basins: the sub-basin of the Black Drin, the sub-basin of the White Drin and the sub-basin of Lake Skadar, which is a transboundary lake. The two other transboundary lakes (Lake Ohrid and Lake Prespa) are part of the Black Drin's sub-basin.

Albania, Greece, Montenegro, Serbia and The former Yugoslav Republic of Macedonia share the Drin basin.

BLACK DRIN[15]

The Black Drin originates from Lake Ohrid and runs through The former Yugoslav Republic of Macedonia and Albania. A major transboundary tributary is the river Radika.

The Black Drin sub-basin in The former Yugoslav Republic of Macedonia is mainly covered by forests (52%) and agricultural land (16%).

The two natural lakes in the sub-basin of the Black Drin (Lake Ohrid and Lake Prespa) are transboundary lakes. The dams at Spilja and Globocica form reservoirs on the Black Drin, used for hydropower production.

According to information by The former Yugoslav Republic of Macedonia, there is an extensive cattle production, but low crop production due to the mountainous character of the sub-basin in the country. There are no subsurface mining activities though there is mineral surface mining. The great number of illegal dumpsites is of particular concern.

The intensive tourism around Lake Ohrid and Lake Prespa and in the National Park Mavrovo is another pressure factor.

The pressure from tourism and human settlements has started to decrease due to the construction of a wastewater treatment plant which treats sewage from the vicinity of Lake Ohrid.

LAKE OHRID[16] AND LAKE PRESPA[17]

Lake Ohrid (358 km^2) is located at an altitude of 695 m and encircled by mountains exceeding 2,000 m in height. The lake is deep (mean depth 163.7 m, maximum depth 288.7 m). Some 249 km^2 (67%) of the lake belongs to The former Yugoslav Republic of Macedonia and 109 km^2 (33%) to Albania. Some 650 km^2 (62%) of the lake basin is in The former Yugoslav Republic of Macedonia and 392 km^2 (38%) in Albania.

Lake Prespa (274 km^2) is a transboundary lake shared by The former Yugoslav Republic of Macedonia (178 km^2), Albania (49 km^2) and Greece (47 km^2). The lake basin is some 2,800 km^2, and the mean depth is 16 m (the maximum is 47 m). The lake is characterized by eutrophication, industrial pollution, toxic substances and other relevant pollution factors.

Lake Prespa is situated at an altitude of 845 m, i.e. above Lake Ohrid, and its waters drain into Lake Ohrid through very porous karst mountains. The water system of Lake Ohrid is rather complex because of the underground links with Lake Prespa. The mean theoretical retention time is 83.6 years.

Lake Ohrid is one of the oldest lakes in the world. It was formed 2 to 3 million years ago. Because the lake has been isolated by surrounding mountains, a unique collection of plants and animals have evolved. Some of these plants and animals were common species millions of years ago but are now considered relics or "living fossils" because they can be found only in Lake Ohrid. The Lake Ohrid area has been a World Natural Heritage Site since 1980.

[14] Based on information submitted by the Ministry of Urban Planning, Construction and Environment, The former Yugoslav Republic of Macedonia. For the lake assessment, use was also made of: Faloutsos D., Constantianos V., and Scoullos M., Assessment of the management of shared lake basins in South-eastern Europe. A report within GEF IW:LEARN, Activity D2. GWP-Med, Athens, 2006.
[15] Based on information by the Ministry of Urban Planning, Construction and Environment, The former Yugoslav Republic of Macedonia.
[16] Based on information submitted by the Ministry for the Environment, Physical Planning and Public Works of Greece; Environmental Performance Review of Albania, UNECE. 2002; Environmental Performance Review of the former Yugoslav Republic of Macedonia, UNECE, 2002; Assessment of the Management of Shared Lake Basins in Southeast Europe, D. Faloutsos, V. Constantianos, M. Scoullos; GEF IW: LEARN Activity D2, 2006.
[17] Based on information submitted by the Ministry for the Environment, Physical Planning and Public Works of Greece.

The water quality monitoring shows significant organic loading to Lake Ohrid from municipal waste, agricultural and urban runoff. Although the phosphorus concentrations and water transparency still suggest an oligotrophic condition, the living organisms tell a different story.

The commercially important fish species in Lake Ohrid, including the famous Lake Ohrid trout, have been over-harvested in recent years and are in immediate danger of collapse. Human activities along the shoreline also threaten the spawning and wintering grounds of these fish. Because the fish in the lake are a single, linked population, they must be managed collectively, with similar requirements in both The former Yugoslav Republic of Macedonia and Albania.

Both the phytoplankton and zooplankton communities are shifting to a species composition more characteristic of a mesotrophic, or more polluted, condition. The macrophytic plants and benthic fauna have also responded to the nutrient loading and contamination present in the shallow-water zone. These bioindicators are sending a clear message that the unique biodiversity of the lake may be permanently altered unless more stringent management actions are taken to reduce the amount of pollution loaded into the lake.

The industrial activities in the town of Pogradec (Albania) include alimentary, textile, metal and wood processing and other light industries. As wastewaters from these plants are discharged without treatment, they may be a significant source of pollution.

The major industries in The former Yugoslav Republic of Macedonia region include the production of automobile spare parts, metal and ceramic processing, plastics, textiles, shoes, electrical parts (including transformers, transmission equipment, circuit boards, fuses, and other parts), and food processing.

In the 1980s, the construction of a sewage collection system for towns in The former Yugoslav Republic of Macedonia along the shores of Lake Ohrid reduced the levels of faecal pathogens. This was a very positive step for the health of the people using the lake for drinking water and recreation. Unfortunately, there are still sections of the coast in both countries where pathogens from human waste pose a significant risk. The problem is most acute in the region around Pogradec, where faecal contamination is extremely high. The planned wastewater treatment plant will help solve this problem as well as reduce the amount of phosphorus and organic material entering the lake.

The sewerage from the town of Pogradec is a major contributor of phosphorus, and the planned wastewater treatment plant will significantly reduce the phosphorus load. Other sources of phosphorus are present throughout the lake basin. Because phosphorus detergents may be one of the largest contributors of phosphorus to wastewater, efforts to reduce their use should be strongly encouraged. Other management actions might include additional wastewater treatment, storm water management, stream bank stabilization measures, and other agricultural best management practices.

In the surrounding villages, the sewage is discharged directly into streams or onto the soil. Thus, the wastewater produced by over 60,000 inhabitants is discharged directly or indirectly into Lake Ohrid.

LAKE SKADAR[18]

Lake Skadar (also known as Shkoder), one of the largest lakes on the Balkan Peninsula, is shared by Albania and Montenegro. It belongs to the Drin River basin. Lake Skadar discharges through the transboundary Bojana/Buna River (44 km; average flow 320 m³/s) into the Adriatic Sea.

The total size of the lake varies considerably due to varying water inflow and use, from 369.7 km² at low water to up to 530 km² at high water. The lake has a transboundary catchment area of 5,180 km², with a medium elevation of 770 m above sea level.

Lake Skadar receives its waters mainly by the 99-km-long Moraca River, which has its source in the central Montenegrin mountains and is altered by four hydropower plants. The lake is famous for a wide range of endemic and rare, or even endangered, plant and animal species. About half of the 250 recorded bird species breed on the lake, including the westernmost breeding site for the Dalmatian Pelicans in Europe and the second largest colony of the Pygmy Cormorant world-wide. Especially due to the bird fauna, the lake has a highly significant international importance. The

[18] Environmental Performance Review of Albania, UNECE. 2002; Environmental Performance Review of Serbia and Montenegro, UNECE. 2002.

lake is also home for some endemic reptiles. Its northern shores are flat with extensive reed beds around the Montenegrin tributaries. The Montenegrin side is protected as a national park (40,000 ha) and a Ramsar site.

Human activities have a considerable impact on the Lake Skadar ecosystem, either directly or indirectly. Major direct factors are irrigation, drainage, poaching and overfishing, and major indirect factors are poor wastewater management and illegal landfills. The only substantial industrial area is the Lake Skadar region.

Approximately 40% of the lake basin is agricultural land and 10% pastures. Due to the high nutrient loading, the lake has eutrophied slightly. One of the basic problems is insufficiently treated sewage water. For example, the Podgorica wastewater treatment plant is designed for 55,000 people, but is currently servicing 150,000. Besides eutrophication, intensive fishing has led to a decline of food for fish-eating birds. Especially due to its international importance for many bird species, Lake Skadar still needs special attention and protection measures to guarantee the proper state of this unique lake ecosystem.

VIJOSE RIVER BASIN[19]

The Vijose River basin is shared by Greece (upstream country) and Albania (downstream country). The river is known as Vjosa in Albania and Aoos in Greece.

Basin of the Vijose River			
Area	**Country**	**Country's share**	
6,519 km^2	Albania	4,365 km^2	67%
	Greece	2,154 km^2	33%

Source: Ministry for the Environment, Physical Planning and Public Works/Central Water Agency, Greece.

Hydrology

The 260-km-long river (70 km in upstream Greece) has its source in Northern Pindos Mountains and ends up in Adriatic Sea. The basin has a pronounced mountainous character with an average elevation of about 885 m above sea level.

Major transboundary tributaries include the rivers Sarantaporos (870 km^2) and Voidomatis (384 km^2).

Discharge characteristics of the Vijose River upstream of the Greek-Albanian border		
Discharge characteristics	**Discharge**	**Period of time or date**
Q_{av}	52 m^3/s	1951-1988
Q_{max}	125.5 m^3/s	…
Q_{min}	15.5 m^3/s	…
Mean monthly values		
October: 25.8 m^3/s	November: 69.2 m^3/s	December: 100.7 m^3/s
January: 105.7 m^3/s	February: 125.5 m^3/s	March: 120 m^3/s
April: 116.2 m^3/s	May: 74.7 m^3/s	June: 44.6 mv/s
July: 26.8 m^3/s	August: 20.6 m^3/s	September: 15.5 m^3/s

Source: Ministry for the Environment, Physical Planning and Public Works/Central Water Agency, Greece.

[19] Based on information submitted by the Ministry for the Environment, Physical Planning and Public Works/Central Water Agency, Greece.

In Greece, the Aoos Springs Hydroelectric Dam (Public Power Corporation) was built on the river.

Pressure factors

Approximately 350,000 people live in the basin (some 328,000 in Albania and 20,000 in Greece).
Of the basin, 47% is covered with forests. Other forms of land use include: cropland (3.5%), grassland (13.6%), barren (6.4%) and shrubs (29.5%). In Greece, the Aoos is part of the Vikos-Aoos National Park, a NATURA 2000 site.

The main pressures result from agricultural activities, animal production and aquaculture.

Transboundary impact

An agreement has recently been concluded between Albania and Greece and entered into force on 21 November 2005. This agreement provides for the establishment of a Permanent Greek-Albanian Commission on transboundary freshwater issues with such specific tasks as the setting of joint water-quality objectives and criteria, the drafting of proposals for relevant measures to achieve the water-quality objectives, and the organization and promotion of national networks for water-quality monitoring.

Trends

The river has a "very good water quality", which is appropriate for all uses in the basin.

Despite the Vijose's very good status, an integrated approach of all environmental, social, economic and technical aspects of water resources management is needed in order to ensure water preservation and environmental integrity in the region.

VARDAR RIVER BASIN[20]

The former Yugoslav Republic of Macedonia (upstream country) and Greece (downstream country) share the basin of the Vardar River, known in Greece as Axios.

Lake Dojran is located in this basin.

Basin of the Vardar River			
Area	**Country**	**Country's share**	
23,750 km^2	Greece	2,513 km^2	11.3%
	The former Yugoslav Republic of Macedonia	19,737 km^2	88.7%

Source: Ministry for the Environment, Physical Planning and Public Works/Central Water Agency, Greece.

VARDAR RIVER

Hydrology

The total length of the river is 389 km, with the 87 km in Greece. The river has its source in the Shara massif (a mountainous area between Albania and The former Yugoslav Republic of Macedonia) and empties into the Aegean Sea at Thermaikos Gulf.

The basin has a pronounced mountainous character with an average elevation of about 790 m above sea level. There are about 120 large and small dams in The former Yugoslav Republic of Macedonia. Floods in the downstream area were considerably reduced due to these dams.

Major transboundary tributaries include the rivers Gorgopis (sub-basin 70 km^2), Sakoulevas (sub-basin 901 km^2) and Vardarovasi (sub-basin 102 km^2).

[20] Based on information submitted by the Ministry for the Environment, Physical Planning and Public Works/Central Water Agency, Greece, and the Ministry of Urban Planning, Construction and Environment, The former Yugoslav Republic of Macedonia.

Discharge characteristics of the Vardar in Greece (measuring station Kafkasos Railway Bridge/Tributary Sakoulevas)		
Discharge characteristics	**Discharge**	**Period of time or date**
Q_{av}	3.5 m^3/s	1950-1990
Q_{max}	0.3 m^3/s	…
Q_{min}	8.5 m^3/s	…
Mean monthly values		
October: 1.2 m^3/s	November: 2.2 m^3/s	December: 5.1 m^3/s
January: 3.8 m^3/s	February: 8.5 m^3/s	March: 8.1 m^3/s
April: 5.8 m^3/s	May: 6.5 m^3/s	June: 2.3 m^3/s
July: 0.7 m^3/s	August: 0.3 m^3/s	September: 0.4 m^3/s

Source: Ministry for the Environment, Physical Planning and Public Works/Central Water Agency, Greece.

Pressure factors

Approximately 3.14 million people live in the basin, among them 1.8 million in The former Yugoslav Republic of Macedonia (91 persons/km²) and 1.6 million in Greece (637 persons/km²).

The main forms of land use are cropland (68.7%), grassland (7.4%) and forests (7.9%). In Greece, a large part of the basin is a protected NATURA 2000 site.

The main pressure on water resources stems from agriculture. In The former Yugoslav Republic of Macedonia, crop and animal production takes place in river valleys, especially the Pelagonija, Polog and Kumanovo valleys, as well as in the whole Bregalnica catchment area.

A few industrial installations also affect the aquatic ecosystem. In The former Yugoslav Republic of Macedonia, mining and quarrying activities are particularly located in the catchments area of the eastern tributaries (rivers Bregalnica and Pcinja). Metal industry at Tetovo and heavy metal industry at Veles, as well as chemical industry, petroleum refineries and pharmaceutical industry at Skopje, are additional pressure factors.

In The former Yugoslav Republic of Macedonia, a number of illegal dumpsites for solid waste from the villages in the sub-basin are of concern; however, there are also controlled land fields for solid wastes from bigger cities. For the time being, the only properly working wastewater treatment plant is located at Makedonski Brod in the Treska River catchment.

Water is abstracted from the Vardar for irrigation (63%), fishponds (11%) and drinking water (12%) as well as for municipal and industrial uses (15%). There is an overuse of water in many parts of the river, mainly for agricultural purposes.

Transboundary impact and trends[21]

In general, the surface water quality can be classified as “good/moderate”. The water is appropriate for irrigation purposes. It can be used for water supply after treatment. The quality of groundwater in general is very good. Often, it is used for water supply without or very little treatment.

The treatment and disposal of solid waste and wastewater and their management at communal level, especially in The former Yugoslav Republic of Macedonia, is still a problem and has to be improved. Organic matter from wastewater discharges results in a transboundary impact.

Greece and The former Yugoslav Republic of Macedonia are considering drawing up a bilateral agreement to replace the existing 1959 agreement, which dealt primarily with the establishment of a joint body for the joint water resources management. The new agreement will be based on the most recent developments in international law and European Union legislation.

[21] Based on information submitted by the Ministry for the Environment, Physical Planning and Public Works/Central Water Agency, Greece.

LAKE DOJRAN[22]

Lake Dojran is a small (total area 43.10 km^2) tectonic lake with a basin of 271.8 km^2. The lake is shared between The former Yugoslav Republic of Macedonia (27.4 km^2) and Greece (15.7 km^2). The lake is rich with fish – 16 species. The "Aquatic Forest of Mouria" has been listed as a "Natural Monument" and also proposed, together with a small part (200 ha) of Lake Dojran, for inclusion in the EU NATURA 2000 network.

Over the last 20 years, the lake's level has dropped continuously due to reduced precipitation and increasing Greek abstraction, mainly for irrigation purposes. The most extreme water level and water volume decrease have occurred since 1988. From 262 million m^3 in 1988, the volume decreased to 80 million m^3 in 2000.

Water quality is characterized by high alkalinity and elevated carbonate and magnesium hardness. Additionally, concentrations of certain toxic substances are near or even beyond toxic levels. In Greece, there are high values of phosphates.

Pollution is caused by municipal wastewater, municipal solid wastes, sewage from tourist facilities, and agricultural point source and non–point source pollution, including transboundary pollution.

In recent years, the lake has been struggling for survival. Since 1988, because of the decrease in water level and volume, according to biologists over 140 species of flora and fauna have disappeared. The water level has dropped 1.5 metres below its permitted hydro-biological minimum. Lake Dojran has been affected by quantity decrease and quality reduction since the early 1990s due to activities in both countries, such as water abstraction and municipal wastewater disposal. The situation was aggravated by the low precipitation in the period 1989-1993 and high evaporation rates observed in the lake basin.

[22] Based on information submitted by the Ministry for the Environment, Physical Planning and Public Works of Greece.

STRUMA RIVER BASIN[23]

Bulgaria (upstream country) and Greece (downstream country) are typically considered to be the riparian countries in the basin of the Struma River, known in Greece as the Strymónas. The share of Serbia and The former Yugoslav Republic of Macedonia in the total basin area is very small.

Basin of the Struma River			
Area	**Country**	**Country's share**	
18,079 km²	Bulgaria	10.797 km²	59.7%
	Greece	7.282 km²	40.3%
	Serbia	…	…
	The former Yugoslav Republic of Macedonia	…	…

Source: Ministry for the Environment, Physical Planning and Public Works/Central Water Agency, Greece.

Hydrology

The total length of the river is 400 km, with the last 110 km in downstream Greece. The river has its source in western Bulgaria (Vitosha Mountain, south of Sofia) and ends up in Aegean Sea (Strymonikos Gulf).

The basin has a pronounced mountainous character with an average elevation of about 900 m above sea level. There is a high risk of flooding.

Major transboundary tributaries include the rivers Butkovas, Exavis, Krousovitis, Xiropotamos and Aggitis (see discharge characteristics below). A few tributaries extend to Serbia and The former Yugoslav Republic of Macedonia. These include the transboundary river Dragovishtitsa (Serbia and Bulgaria) as well as the transboundary rivers Lebnitsa and Strumeshnitsa (The former Yugoslav Republic of Macedonia and Bulgaria).

[23] Based on information submitted by the Ministry of Environment and Water, Bulgaria, and the Ministry for the Environment, Physical Planning and Public Works/Central Water Agency, Greece.

Discharge characteristics of the Struma River at the gauging station Marino Pole (Bulgaria)		
Discharge characteristics	**Discharge**	**Period of time or date**
Q_{av}	75.57 m^3/s	1961 – 1998
Q_{max}	149.00 m^3/s	1961 – 1998
Q_{min}	24.13 m^3/s	1961 – 1998
Mean monthly values		
October: 54.79 m^3/s	November: 62.58 m^3/s	December: 70.04 m^3/s
January: 74.99 m^3/s	February: 85.86 m^3/s	March: 92.22 m^3/s
April: 101.30 m^3/s	May: 119.10 m^3/s	June: 88.89 m^3/s
July: 57.02 m^3/s	August: 51.06 m^3/s	September: 49.18 m^3/s

Source: Ministry of Environment and Water, Bulgaria.

Discharge characteristics of the Aggitis River (a tributary to the Struma) at the gauging station Krinida in Greece		
Q_{av}	27.76 m^3/s	Average for: 1987-1988 & 1997-1998
Mean monthly values		
October: 16 m^3/s	November 18.7 m^3/s	December: 36.4 m^3/s
January: 40.2 m^3/s	February: 42.2 m^3/s	March: 47.4 m^3/s
April: 49 m^3/s	May: 36.2 m^3/s	June: 21.8 m^3/s
July: 7.8 m^3/s	August: 6.7 m^3/s	September: 10.7 m^3/s

Source: Ministry for the Environment, Physical Planning and Public Works/Central Water Agency, Greece.

There are about 60 artificial lakes in the Bulgarian part of the river basin, which were built for water supply, power generation and irrigation. The Kerkini Reservoir in Greece was created with the construction of a levee in 1933 for regulating the river discharges, irrigation purposes and flood protection (a new levee was constructed in 1982). The Kerkini Reservoir was finally developed into an important wetland, protected under the Ramsar Convention on Wetlands.

In Greece, irrigation dams exist also at Lefkogeia and Katafyto.

Over the last 20 years, precipitation decreased by some 30%, which resulted in shrinking water resources.

Pressure factors

In Bulgaria, about 430,000 people (39.83 persons/km^2) live in the basin, whereas 192,828 persons (26.49 persons/km^2) live in the Greek part of the basin (according to 1991 Greek statistics).

Bulgaria reports that agriculture uses 2% of the available water resources in the Bulgarian part of the basin, whereas industry uses 6%, the urban sector 10%, and the energy sector 82%. Cropland (42.1%) is the prevailing form of land use. Grassland covers 8.7% of the area, and forests 20.6%. A large part (24.6%) is shrub land. In Bulgaria, mining sites and dumpsites occupy some 40 km^2.

The main pressure results from agriculture and fish farming. Some industrial activities are concentrated in the sub-basin of the river Aggitis.

Untreated wastewaters have a significant impact in the Bulgarian part of the basin. Wastewater treatment installations exist in all major Greek towns (Serres and Kavala, Drama).

Water-quality characteristics (minimum and maximum values for the period 2000-2005) of the Struma River upstream from the Bulgarian-Greek border (Monitoring station 30065124)					
Value	BOD_5 (mg/l)	Ammonia (mg/l)	Nitrites (mg/l)	Nitrates (mg/l)	Phosphates (mg/l)
Maximum	6.5	1.7	0.07	3.5	1.7
Minimum	1	0.1	0.01	1	0.5

Source: Ministry of Environment and Water, Bulgaria.

Transboundary impact

The river receives wastewater from agricultural run-offs and effluents from livestock breeding units. Organic matter from wastewater discharges is also of concern.

An agreement between Greece and Bulgaria, dealing with the mutual utilization and management of the shared water resources, was concluded in 1964. According to this bilateral agreement, both countries are bound, inter alia, not to cause significant damage to each other, arising from the construction and operation of projects and installations on the transboundary river and to exchange of hydrological and technical data.

In 1971, an agreement was signed between the two countries for the establishment of a Greek-Bulgarian Committee dealing with electrical energy issues and with the use of waters of the transboundary river. This Committee has been assigned to follow up the proper application of the 1964 agreement.

The existing cooperation framework between the two riparian countries is linked to the development of a joint integrated water resources management plan for each transboundary river basin following the provisions of the Water Framework Directive.

Trends

The water quality is generally "good". The water is suitable for use, especially for irrigational agriculture. Decreasing industrial activity after 1990 in Bulgaria resulted in water-quality improvements.

NESTOS RIVER BASIN[24]

Bulgaria (upstream country) and Greece (downstream country) share the basin of the Nestos River, also known as Mesta in Bulgaria.

Basin of the Nestos River			
Area	Country	Country's share	
5,613 km^2	Bulgaria	2,770 km^2	49.4%
	Greece	2,834 km^2	50.6%

Source: Ministry for the Environment, Physical Planning and Public Works/Central Water Agency, Greece.

Hydrology

The river has its source in the Rila Mountains in the vicinity of Sofia (Bulgaria) and ends up in the North Aegean-Sea. The basin has a pronounced mountainous character.

A major transboundary tributary is the river Dospatska, also known as Dospat.

[24] Based on information submitted by the Ministry of Environment and Water, Bulgaria, and the Ministry for the Environment, Physical Planning and Public Works/Central Water Agency, Greece.

Discharge characteristics of the Nestos/Mesta River at the gauging station 52 850 (Hadjidimovo, Bulgaria)		
Discharge characteristics	**Discharge**	**Period of time or date**
Q_{av}	23.36 m^3/s	1961 – 1998
Q_{max}	66.30 m^3/s	1961 – 1998
Q_{min}	12.39 m^3/s	1961 – 1998
Mean monthly values		
October: 14.26 m^3/s	November: 18.77 m^3/s	December: 25.14 m^3/s
January: 22.76 m^3/s	February: 26.99 m^3/s	March: 28.70 m^3/s
April: 41.52 m^3/s	May: 48.03 m^3/s	June: 29.22 m^3/s
July: 10.20 m^3/s	August: 6.88 m^3/s	September: 8.33 m^3/s

Source: Ministry of Environment and Water, Bulgaria.

Major dams on Greek territory for hydropower generation and irrigation include the Thisavros (built in 1997), Platanovrisi (built in 1999) and Temenos Dams (planned).

The Nestos delta in Greece is a Ramsar site of 440 km^2. A large part of the Nestos in Greece also belongs to the NATURA 2000 sites.

Discharge characteristics of the Nestos River at two gauging stations in Greece (first figure refers to station Thisavros, the second figure to station Temenos)		
Discharge characteristics	**Discharge**	**Period of time or date**
Q_{av}	40.7 and 45.33 m^3/s	Thisavros 1965-1990, Temenos 1964-1963
Q_{max}	68.4 and 75.7 m^3/s	
Q_{min}	12.7 and 13.8 m^3/s	
Mean monthly values		
October: 19.9 and 21.2 m^3/s	November: 29.6 and 22.9 m^3/s	December: 47.2 and 54.8 m^3/s
January: 47.4 and 54.7 m^3/s	February: 53.7 and 62.9 m^3/s	March: 57.5 and 65 m^3/s
April: 67.8 and 75.7 m^3/s	May: 68.4 and 73.3 m^3/s	June: 49.3 and 52.4m^3/s
July: 21.9 and 23.7 m^3/s	August: 12.7 and 13.5 m^3/s	September: 13.2 and 13.8 m^3/s

Source: Ministry for the Environment, Physical Planning and Public Works/Central Water Agency, Greece.

Pressure factors

Forests cover 39% of the basin, croplands 23.5%, and shrubs 25.5%.

In Greece, 42,164 people live in the basin (14.83 persons/km^2) following the 1991 statistics, and around 137,000 persons (49.46 persons/km^2) live in the Bulgarian part.

The main pressure factor in the basin is agriculture. Uncontrolled solid waste disposal in some parts of the river causes water pollution and environmental problems, especially in times of heavy precipitation.

Wastewater treatment installations exist in the area. In Bulgaria, however, organic matter discharged from these installations and untreated wastewaters has a transboundary impact.

Water-quality determinands in the Nestos River downstream from the city of Hadzhidimovo (Monitoring station 30064117) in Bulgaria					
Date	BOD_5 (mg/l)	Ammonia (mg/l)	Nitrites (mg/l)	Nitrates (mg/l)	Phosphates (mg/l)
Water quality in 2000					
17.1.2000	0.7	0.5	0	0.4	0.2
01.2.2000	2	0.2	0.08	0.3	0.4
06.3.2000	0.5	1.7	0.04	2.3	0.3
03.4.2000	2	0.3	0.02	1.5	0.2
16.5.2000	2.5	0.4	0.04	0.3	0.3
12.6.2000	2	0.1	0.03	0.5	0.3
04.7.2000	4	0.4	0.04	0.4	0.3
01.8.2000	2.6	0	0.03	0.5	0.3
05.9.2000	2	0.12	0.04	0.43	0.31
02.10.2000	2.4	0	0.01	0.2	0.2
07.11.2000	5.2	0.1	0.02	0.4	0.2
04.12.2000	1.8	0.2	0.01	0.5	0.2
Water quality in 2005					
17.1.2005	0.9	0.14	0.007	0.83	0.22
02.2.2005	1.54	0.13	0.007	0.78	0.27
01.3.2005	1.4	0.09	0.016	1	0.51
14.4.2005	1.29	0.05	0.009	0.39	0.12
03.5.2005	1.15	0.06	0.01	0.08	0.09
14.6.2005	1.2	0,09	0.011	0.52	0.19
05.7.2005	1.33	0	0.018	0.4057	0.0738
02.8.2005	1.13	0	0.0238	0.4675	0.1128
14.9.2005	4.34	0.003	0.0196	0.4808	0.0495
04.10.2005	3.54	0.0674	0.0126	0.0569	0.3155
17.11.2005	14.02	0.043	0.019	0.5525	0.1524
06.12.2005	1.66	0.143	0.01	0.533	0.0846

Source: Ministry of Environment and Water, Bulgaria.

Trends

The water quality is "suitable for irrigation and water supply for other users". In recent years, the quality of the Nestos has improved as a result of reduced industrial activity in Bulgaria.

Global climate change has affected the basin over the last 20 years, resulting in an approximately 30% decrease in precipitation and a subsequent decrease in water resources.

Besides the 1964 and 1971 agreements between Bulgaria and Greece, already mentioned in the assessment of the status of the Struma River, an agreement was concluded between Bulgaria and Greece on 22 December 1995, dealing, inter alia, with the exchange of information on water quality and quantity and any development plans that would affect the natural flow of the river. By virtue of this agreement, a Joint Commission has been established.

MARITZA RIVER BASIN[25]

Bulgaria, Greece and Turkey share the basin of the Maritza River, which is also known as Meriç and Evros.

Basin of the Maritza River			
Area	**Country**	**Country's share**	
52,600 km²	Bulgaria	34,067 km²	65%
	Greece	3,685 km²	7%
	Turkey	14,850 km²	28%

Source: Ministry for the Environment, Physical Planning and Public Works/Central Water Agency, Greece.

MARITZA RIVER

Hydrology

The river has its source in the Rila Mountain (Bulgaria) and flows into in the Aegean Sea (Greece). Major transboundary tributaries include the rivers Arda/Ardas (Bulgaria, Greece and Turkey), Tundja (Bulgaria and Turkey) and Erithropotamos (Bulgaria and Greece). The river Ergene is an important tributary, which is located in Turkey.

The total number of man-made and natural water bodies in the Bulgarian part of the basin has been as high as 722. Hydropower production is common in the upper part of the basin, and a cascade of dams with hydropower generators forms big reservoirs. In Greece, dams for irrigation purposes include those on the rivers Arda/Ardas, Lyra, Provatonas, Ardanio and Komara (the last being under construction).

Discharge characteristics of the Maritza River (Monitoring site: Maritza River, close to the border with Greece)		
Discharge characteristics	**Discharge**	**Period of time or date**
Q_{av}	107.92 m³/s	1961–1998
Q_{max}	204.81 m³/s	1961–1998
Q_{min}	43.05 m³/s	1961–1998
Mean monthly values		
October: 54.84 m³/s	November: 69.01 m³/s	December: 96.61 m³/s
January: 99.76 m³/s	February: 140.66 m³/s	March: 163.11 m³/s
April: 186.99 m³/s	May: 184.89 m³/s	June: 127.38 m³/s
July: 74.17 m³/s	August: 54.73 m³/s	September: 46.72 m³/s

Source: Ministry of Environment and Water, Bulgaria.

[25] Based on information submitted by the Ministry of Environment and Water, Bulgaria, and the Ministry for the Environment, Physical Planning and Public Works/Central Water Agency, Greece and the Ministry of Foreign Affairs of Turkey.

Discharge characteristics of the Maritza River (Monitoring site: Evros-Pythio, Greece)		
Discharge characteristics	**Discharge**	**Period of time or date**
Q_{av}	383 m^3/s	1951–1956
Q_{max}	921 m^3/s	1951–1956
Q_{min}	234 m^3/s	…

Source: Ministry for the Environment, Physical Planning and Public Works/Central Water Agency, Greece.

The climatic and geographical characteristics of the Maritza basin lead to specific run-off conditions. Floods may cause severe damage in Bulgaria and downstream Greece and Turkey; among the most disastrous were the floods in 2005 (recurrence interval, 1,000 years) and in 2006.

As the downstream countries, Turkey and Greece, are highly vulnerable to floods, it is evident that measures for flood prevention can only be improved and their effects be mitigate through cooperation and use of common information sources.

The operation of the dams should also be carried out in a coordinated manner among the riparian countries as better dam operation techniques and rules can considerably mitigate floods. The dams should be operated in accordance with correct precipitation data and the conditions in the downstream countries. The establishment of "Flood Early Warning System" is essential.

Pressure factors and transboundary impact

According to Greek assessments for the entire basin, the main pressure stems from farming and irrigated agriculture. Industrial facilities have grown over the last decade. Sewerage and waste management (controlled and un-controlled dump sites) have a significant impact.

Population data for the Maritza River basin		
Bulgaria *	1,613,241 (year 2003)	77 persons/km^2
Turkey **	98,7216	67 persons/km^2
Greece **	133,048 (year 1991)	36 persons/km^2

Sources: (*) Ministry of Environment and Water, Bulgaria. (**) Ministry for the Environment, Physical Planning and Public Works/Central Water Agency, Greece.

The assessment of pressure factors by Bulgaria is in line with this overall statement.

Crop and animal (mainly pigs, but also ducks, sheep and cows) production in Bulgaria is located in the lowland part of the Maritza. By magnitude, diffuse sources are the second biggest pressure factor in the Bulgarian part of the basin; 74% of diffuse pollution comes from agriculture. There is a need for restoration of the existing irrigation infrastructure.

There are also mining activities in the mountainous Bulgarian part of the basin. Essentially, they have only local impacts, with pollution by heavy metals. There are 11 tailing ponds for mining waste in the area. The largest open cast mining for coal in the country is also located in the basin.

Main industrial activities in Bulgaria include food production and production of non-ferrous metals and chemicals. Thermal power plants use the coal produced in the basin. There are 38 waste sites in the Bulgarian part; however, information on the percentage of the population with organized waste management is not yet known.

The sewerage system services 78% of the Bulgarian population in the basin and wastewater treatment plants treat 62% of urban wastewaters.

Trends

According to Greek assessments, the water in the basin is "appropriate for irrigation" and "appropriate for other supply after treatment".

Although the status of waters is "generally good", a number of water pollution control measures are foreseen by the riparian countries. There is also a need for an early warning system for floods as well as accidental pollution (see also the assessments of the tributaries below).

Global climate change has affected the basin over the last 20 years, resulting in approximately 30% decrease in precipitation and a subsequent decrease in water resources.

As far as Greece and Bulgaria are concerned, an agreement between the two countries dealing with the mutual utilization and management of the shared water resource was concluded in 1964. According to this bilateral agreement, both countries are bound, inter alia, not to cause significant damage to each other, arising from the construction and operation of projects and installations on the transboundary river and to exchange hydrological and technical data. In 1971, an agreement was signed between the two countries for the establishment of a Greek-Bulgarian Committee, dealing with electrical energy issues and with the use of waters of the transboundary river. This Committee has been assigned to follow up the proper application of the 1964 agreement.

As far as Greece and Turkey are concerned, mention should be made of the 1934 bilateral agreement pertaining to the regulation of hydraulic facilities on both banks/shores of Evros/Meriç river. This agreement provides, inter alia, the conditions for constructing dikes and other hydraulic facilities

The establishment of a cooperation mechanism in the Maritza River basin, besides the existing bilateral frameworks, involving all three riparian countries, should be considered.

Currently, there is an on-going cooperation process to prevent and limit floods and their damaging effects in the Maritza basin. In addition, a coordination committee including the experts of three riparian countries should be established.

ARDA RIVER

Bulgaria, Greece and Turkey share the sub-basin of the river Arda (5,201 km^2 in Bulgaria), also known as Ardas.

The Arda has its source in Rodopi Mountains (Bulgaria) and discharges into the Maritza river. The sub-basin has a pronounced mountain character.

Floods cause severe local and transboundary damage; among the most disastrous floods was the 2005 flood event, caused by intensive rainfalls in the upper part of the sub-basin.

Discharge characteristics of the Arda/Ardas River at the boundary gauging station in Bulgaria		
Discharge characteristics	**Discharge**	**Period of time or date**
Q_{av}	72.63 m^3/s	1961-1998
Q_{max}	148.63 m^3/s	1961-1998
Q_{min}	27.61 m^3/s	1961-1998
Mean monthly values		
October: 23.03 m^3/s	November: 60.34 m^3/s	December: 129.21 m^3/s
January: 114.72 m^3/s	February: 154.94 m^3/s	March: 126.03 m^3/s
April: 100.41 m^3/s	May: 71.91m^3/s	June: 47.37 m^3/s
July: 22.51 m^3/s	August: 11.50 m^3/s	September: 10.95 m^3/s

Source: Ministry of Environment and Water, Bulgaria.

According to Bulgarian statistics for the years 2000, 2005 and 2006, respectively, forests cover 59% of the Bulgarian part of the sub-basin, cropland 16.8% and grassland 10%. Almost 45% of the Bulgarian part of the sub-basin is a protected area.

Dams are common for the Arda sub-basin; 100 are located in Bulgarian territory. The largest serve multiple purposes: energy production, irrigation, industrial water supply and drinking-water supply.

The population density for the Bulgarian part of the sub-basin is 51 persons/km^2 (total number in 2003: 262,736 inhabitants).

Animal husbandry (cattle, cows and sheep) is a typical activity in the Bulgarian part of the sub-basin. Pollution from agricultural production is insignificant.

Mining activities cause local impact due to heavy metals in the discharges from mines. There are also five tailing ponds containing mining waste, which are a potential source of pollution. Main industrial activities in the area include food production and production of non-ferrous metals and chemicals. At times industrial accidents have occurred due to technological problems, but they have had only local effects. There are nine waste disposal sites in the Bulgarian part; however, information on the percentage of the population with organized waste management is not yet known.

A sewerage system connecting 49% of the population was built, but the wastewater treatment plants are still under construction.

TUNDJA RIVER

Bulgaria and Turkey share the Tundja sub-basin (7,884 km^2 in Bulgaria). The river has its source in the Stara Planina Mountain (Bulgaria) and flows into the Maritza River.

Discharge characteristics of the Tundja River at the boundary gauging station (Bulgaria)		
Discharge characteristics	**Discharge**	**Period of time or date**
Q_{av}	32.09 m^3/s	1961-1998
Q_{max}	69.36 m^3/s	1961-1998
Q_{min}	18.81 m^3/s	1961-1998
Mean monthly values		
October: 12.93 m^3/s	November: 21.89 m^3/s	December: 32.82 m^3/s
January: 38.40 m^3/s	February: 57.87 m^3/s	March: 61.70 m^3/s
April: 53.23 m^3/s	May: 46.85 m^3/s	June: 28.09 m^3/s
July: 12.94 m^3/s	August: 10.29 m^3/s	September: 9.94 m^3/s

Source: Ministry of Environment and Water, Bulgaria.

Dams are common in Tundja sub-basin: there are 264 located in Bulgarian part. The larger dams/reservoirs serve multi-purpose functions, providing energy production, irrigation, industrial water supply and drinking-water supply.

Floods may cause severe local and transboundary damage; among the most disastrous was the 2005 flood, caused by intensive rainfall in the upper part of the sub-basin.

The population density in the Bulgarian part of the sub-basin is 62 persons/km^2. In 2003, the total number of the population was 488,296 inhabitants.

According to Bulgarian statistics for 2000, 2005 and 2006, respectively, forests cover 30% of the Bulgarian part of the sub-basin, cropland 36% and grassland 5%.

In the lowland area of the Tundja, Bulgaria is growing crops and there is animal husbandry (mainly pigs, but also sheep and cows). Almost 26% of the Bulgarian part of the sub-basin is a protected area.

Among pollution sources, wastewater discharge from municipalities and industry ranks in first place, followed by diffuse pollution, with 78% of diffuse pollution coming from agriculture. The sewerage system currently serves 74% of the population in the Bulgarian part of the sub-basin. Wastewater treatment plants treat 54% of the urban wastewaters.

There are 11 waste disposal sites in the Bulgarian part; however, information on the percentage of the population with organized waste management is not yet known. Sometimes industrial accidents occur due to technological problems, but they have only local effects.

DRAINAGE BASIN OF THE NORTH SEA AND EASTERN ATLANTIC

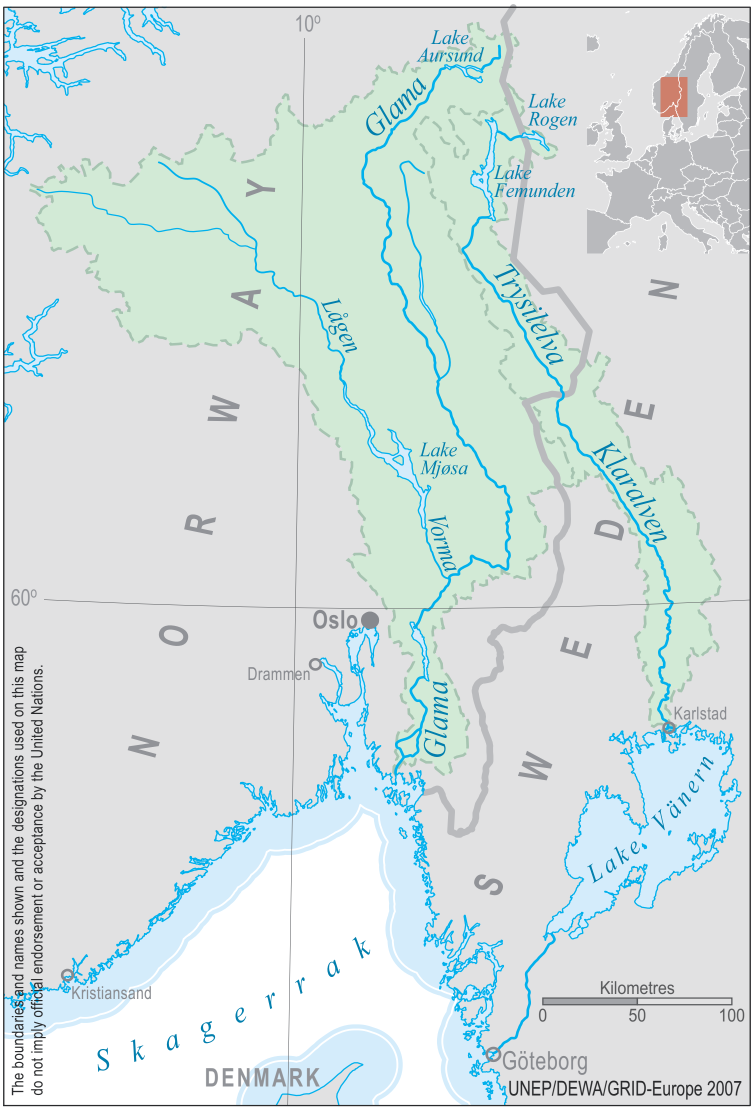
This chapter deals with major transboundary rivers discharging into the North Sea and Eastern Atlantic as well as with some of their transboundary tributaries. It also includes lakes located within the basins of the North Sea and Eastern Atlantic.

TRANSBOUNDARY WATERS IN THE BASINS OF THE NORTH SEA AND EASTERN ATLANTIC[1]

Basin/sub-basin(s)	Total area (km²)	Recipient	Riparian countries	Lakes in the basin
Glama	42,441	North Sea	NO, SE	…
Klaralven	11,853 [2]	North Sea	NO, SE	…
Wiedau	1,341	North Sea	DE, DK	…
Elbe	148,268	North Sea	AT, CZ, DE, PL	…
Ems	17,879 [3]	North Sea	DE, NL	…
Rhine	197,100 [4]	North Sea	AT, BE, CH, DE, FR, IT, LI, LU, NL	Lake Constance
- Moselle	28,286	Rhine	BE, DE, FR, LU	…
- Saar	7,431	Moselle	FR, DE	…
- Vechte	2,400	Swarte water > Ketelmeer > Ijssel-meer > North Sea	DE, NL	…
Meuse	34,548 [5]	North Sea	BE, FR, NL	…
Scheldt	36,416 [6]	North Sea	BE, FR, NL	…
Yser	[7]	North Sea	BE, FR	…
Bidasoa	*500*	*Eastern Atlantic*	*ES, FR*	…
Mino	17,080	Eastern Atlantic	ES, PT	Frieira reservoir
Lima	2,480	Eastern Atlantic	ES, PT	Alto Lindoso reservoir
Douro	97,600	Eastern Atlantic	ES, PT	Miranda reservoir
Tagus	80,600	Eastern Atlantic	ES, PT	Cedillo reservoir
Guadiana	66,800	Eastern Atlantic	ES, PT	…
Erne	4,800	Eastern Atlantic	GB, IE	…
Foyle	2,900	Eastern Atlantic	GB, IE	…
Bann	5,600	Eastern Atlantic	GB, IE	…
Castletown	*400*	*Eastern Atlantic*	*GB, IE*	…
Fane	*200*	*Eastern Atlantic*	*GB, IE*	…
Flurry	*60*	*Eastern Atlantic*	*GB, IE*	…

[1] The assessment of water bodies in italics was not included in the present publication.
[2] Basin area until Lake Värnern.
[3] Area for the Ems River Basin District.
[4] Area for the Rhine River Basin District.
[5] Area for the Meuse River Basin District.
[6] Area for the Scheldt River Basin District.
[7] The Yser is part of Scheldt River Basin District.

GLAMA RIVER BASIN[1]



The Glama River, also known as the Glåma and the Glomma, is shared by Norway and Sweden.

With a total length of some 604 km, the Glama runs from Lake Aursund near Røros in Sør-Trøndelag (Norway) and empties into the Oslofjord at Fredrikstad. Major tributaries include the Vorma and Lågen rivers. The Vorma River drains Lake Mjøsa and joins the Glama at Nes. The Lågen River drains into Lake Mjøsa, collecting water from the large Gudbrandsdal valley and significantly increasing the Glama's flow.

The Glama has experienced several major floods due to melting snow from Jotunheimen, Rondane and other mountain areas in Norway. A number of hydroelectric stations were built to provide electricity to the urban-industrial complex in the lower part of the river between Sarpsborg and Fredrikstad. Today, the hydropower stations on the rivers Glama and Lågen cover about 9% of Norway's electricity demand.

The Glama, passing through a heavily forested region, is Norway's chief timber-floating river. The total agricultural area in the basin, mainly located in the southern part, is about 1,500 km^2.

The lower part of the river was industrialized in the beginning of the 20th century, the main activities being pulp and paper industries and a zinc smelter. Today, one of the main industrial activities is a chromium-titanium plant situated close to the river mouth. There is also a big plant for waste incineration.

Basin of the Glama River			
Area	**Country**	**Country's share**	
42,441 km^2	Norway	42,019 km^2	99%
	Sweden	422 km^2	1%

Source: Ministry of Environment, Norway, and Swedish Environmental Protection Agency.

From 1986 to 1995, the Glama carried between 120,000 and 440,000 tons per year of suspended particulate matter. The yearly contribution of lead by the Glama is about 10-20 tons; it is a mixture of natural lead from minerals, atmospherically long-range transported lead and lead from local anthropogenic sources. Studies of the bottom sediments in the estuary show an increasing concentration of lead, with increasing distance from the river mouth. The estuary is affected by material transported by the river and autochthonous material due to the highly productive conditions in the estuary itself. Eutrophication is also a common phenomenon.

[1] Based on information submitted by the Governments of Norway and Sweden as well as information from a joint project by the Institute for Energy Technology of Norway and the Norwegian Institute for Water Research.

KLARALVEN RIVER BASIN[2]

The Klaralven River, also known as the Klarälven, is shared by Norway (upstream country) and Sweden (downstream country).

Basin of the Klaralven River			
Area	**Country**	**Country's share**	
11,853 km²	Norway	2,872 km²	24.2%
	Sweden	8,981 km²	75.8 %

Source: Swedish Environmental Protection Agency ("Statistics Sweden, 2000").

The almost 460-km-long Klaralven ("clear river" in Swedish) runs for almost 300 km on Swedish territory. The river begins with a number of streams flowing into Lake Femunden on the Norwegian side of the border. Some of these watercourses also come from Sweden, mainly from Lake Rogen in Härjedalen. The river flowing south from Lake Femunden is first called the Femundselva and later the Trysilelva. The river crosses the border and changes its name to the Klaralven. It flows through northern Värmland, where it follows a valley towards the south. The river empties into Lake Vänern in Sweden with a delta near Karlstad.

The river's average discharge is 165 m^3/s. The maximum measured discharge was 1,650 m^3/s.Spring floods are common, mainly caused by run-off from the snowy mountains in the northern areas of the basin.

The Klaralven has clean and fresh water, suitable for bathing. The river is internationally recognized as excellent sport fishing watercourse. Following Norwegian data for the period 1969-2002, the river carried some 48,000 tons TOC, 75 tons phosphorus and 2,600 tons nitrogen per year. However, these determinands were not analysed in Sweden.

WIEDAU RIVER BASIN[3]

The Wiedau River, also known as the Vidå, is shared by Denmark and Germany.

Basin of the Wiedau River			
Area	**Country**	**Country's share**	
1,341 km²	Denmark	1,080 km²	81%
	Germany	261 km²	19%

Sources: Ministry for the Environment, Nature Protection and Nuclear Safety (Germany) and LIFE Houting-project.

The Wiedau is a typical lowland and tidal river. It starts east of Tønder (Denmark) and flows to the west, ending in the Wadden Sea at the German-Danish North Sea coast.

The mean water flow at the outflow into the Wadden Sea is approximately 15,000 l/s (minimum 4,000 l/s, maximum 95,000 l/s). The Wiedau is highly controlled by weirs and gates to protect it from tides and surges, and yet does discharge its water into the North Sea. The sluice at Højer town regulates the water exchange with the Wadden Sea.

The river's important uses are fishing and canoeing. 90% of the basin area is arable land.

In the past, the main parts of the watercourses in the basin were heavily modified through drainage, dredging and physical alterations. During the last decade, Denmark has completed a number of nature restoration projects, including the reconstruction of 27 smaller weirs to make them passable for migrating fish. Other projects brought 37 km of straightened, modified water stretches back to original meandering.

[2] Based on information submitted by the Governments of Norway and Sweden.
[3] Based on information submitted by the Government of Germany and information from the LIFE Houting-project.

Nowadays, the river system is inhabited by 24 different fish species, which is considered high in Danish terms. However, the sizes of a number of the populations are quite small and they only occur in limited parts of the river system.

ELBE RIVER BASIN[4]

Four countries (Austria, Czech Republic, Germany and Poland) share the basin of the Elbe River.

[4] Based on contributions by the International Commission for the Protection of the Elbe River and the Ministry of the Environment of the Czech Republic.

Basin of the Elbe River			
Area	**Country**	**Country's share**	
148,268 km^2	Austria	920.7 km^2	0.62%
	Czech Republic	49,933 km^2	33.68%
	Germany	97,175 km^2	65.54%
	Poland	239.3 km^2	0.16%

Source: International Commission for the Protection of the Elbe River.

Hydrology

The Elbe River, with a total length of 1,094.3 km, originates in the Giant Mountains in the northern Czech Republic. Its main tributary is the Vltava River in Southern Bohemia (Czech Republic). Other tributaries of the Elbe River include the Ohre River in the Czech Republic as well as the Schwarze Elster, Mulde, Saale and Havel rivers in Germany.

The mean annual discharge at the border between the Czech Republic and Germany (catchment area – 51,394 km^2) is 311 m^3/s. At Cuxhaven (Germany), the Elbe discharges into the North Sea. The mean annual discharge at the mouth is 861 m^3/s.

In the Czech Republic, except some small ones, there are almost no natural lakes. In the German part of the Elbe River basin, specifically the Middle and Northern German lowlands, there are a number of natural lakes, such as the Mueritz See, Schweriner See, Plauer See, Koelpinsee and Schaalsee.

The largest hydraulic structures include the Lipno, Orlik, Slapy, Svihov and Nechranice reservoirs in the Czech Republic and the Bleiloch, Hohenwarte, Bautzen and Eibenstock reservoirs in Germany. Water-quantity problems are linked to floods (e.g. in August 2002) and droughts (e.g. in the summer of 2003).

Pressure factors

In the Czech part of the Elbe basin, the principal pressure factors are similar to those in Germany (see below). The main problems are related to point sources, which cause pressures on the oxygen balance, emit specific pollutants, partially also nutrients, and lead to salinization, acidification and thermal pollution. As for non-point sources, agriculture and forestry with nutrient inputs are of utmost concern. One of the main problems is eutrophication, particularly of some reservoirs.

In the German part of the Elbe basin, the principal pressure factors include pressures on the oxygen balance, nutrient pressures, pressures by specific pollutants, thermal pollution, salinization, acidification, water abstractions, flow regulation and morphological alterations. These pressure factors have sometimes led to situations in the Elbe and its tributaries, which were assessed as "slightly polluted by non-point and point sources of pollution". Eutrophication of reservoirs is also a problem in the German part of the basin.

In the 1990s, a comprehensive monitoring network was established to provide insight into over 100 physico-chemical and biological determinands of the Elbe and its major tributaries based on identical or comparable analytical methods.

Transboundary impact

In the 1980s, the Elbe was still one of the most polluted transboundary rivers in Europe.

Water pollution has substantially decreased from the 1990s onwards. Oxygen concentrations have been improved almost in the whole Elbe River; at present, the oxygen status is "mostly satisfactory". Likewise, the nutrient load has progressively decreased. The phosphorus load in Germany has also diminished, especially from point sources. In the Czech Republic, substantive progress was achieved, above all due to the operation of efficient wastewater treatment plants with phosphates' reduction.

The reduction of the pollution of the Elbe with heavy metals, organic hazardous substances and nutrients was mostly due to decreasing or ceasing industrial production, as well as to the construction of new municipal and industrial wastewater treatment plants. This is shown in the following table, which provides calculated load values (based on measured concentrations and river discharges) for two years (1989 and 2004) with almost equal river discharges.

Pollution load of the Elbe River for two years with approximatelythe same river discharge				
Determinands	Unit	Year 1989	Year 2004	Reduction (in %)
Mean annual discharge	m^3/s	520	511	...
Mercury	t/a	12	1.0	92
Lead	t/a	110	59	46
Cadmium	t/a	6.4	5.2	19
Zinc	t/a	2,400	700	71
Chromium	t/a	190	26	86
Nickel	t/a	200	54	73
Arsenic	t/a	52	45	13
Hexachlorobenzene	kg/a	150	19	87
Hexachlorobutadiene	kg/a	96	<1	>99
Trichloromethane	kg/a	13,000	160	99
Trichloroethene	kg/a	7,300	<16	>99
Tetrachloroethene	kg/a	8,300	120	99
1,2,4-Trichlorobenzene	kg/a	570	<9.7	>98
Total nitrogen	t/a N	140,000	75,000	46
Total phosphorus	t/a P	9,100	3,100	66
AOX (Cl)	kg/a	1,600,000	350,000	78
BOD_{21}	t/a O_2	430,000	210,000	51
COD	t/a O_2	760,000	440,000	42

Source: International Commission for the Protection of the Elbe River.

Despite these positive developments, diffuse pollution sources and "old pollution sites" are still of concern and have to be dealt with more intensively.

According to an analysis of the Elbe River basin characteristics in 2004[5], the status of surface water bodies was estimated as follows: 11% of water bodies "not at risk", 26% of water bodies "needing further assessment to determine risk", and 63% "at risk of failing the environmental objectives". This analysis provides the grounds for further measures to achieve the objectives of the Water Framework Directive (WFD).

Trends

The transboundary impact from the Czech Republic on German territory is decreasing. Eutrophication will remain one of the main problems.

A higher number of wastewater treatment plants and their improved efficiency as well as the implementation of a River Basin Management Plan will substantially improve the status of water bodies.

[5] Prepared for the 2005 reporting under the Water Framework Directive.

EMS RIVER BASIN DISTRICT[6]

Germany and the Netherlands share the Ems River basin. As the management unit, the Ems River Basin District[7] was created, which includes the Ems-Dollart estuary.

Ems River Basin District			
Total area	**Country/area**	**Country's/area's share**	
17,879 km²	Germany	15,008 km²	84%
	Netherlands	2,389 km²	13%
	Ems-Dollart estuary	482 km²	3%

Sources: International River Basin District Ems: features, pressures and assessment of the impact of human activities on the environment, Part A, 2005. International Steering Group on the Ems River basin district, Germany and the Netherlands.

[6] Source: International Steering Group on the Ems River basin district, Germany and the Netherlands.
[7] According to the EU WFD, a River Basin District is an area of land and sea, made up of one or more neighbouring river basins together with their associated groundwaters and coastal waters, which is identified under Article 3 (1) as the main unit for management of river basins.

The Ems, also known as the Eems, is a river in north-western Germany and north-eastern Netherlands. It runs through the German States of North Rhine-Westphalia and Lower Saxony. The Ems' tributaries in the Netherlands (Provinces of Groningen and Drenthe) discharge directly into the Ems-Dollart tidal system.

The source of the river is at the southwest edge of the Teutoburg Forest in North Rhine-Westphalia. At Meppen, the Ems is joined by its largest tributary, the Hase. Near the city of Emden, the Ems flows into Dollart bay and then continues as a tidal river towards the Dutch city of Delfzijl. The total length of the Ems is 371 km.

At the Rheine gauging station (Germany) the discharge values are as follows: HHQ – 332 m^3/s; MQ – 37 m^3/s and MNQ – 5.8 m^3/s. At this gauging station, the discharge during the 1946 flood event with a recurrence interval of 100 years amounted to 1,030 m^3/s.

Hydromorphological changes have a high or very high influence on the ecological quality of the water bodies. The water bodies in the river basin are loaded by nutrients, especially nitrates.

RHINE RIVER BASIN DISTRICT[8]

The International River Basin District Rhine, established as the management unit under the WFD, has a size of approximately 200,000 km² and is shared by nine countries.

Basic figures for the Rhine River Basin District										
Indicator	**RBD**	**IT**	**CH**	**LI**	**AT**	**DE**	**FR**	**LU**	**BE**	**NL**
Countries' area in km²	197,100	<100	27,930	<200	2,370	105,670	23,830	2,530	<800	33,800
Countries' areas share in km²	100	<1	14	<1	1	54	12	1	<1	17
Countries' population share in %	100	…	9	<1	1	64	6	1	<1	20
Urban areas in km²	14,800	…	950	…	70	9,750	1,490	160	40	2,340
Agricultural land in km²	99,310	…	9,620	…	990	56,000	13,000	1,410	430	17,860
Forests in km²	69,040	…	16,290	…	1,270	38,990	9,040	940	290	2,220
Wetlands in km²	370	…	<20	…	<5	100	<20	0	<5	230
Water bodies in km²	13,350	…	1,200	…	40	790	150	10	0	11,160

Source: Internationale Flussgebietseinheit Rhein: Merkmale, Überprüfung der Umweltauswirkungen menschlicher Tätigkeiten und wirtschaftliche Analyse der Wassernutzung (International River Basin District Rhine: features, assessment of the impact of human activities on the environment and economic analysis of water uses). International Commission for the Protection of the Rhine.

RHINE RIVER

Hydrology

The Rhine River, with a total length of 1,320 km, is one of the most important transboundary watercourses in western Europe. Its source is in the Swiss Alps. The Rhine passes through Lake Constance (see separate assessment below). Important transboundary tributaries include the Moselle and Vechte rivers, which are separately assessed below.

The long-term mean annual discharge (MQ) at the Konstanz gauging station (Germany) is 338 m³/s; at Karlsruhe-Maxau (Germany), 1,260 m³/s; and at Rees, upstream of the German-Dutch border, 2,270 m³/s.

Pressure factors and transboundary impact

The Rhine is one of the most intensively used water bodies in Europe. Some 58 million people live in the Rhine basin and some 20 million people depend on the Rhine as their main source of drinking water supply, either through direct abstraction (Lake Constance), bank filtration or abstraction of groundwaters, which are artificially recharged by Rhine water infiltration through dunes.

96% of the population in the Rhine basin is connected to some 3,200 municipal wastewater treatment plants, which also treat wastewater from small industries and run-off water from sealed surfaces.

[8] Based on information by the International Commission for the Protection of the Rhine as well as the publication "Internationale Flussgebietseinheit Rhein: Merkmale, Überprüfung der Umweltauswirkungen menschlicher Tätigkeiten und wirtschaftliche Analyse der Wassernutzung" (International River Basin District Rhine: features, assessment of the impact of human activities on the environment and economic analysis of water uses), International Commission for the Protection of the Rhine, 18 March 2005.

Currently, over 950 of major industrial point pollution sources have been identified. These big and medium-sized enterprises operate their own treatment plants. In 2000, eight industrial enterprises were responsible for a considerable share of the total emission of at least one of the following substances: Hg, Cr, Cu, Ni, Pb, N-total and P-total. The share of single enterprises varied between 1% (N-total) and 18% (Cr). There were no single enterprises that discharged more than 1% of the total emission of Zn, Cd or Lindan.

Nitrogen, phosphorus and pesticides originate from diffuse pollution sources in agriculture or run-off in rural areas. Run-off water, including water from sealed surfaces and streets is also responsible for heavy metal inputs into the watercourses of the basin. The table below shows the significant share of pollution from diffuse sources.

Mining activities, although decreasing, have an impact on the sub-basins of the Moselle and Saar rivers, the Ruhr area in Germany and the western side of the Lower Rhine area. Adverse effects, sometimes visible over the whole length of the Rhine downstream of the confluence with the Moselle, include hydraulic changes, thermal pollution and pollution by chlorides and heavy metals. Mining of hard coal has significantly changed groundwater flow (see assessment of the Moselle sub-basin), and opencast mining of brown coal is lowering the groundwater level in parts of the Lower Rhine area, with adverse impacts on aquatic and terrestrial ecosystems.

The Rhine is an important shipping route. Apart from hydromorphological changes, required for shipping purposes, ship transport adversely affects riverbanks and their ecology and leads to higher turbidity (raising of sediments). Other pressure factors include water abstraction for cooling purposes, hydropower production and agriculture.

Emissions in the Rhine River Basin District				
Emissions upstream of Lake Constance (average for 1996–1997)				
Determinands	**Municipal and industrial sources**		**Diffuse pollution**	**Total**
N-total (in kg)	3,630,000		13,000,000	16,630,000
P-total (in kg)	140,000		370,000	510,000
Emissions downstream of Lake Constance				
Determinands	**Municipal sources**	**Industrial sources**	**Diffuse pollution**	**Total**
N-total (in kg)	107,120,000	22,853,000	289,881,000	419,854,000
P-total (in kg)	9,719,000	2,424,000	14,032,000	25,175,000
Cr (in kg)	11,467	34,971	88,205	134,643
Cu (in kg)	56,820	48,139	213,627	318,586
Zn (in kg)	357,689	107,071	1,223,103	1,687,863
Cd (in kg)	863	809	6,350	8,022
Hg (in kg)	353	306	1,222	1,881
Ni (in kg)	31,979	30,993	105,036	168,008
Pb (in kg)	23,827	19,265	148,882	191,974
Lindan (in kg)	0	1	219	220

Source: Internationale Flussgebietseinheit Rhein: Merkmale, Überprüfung der Umweltauswirkungen menschlicher Tätigkeiten und wirtschaftliche Analyse der Wassernutzung (International River Basin District Rhine: features, assessment of the impact of human activities on the environment and economic analysis of water uses), International Commission for the Protection of the Rhine.

Share of nitrogen and phosphorus emission in various transboundary sub-basins

Sub-basins	N-total (in %)			P-total (in %)		
	Municipal sources Industrial sources		Diffuse sources	Municipal sources Industrial sources		Diffuse sources
Alpine Rhine and Lake Constance	22		78	27		73
Upper Rhine	12	4	85	21	4	75
Moselle and Saar	9	1	90	58	2	40
Delta Rhine (Netherlands)	13	4	83	35	7	58

Source: Internationale Flussgebietseinheit Rhein: Merkmale, Überprüfung der Umweltauswirkungen menschlicher Tätigkeiten und wirtschaftliche Analyse der Wassernutzung (International River Basin District Rhine: features, assessment of the impact of human activities on the environment and economic analysis of water uses), International Commission for the Protection of the Rhine.

Trends

Owing to heavy investments into wastewater treatment and industrial safety technology over a long period of time, the pollution of the Rhine River has been significantly reduced. The salmon, one of the indicator species for demonstrating the success of pollution abatement measures, recently returned to the river. The remaining pollution stems mainly from diffuse sources. Therefore, agriculture is one of the target areas for further improving the status of watercourses in the International River Basin District Rhine.

In order to achieve the targets of the WFD related to the status of surface waters, further measure have been identified as to nutrients, chromium, copper, zinc and PCB-153 as the relevant pollutants; further "target" substances include nickel and its compounds, HCB and tributyl-tin. As to groundwaters, there is hardly a quantity problem, however, nitrates and some pesticides have been identified as target substances to improve groundwater quality.

LAKE CONSTANCE[9]

Lake Constance, which belongs to the Rhine basin, is the second largest pre-Alpine European lake and serves as an important drinking water supply for 4 million people. A major tributary to Lake Constance is the Alpine Rhine with its sub-basin in Italy, Switzerland, Liechtenstein and Austria.

The lake basin is situated in the Molasse basin of the northern Alpine foreland and was mainly formed by water and ice activity during the last Quaternary glaciation period more than 15,000 years ago. The lake basin area of about 11,000 km^2 (~20 times the lake surface) covers the territories of the five European countries: Germany (28%); Switzerland, Liechtenstein and Italy (48%); and Austria (24%). With an area of 572 km^2 and a total volume of 48.5 km^3, Lake Constance lies 395 m above sea level. Its two major parts are the Upper Lake Constance (472 km^2, 47.6 km^3, max. depth 253 m, mean depth 101 m) and Lower Lake Constance (62 km^2, 0.8 km^3, max. depth 40 m, mean depth 13 m). More than 75% of the water inflow originates from the Alps, mainly through the tributaries Alpine Rhine (Alpenrhein) and Bregenzerach. The lake has a water retention time of 4.3 years.

The phytoplankton succession typically shows a spring bloom followed by the "clear water" phase with very low phytoplankton abundance due to zooplankton grazing. Diatoms contribute up to 90% of the phytoplankton biovolume in spring. Phytoplankton, bacteria and crustaceans are the most important contributors of biomass. During summer, zooplankton is the main food source for most fish in Lake Constance. About 30 species of fish contribute to the fauna of Lake Constance. The dominant species are whitefish (*Coregonus lavaretus L.*) and perch (*Perca fluviatlis L.)* – contributing to 90% of total commercial fishing yield (1032 tons, annual mean for the period 1995–2004).

Lake Constance is certified by the Ramsar Convention as a habitat of international importance especially for water and wading birds. It is an intensively monitored hard-water lake with low-phosphorus content - overall mesotrophic (the Upper Lake is almost oligotrophic: phosphorus levels <10

[9] Based on information provided by the Governments of Austria, Germany and Switzerland.

µg/l since 2005). Originally an oligotrophic water body, eutrophication started to threaten the lake in the late 1950s and remarkably affected the species composition of the biota. Starting in the early 1980s, phosphorus concentrations strongly declined, and overall water quality improved. This was due to reduced nutrient loads (more than €4 billion have been invested to improve sewage treatment).

In recent times, the pressures by rising population figures and industrial and agricultural activities may deserve concern. Today, some 60% of shore and shallow-water zones are characterized as deviating from the natural state, and therefore a main focus is on ecological improvement by shoreline restoration. For this purpose, the International Commission for Protection of Lake Constance has initiated an action programme "Shore-water and Shallow-water Zone".

The biological quality of tributaries discharging into the lake varies from unpolluted headwater rivers to slightly polluted lower reaches. Hydromorphological changes have been severe in these areas, as canalization and artificial riverbeds and banks are common. Recently, revitalization has been undertaken in the floodplains of the Alpine Rhine, the main tributary discharging into the lake.

Lake Constance is also facing climate change with increasing winter temperatures and higher precipitation in the form of rain. The summers will be dryer and hotter resulting in lower water levels and changes in the littoral zone. This climatic change might be accompanied by an increasing number of exotic species in the future, which may threaten indigenous biota.

MOSELLE RIVER[10]

Belgium, France, Germany and Luxembourg share the sub-basin of the Moselle River, which includes the transboundary Saar River.

Sub-basin of the Moselle River			
Area	**Country**	**Country's share**	
28,286 km²	France	15,360 km²	54.3%
	Luxembourg	2,521 km²	8.9%
	Belgium	767 km²	2.7%
	Germany	9,637 km²	34.1%

Source: International Commission for the Protection of the Moselle and Saar.

Hydrology

The Moselle, also known as the Mosel, Musel and Moezel, is one of the largest tributaries of the Rhine. The source of the Moselle is at the western slope of the Ballon d'Alsace in the Vosges mountains (France). Its total length from source to mouth at the confluence with the Rhine at the city of Koblenz (Germany) is approximately 545 km. Based on measurements at the gauging station Cochem, the calculated average discharge at the mouth is 328 m³/s.

The Saar River is the largest transboundary tributary of the Moselle. The 227-km-long Saar joins the Moselle next to the city of Trier. The Saar catchment area of 7,431 km² is almost equally shared by France and Germany. Its discharge at the confluence with the Moselle is 80 m³/s.

The Moselle has been made navigable for large cargo ships from the Rhine at Koblenz up to Neuves-Maisons, south of Nancy. For smaller ships, it is connected to other French rivers through the Canal de l'Est and the Canal de la Marne au Rhin.

Pressure factors and transboundary impact

The Moselle valley between Nancy, Metz and Thionville is an industrial area, with coal mining and steel manufacturing. Hard coal mining in the Moselle and Saar region also causes significant transboundary impacts on groundwaters.

[10] Based on information contained in the publication: Richtlinie 2000/60/EG - Internationale Flussgebietseinheit Rhein, Internationales Bearbeitungsgebiet „Mosel-Saar": Bestandsaufnahme (Directive 2000/60/EG – International River Basin District Rhine, International area Moselle-Saar: Inventory). International Commission for the Protection of the Moselle and Saar, June 2005.

At Cattenom (France), one of the most powerful European nuclear power stations uses the Moselle for cooling purposes. Water transfer from the Vieux-Pré reservoir in the Vosges usually compensates its thermal pollution;[11] and pollution by radioactive substance, with the exception of tritium, is below measurement level. The relatively high chloride level is both of natural origin and due to emissions from French sodium industry. In 2003, the chloride concentration in the upper reaches of the Moselle was still around 330 mg/l and at Koblenz 200 mg/l.

Transboundary impact from Luxembourg is mainly related to nitrogen (from animal husbandry and from some municipal wastewater treatment plants, which are not yet eliminating nitrogen). The impact from Belgium is similar to that from Luxembourg. The German impact, mostly related to ongoing and ceased mining activities, is decreasing although some hazardous substances and chlorides are still entering the Saar.

VECHTE RIVER

Germany (upstream country) and the Netherlands (downstream country) share the sub-basin of the Vechte River.

Sub-basin of the Vechte River			
Area	**Country**	**Country's share**	
2,400 km^2	Germany	1,536 km^2	64%
	Netherlands	864 km^2	36%

Source: Netherlands Institute for Inland Water Management and Waste Water Treatment (RIZA).

The Vechte, also known as the Overijsselse Vecht, has a length of 167 km. 107 km of the river is on German side and 60 km in the Netherlands. The mean discharge at the mouth of the Vechte[12] is 50 m^3/s, at low water 5 m^3/s, and under conditions of high water, about 300 m^3/s.

The Vechte originates in the Baumberge hills in the German State of North Rhine-Westphalia near the city of Münster and flows across the border into the Dutch province of Overijssel. There, it confluences with the River Zwarte Water near the town of Hasselt.

The total population in the catchment is about 800,000 people. The Dutch part of the basin is more intensively used than the German part. The human pressure on the aquatic environment is high, both from cities and from intensive agriculture. Discharges from many sewage treatment plants end up in relatively small tributaries. Most of the watercourses in the sub-basin have been strongly regulated by river straightening and dams. In large parts of the area, water inlet from outside the basin plays an important role for agriculture in the summer.

[11] Law regulates the possible increase of water temperature; thus, under extreme weather events, the power station may experience operational difficulties.
[12] Source: EUROHARP project (http://www.euroharp.org/).

MEUSE RIVER BASIN DISTRICT[13]

Belgium, France, Germany, Luxembourg and the Netherlands share the Meuse River basin. The International River Basin District Meuse is the management unit under the WFD.

Meuse River Basin District			
Area	**Country**	**Country's share**	
34,548 km^2	France	8,919 km^2	25.8%
	Luxemburg	65 km^2	0.2%
	Belgium	13,896 km^2	40.2%
	Netherlands	7,700 km^2	22.3%
	Germany	3,968 km^2	11.5%

Source: Roof report under the WFD for the International River Basin District Meuse.

Hydrology

The Meuse River takes its source at an altitude of 384 m above sea level at Pouilly-en-Bassingy in France. Having a total length of 906 km, it flows through France, Belgium and the Netherlands before entering the North Sea. The average discharge at the mouth is 230 m^3/s.

The peak run-off usually occurs in winter and spring. A maximum flow of 3,100 m^3/s was measured in 1993 at Eijsden (border station between Belgium and the Netherlands). Summer and autumn are mainly characterized by longer periods of low flows, for example, 10 m^3/s to 40 m^3/s at Eijsden.

A number of locks and dams were built in the river for navigation purposes or protection against floods, leading to significant modifications of the natural character of the river in most of its sections.

Majors tributaries of the Meuse, some of them transboundary, include the Chiers, Semois, Lesse, Samber, Ourthe, Rur, Schwalm, Niers and Dommel rivers.

Pressure factors

Some 8.8 million people live in the International River Basin District Meuse and use water for drinking and domestic purposes, agriculture and industry, hydropower generation, navigation and recreation. The water of the Meuse also supports surrounding ecosystems, and is exported by pipelines and canals to provide drinking water to people living outside the basin.

The basin of the river Meuse can be divided into three sections, with differing geomorphological and physical features and human impacts.

The first section, from the source to the city of Charleville-Mézières (France), is characterized by low-flow velocity and low pressure from industry and municipalities.

The second section, where the Semois, Lesse, Sambre and Ourthe rivers join the Meuse, stretches from Charleville-Mézières to Liège (Belgium). During periods of heavy precipitation, these tributaries contribute substantially to the flow of the Meuse and may cause rapid water level rises. The sub-basins of these tributaries make up the principal natural values of this river section and are especially important as spawning grounds and growth areas for rheophile fish. A few small islands in the river and parts of the banks have remained in their natural condition, offering habitats for a variety of species of plant and animal life. The section has also many heavily urbanized and industrial sites, both along the main watercourse as well as along the Sambre, one of the tributaries. In the upper part of this section of the river, there are a few small islands in the river and parts of the banks that remained natural and offer habitats for a variety of plant and animal life. There was major development of the principal Meuse watercourse to make it navigable.

[13] Source: International Meuse Commission ("Characteristics, Review of the Environmental Impact of Human Activity, Economic Analysis of Water Use - Roof report under the Water Framework Directive" and "The international river district Meuse: a status assessment").

The third section, a flood plain area, stretches from Liège to the mouth. This section is navigable, which limits the possibilities for a natural low-water channel and severely reduces the fluvial dynamics. This region is also characterized by dense population, intensive agriculture and many industries. Areas of great ecological value exist (e.g. woods, heather fields and marshlands), but their area has been reduced and they are widely dispersed. The north-western part offers an attractive and relatively open area that is surrounded by urban harbour areas.

Further urban development and increasing transport, as well as industrial and agricultural activities, are significant pressures for the water systems. Safety and flood control measures (e.g. delta works and the closure of the Haringvliet in the Netherlands) in the 1970s were essential social measures, but deprived the area of tidal dynamics, resulting in a decreased ecological potential. Recently, the Dutch Government decided to introduce, by 2008, a different modus operandi for the floodgates of the Haringvliet, with the aim of reintroducing the tidal influence.

Transboundary impact

Human impact has altered the natural hydromorphological and ecological conditions. The main driving forces for these alterations are urbanization, industrialization, agriculture, shipping and flood protection - which have a transboundary impact - and drinking-water supply.

For the French part of the river basin, agriculture is the main driving force. In the Walloon region (Belgium), the more densely populated and industrialized sub-basins of the Vesdre and Sambre rivers experience urbanization as major driving force. For the Semois and Lesse rivers, only smaller longitudinal obstacles are present, with no strong driving forces restricting restoration potentials.

In the German, Flemish and Dutch lowlands, urbanization and agriculture are the major cause to alterations in hydromorphological characteristics. In the Dutch part of the Meuse River, most pressures derive from flood defence and shipping. For the smaller tributaries, especially in the Netherlands, agriculture remains a major driving force. In addition to the strongest estimated impact of longitudinal obstacles and changes in river discharge over the basin, local pressures affecting the habitat quality can seriously affect the ecological integrity of the river's water.

Based on the results of the internationally coordinated bio-monitoring of the Meuse, the artificial alterations of the riverbanks and a lack of natural substrates, together with poor water quality, were identified as major threats to the river's benthic macro-invertebrate communities. Changed flow conditions and bed characteristics are among the major causes for the absence of natural rheophilic fish communities. Some weirs represent a considerable obstacle for organisms to move upstream, especially for migration of fish.

Trends

The riparian countries (including the Belgian regions) are implementing the decisions of their own Governments as well as recommendations of the International Meuse Commission (IMC). The IMC has been established under the Agreement on the River Meuse (Ghent, 2002) and acts as the platform for international coordination to implement obligations under the WFD for the International River Basin District Meuse.

The measures taken in the past have led to an improvement of the water quality. Further improvements are expected in the future due to more stringent policies at the national and EU levels.

SCHELDT RIVER BASIN DISTRICT[14]

Belgium, France and the Netherlands share the Scheldt River basin (22,116 km²). The Scheldt has the Lys (Leie), Zenne and Dender rivers as major transboundary tributaries.

As management unit, the Scheldt International River Basin District was established (36,416 km²). Apart from the Scheldt and Yser basins, the International River Basin District Scheldt also includes basins of national rivers, most notably the basins of the Somme, Authie and Canche rivers, which are located entirely in France, as well as transitional and coastal waters.

The basin of the Yser (Ijser), shared by Belgium and France, has an area of 1,750 km².

Scheldt River Basin District		
Area	Country/region	Country's or region's share
36,416 km²	Belgium (Flemish region)	33%
	Belgium (Walloon region)	10%
	Belgium (Brussels capital region)	0.44%*
	France	50%
	Netherlands	6%

* Equals 10% of the population of Belgium
Source: Scheldt International River Basin District, Roof report, February 2005. Internationale Scheldecommissie (ISC) – Commission Internationale de l'Escaut (CIPE).

[14] Source: Scheldt International River Basin District. Roof report. February 2005. Internationale Scheldecommissie (ISC) – Commission Internationale de l'Escaut (CIPE).

Hydrology (rivers Scheldt and Yser)

The 350-km-long Scheldt River has its source on the Saint-Quentin plateau, near the village of Gouy-Le-Catelet in France in the Artois hills. The river courses through Northern France, Belgium (Flemish and Walloon regions) and the Netherlands before it discharges into the North Sea via a long estuary. The estimated average discharge at Lillo is 130 m^3/s. The wide and flat valleys in the Scheldt basin suffer from numerous floods, especially in winter, when the groundwater level and water flow is highest. The water of the Scheldt estuary is by nature very nutritious. Therefore, it is an important place for fish and other animals to reproduce. In the Scheldt, fishery mainly fishes for cockles, eels and soles.

The Yser River is approximately 80 km long, rising in northern France and flowing generally northeast through north-western Belgium and into the North Sea at Nieuwpoort. It connects a network of canals.

Pressure factors having adverse effects on water quality

The Scheldt International River Basin District is a highly urbanized, densely populated, and heavily built-up area. As in some areas the European Waste Water Treatment Directive has not yet fully implemented but is scheduled for the near future, the impact of the urban pollution will decrease.

There are a number of major industrial areas (e.g., around the towns of Kortrijk and Ostend; in the ports of Zeebrugge, Ghent, Antwerp, Vlissingen and Terneuzen, Calais, and Dunkerque; along the Antwerp-Brussels-Charleroi axis, in particular the petrochemical site of Feluy-Seneffe-Manage in the Walloon Region; along the Albert Canal; near the agglomeration Lille-Roubaix-Tourcoing; in the Valenciennes area; and around the towns of Mons, Saint-Ghislain, La Louvière, Tournai and Mouscron).

There is also a dense transport infrastructure including railways, waterways and motorways. The shipping trade uses the Scheldt intensively. The river provides the connection between the North Sea and the harbours of Antwerp, Ghent, Terneuzen and Vlissingen. Thanks to this accessibility, many industrial activities take place on the banks of the Scheldt. These industries pollute the Scheldt with wastewater containing chemicals, nutrients and heavy metals.

Agriculture covers 61% of the total area of the International River Basin District Scheldt. In the northern part, the main agricultural activity is live-stock farming, whereas crop farming is the main agricultural activity in the southern part.

The relative importance of the pressure factors in transboundary sub-basins of the International River Basin District Scheldt are summarized in the table below.

Pressure factors for transboundary sub-basins in the Scheldt International River Basin District

Sub-basin	Main pressures			
	Population	Industry	Agriculture	Transport
Scheldt, upper course	++++	+++	++++	**
Scheldt, middle course	+++	++	++	***
Scheldt, lower course	++++	++++	++++	***
Zenne	++++	++	++	***
Dender	++	++	++	**
Lys/Leie	++++	+++	++++	**
Yser (IJser)	++	+	++++	**

For population, industry and agriculture:
Very high pressure: ++++
High pressure: +++
Moderate pressure: ++
Low pressure: +

For transport:
Indicator values higher than RBD averages: ***
Some indicator values higher than RBD averages: **

Source: Scheldt International River Basin District. Roof report. February 2005.

It should be noted that indicators to characterize the pressure from the population included the discharged nitrogen load, the discharged phosphorus load and the discharged load of suspended solids. Indicators for pressures from industry covered metal micro-pollutants, organic micro-pollutants, macro-pollutants (nitrogen, phosphorus, total organic carbon), and salts (chlorides, cyanides, fluorides). For agriculture, the share of cultivated area in the total area of the sub-basin; the share of commercial crops in the total cultivated area of the sub-basin; the percentage of the total cattle, pig and poultry livestock present in the area of the sub-basin; and the livestock density for cattle, pigs and poultry were taken into account. The pressure of transport on the aquatic environment was difficult to estimate as accurate data were lacking; but it is important to mention transport regarding the impact of polycyclic aromatic hydrocarbons on the aquatic environment.

Other pressure factors (hydromorphology)

The probable impact of the envisaged deepening of the Scheldt waterway to 14.70 meters below mean sea level (13.10 meter tide-independent accessibility) to keep the harbour of Antwerp accessible to larger vessels – as part of the Scheldt Estuary Development Outline 2010[15] – was thoroughly evaluated. Several studies were carried out during recent years, including: (a) a strategic environmental impact report; (b) social cost/benefit analysis, (c) studies on the development of the natural environment; and (d) birds and habitat criteria. Comprehensive consultations with all stakeholders were held and communications were widely issued.

[15] The Dutch-Flemish bilateral Technical Scheldt Commission developed a long-term vision for the Scheldt estuary with three objectives:
- Safety maximum protection against flooding in the region
- Accessibility optimum accessibility to the harbours on the Scheldt estuary
- Natural environment – a dynamic, healthy natural environment (see http://www.ontwikkelingsschets.nl/).

The deepening will cause minor effects due to (a) a new flexible dumping strategy and (b) a nature restoration programme including de-poldering along the river. Specific monitoring programmes are established to continuously follow-up the changes of the estuary and its ecological quality.

The Wild Birds and Habitat Directives[16] prohibit interventions that cause damage to protected natural environments unless the intervention serves a major social interest and no alternatives are available. The WFD also stresses restricting adverse effects of man-induced morphological changes, such as deepening waterways or building dikes. Study results show that the overall package of measures in the Development Outline would not cause any damage to protected natural environments. In fact, these measures would increase the robustness of the natural environment of the Scheldt estuary. In the coming years, part of this package will be carried out in a nature restoring programme that includes 600 ha and 1,100 ha of de-poldering along the Dutch and Flemish (Belgian) parts, respectively, of the Scheldt. The major adverse effects on protected natural habitats of deepening the waterway and more than 150 years of poldering are not completely restored, but sufficiently counteracted to ensure compliance with the targets of the Birds and Habitat Directive as well as the EU WFD. For the upcoming deepening of the waterway and the implementation of a flexible strategy of dumping adverse effects are estimated as minor. In this way, the positive effects of the nature restoration programme will be maintained.

Transboundary impact

It was not yet possible for the International Scheldt Commission to carry out a transnational comparison of the current chemical status because joint standards have not yet been established for the Scheldt International River Basin District and the countries/regions still use different monitoring and assessment methods. A general and complete transnational comparison of the ecological status is also lacking. Preliminary assessments were made on the basis of available data and expert judgment.

The roof report of the International Scheldt Commission[17] concluded that very few waterbodies in the Scheldt International River Basin District are currently "in good ecological status".

On the basis of the collected data, the International Scheldt Commission concluded in 2005 that none of the examined transboundary watercourses (Scheldt, Yser, Lys/Leie, Zenne and Dender) were in good physico-chemical status. Most of the watercourses also showed bad oxygen balances. Nutrients were a problem everywhere, and national/local metal standards had been exceeded for copper, zinc, lead and cadmium at a number of monitoring sites.

In the coastal waters of the International River Basin District, the overall quality of macrofauna is "good", but the quality of phytoplancton is "generally insufficient", and PCBs, PAH, lindane, organotin compounds and nutrients are a problem.

Trends

The three riparian countries are implementing the decisions of their own Governments as well as recommendations of the International Scheldt Commission. The Commission has been established by the signatories under the Agreement on the River Scheldt (Ghent, 2002) and acts as the platform for international coordination to implement obligations under the WFD for the International River Basin District Scheldt.

This has lead to an improvement of the water quality in France, Belgium and the Netherlands.

Further improvements are expected in the future due to more stringent policies, i.e. better implementation and enforcement, as well as new or improved policies, at the national and EU levels.

[16] Council Directive 79/409/EEC on the conservation of wild birds and Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora.
[17] Scheldt International River Basin District. Roof report. February 2005.

MINO RIVER BASIN[18]

The basin of the Mino River, also known as Miño (in Spain) and Minho (in Portugal), is shared by Spain (upstream country) and Portugal (downstream country).

[18] Based on information submitted by the Portuguese National Institute of Water (Instituto da Agua, INAG) as well as Freshwater in Europe – Facts, Figures and Maps United Nations Environment Programme Division of Early Warning and Assessment, Office for Europe, 2004.

Basin of the Mino River			
Area	Country	Country's share	
17,080 km²	Portugal	850 km²	5%
	Spain	16,230 km²	95%

Source: Portuguese National Water Plan (Instituto da Agua, INAG,2002).

MINO RIVER

Hydrology

The Mino River has its source in Spain in the Meira Mountains (750 m) and empties into the Atlantic Ocean at Caminha. The basin has a pronounced mountainous character with an average elevation of about 683 m above sea level.

A major transboundary tributary to the Mino is the Trancoso. The major Portuguese tributaries are the rivers Gadanha, Mouro and Coura. One major Spanish tributary is the Louro (see below).

Discharge characteristics of the Mino River at the station Foz do Mouro (Portugal)		
Discharge characteristics	Discharge, m^3/s	Period of time or date
Q_{av}	314	1 March 1973 – 31 January 2007
Q_{max}	4,681	1 March 1973 – 31 January 2007
Q_{min}	7	1 March 1973 – 31 January 2007

Source: Portuguese National Institute of Water (Instituto da Agua, INAG).

In Portugal, there are two reservoirs on the Coura tributary; lakes and reservoirs occupy some 2.8% of the basin area.

Pressure factors

In Portugal, agriculture uses about 95% and the urban sector about 5% of the available water resources. The main forms of land use are forests (62.7%) and cropland (30.8%).

The population density is about 92 persons/km².

Pressures on water resources from agricultural activities are mainly due to the use of fertilizers and pesticides, as well as irrigation. Some untreated or insufficiently treated wastewater discharges, mainly from Spain, cause additional pressures.

Eutrophication is generally decreasing along the main stem of the river, mainly due to the river's self-purification capacity.

In Portugal, manufacturing industry is almost not present and causes hardly any impact. There are, however, two abandoned wolfram mines that have a local impact on the quality of water resources. Transport is another pollution source, due to exhaust gases, fuel transport and spills or leakages of dangerous substances.

During flood events, unsafe and/or irregular drinking-water supply is of concern.

Transboundary impact

The waters of the river Louro, a Spanish tributary to the Mino, have a significant impact on Portuguese territory. The river drains important agglomerations in Spain and carries insufficiently treated industrial and municipal wastewaters from the industrial area of Porriños and the city of Tuy in Spain.

Organic matter from wastewater discharges and pathogens from wastewater discharges and pesticides are mostly of local significance. Nitrogen forms are both of local and transboundary significance and have also an adverse impact on the marine environment.

Trends

Since 2002, the status of the Mino River in Portuguese territory has improved significantly. This was mainly due to the implementation of the Portuguese National Water Plan (PNA) and the Portuguese Water Supply and Residual Water Treatment Plan (PEAASAR), notably the specific Residual Water Treatment Plants (ETARs) to treat industrial and urban sewage. Some occasional pollution events still occur due to inappropriate agricultural practices. Transboundary pollution originating from Spain is still significant, and requires more stringent control measures by Spain.

FRIEIRA RESERVOIR[19]

The Frieira Reservoir is an artificial lake constructed for hydroelectric power production. The reservoir is situated in Spain in the Mino River basin in the border area between Spain and Portugal, but both countries jointly manage it.

Constructed for hydropower production purposes, the Frieira Reservoir is shallow (mean depth 20 m, maximum depth 27 m) and has a surface area of 4.66 km^2. Due to its shallowness, the water storage capacity of the reservoir is relatively small (0.044 km^3). The mean inflow is 9.524 km^3/year and the minimum outflow 3.7 km^3/year.

The status of the reservoir is "mesotrophic" (mean total phosphorus concentration 29 µg/l); its water quality and quantity is regularly monitored.

The management of the reservoir is mainly based on the Convention on cooperation for the protection and sustainable use of the waters of the Spanish-Portuguese catchment areas that was signed in 1998 and entered into force in 1999.

[19] Based on information from the Government of Spain as well as the publication Monitoring of International Lakes - Background document for the Guidelines on Monitoring and Assessment of Transboundary and International Lakes (UNECE, 2002).

LIMA RIVER BASIN[20]

The basin of the Lima River, known as the Limia in Spain, is shared by Spain (upstream country) and Portugal (downstream country).

Basin of the Lima River			
Area	Country	Country's share	
2,480 km²	Portugal	1,180 km²	48%
	Spain	1,300 km²	52%

Source: Portuguese National Water Plan (Instituto da Agua, INAG, 2002).

LIMA RIVER

Hydrology

The Lima has its source in Spain at Lake Beon (975 m) and ends up in the Atlantic Ocean at the city of Viana do Castelo. The basin has a pronounced mountainous character with an average elevation of about 447 m.

A major transboundary tributary to the Lima is the Castro Laboreiro. The Vez is a major Portuguese tributary.

Discharge characteristics of the Lima River (monitoring site Snirh)		
Discharge characteristics	Discharge, m³/s	Period of time or date
Q_{av}	68	16 April 1945 – 30 September 1990
Q_{max}	1,380	16 April 1945 – 30 September 1990
Q_{min}	0	16 April 1945 – 30 September 1990

Source: Portuguese National Institute of Water (Instituto da Agua, INAG).

There are two major reservoirs on the Lima: the transboundary reservoirs of the Alto Lindoso Dam and the Touvedo Reservoir. These dams were constructed in 1992 and 1993, respectively.

Ponte de Lima, Ponte da Barca and Arcos de Valdevez in Portugal are the urban areas mostly affected by floods. The existing reservoirs, constructed for hydropower production, reduce the risks of flooding in the first two villages; however, due to the specifics of flow formation after heavy precipitation in the Serra da Peneda/Peneda mountain range, the resulting increased flood discharges cannot always be stored in the existing reservoirs.

In Portugal, lakes and reservoirs occupy some 1.6% of the basin area. Protected areas include the Lagoas de Bertiandos and San Pedro dos Arcos, which are – permanent and temporary, respectively – freshwater lagoons on the right bank of the Lima in Portugal.

Pressure factors

In Portugal, agriculture uses about 90%, industry about 6%, and the urban sector about 4% of the available water resources. The main forms of land use are forests (70.9%) and cropland, which cover 25.4% of the Portuguese part of the basin. The population density is about 130 persons/km².

In Portugal, pressures on water resources from agricultural activities are mainly due to the use of fertilizers and pesticides, as well as irrigation. There is a risk of contamination due to several abandoned ore mines. There is also some risk of accidental water pollution from industrial wastewater discharges. The former dumpsites were recently closed.

[20] Based on information submitted by the Portuguese National Institute of Water (Instituto da Agua, INAG) as well as the publication Freshwater in Europe – Facts, Figures and Maps (UNEP/DEWA-Europe, 2004).

Due to road and railroad crossings, there is also a risk of water pollution if road/railroad accidents should occur.

Trends

Since 2002, the status of the Lima on Portuguese territory has improved significantly, mainly due to the measures described in the above chapter on the Mino. Some occasional pollution events still occur due to inappropriate agricultural practices. Transboundary pollution originating from Spain is still significant, and requires more stringent control measures by that country.

ALTO LINDOSO RESERVOIR[21]

The Alto Lindoso Reservoir is an artificial water body in the Lima River basin on the border between Spain (upstream country) and Portugal. The reservoir was reconstructed in the 1980s for hydropower purposes. Alto Lindoso is one of the most important hydropower plants for Portugal's energy sector. The reservoir has also significance for recreational uses.

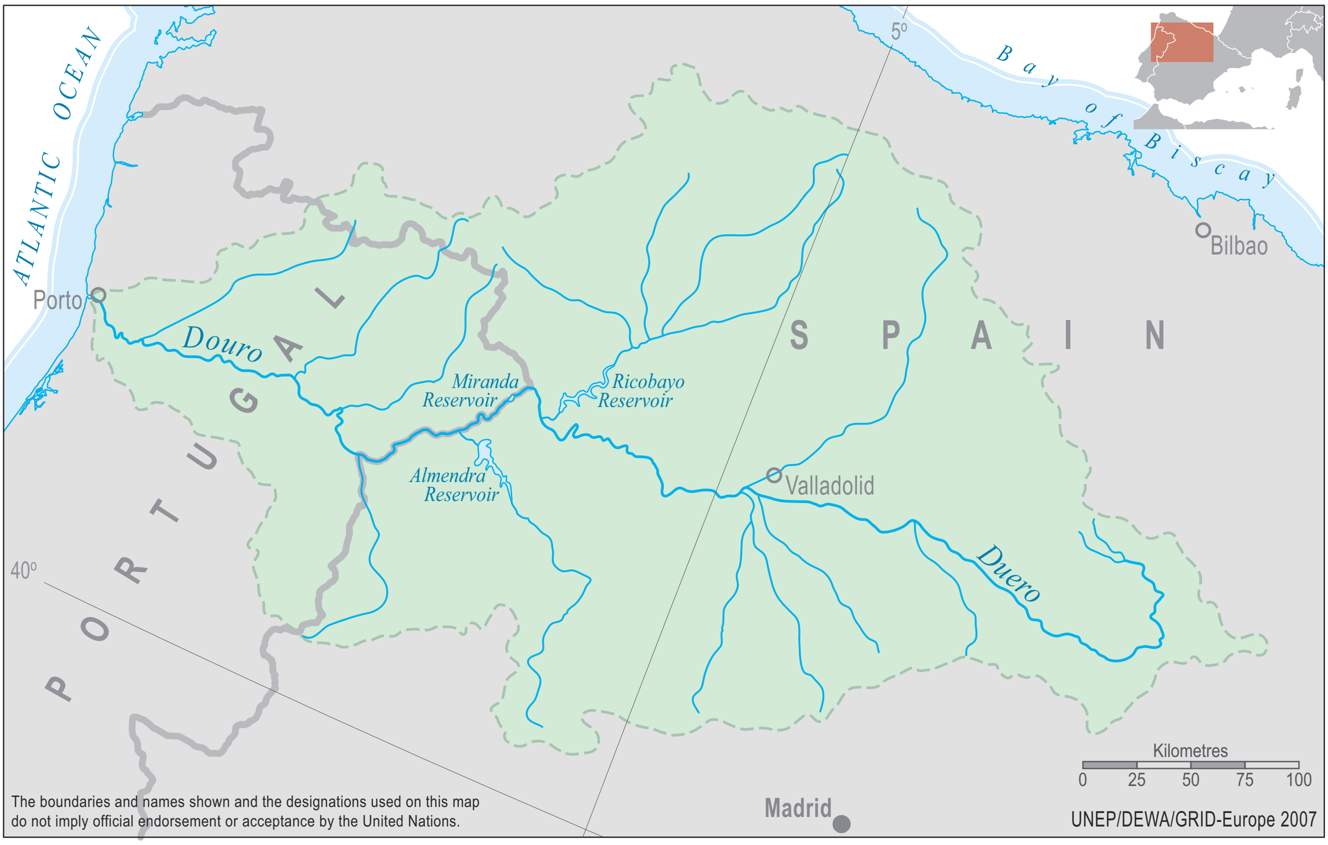
The total surface area of the Alto Lindoso Reservoir is 10.72 km^2. The reservoir is relatively deep (maximum depth 109 m, mean depth 73 m) and its water storage capacity is relatively high (0.379 km^3). The maximum and average inflows are 1.39 km^3/a and 0.65 km^3/a, respectively. The total basin area of the reservoir is 1,525 km^2, from which 1,300 km^2 are in upstream Spain.

The status of this important hydropower reservoir is "mesotrophic". The main sources of nutrient loading are in the Spanish part of the basin.

[21] Based on information from the Government of Spain as well as the publication Monitoring of International Lakes - Background document for the Guidelines on Monitoring and Assessment of Transboundary and International Lakes (UNECE, 2002).

DOURO RIVER BASIN[22]

The basin of the Douro River, known in Spain as the Duero, is shared by Spain (upstream country) and Portugal (downstream country).



Basin of the Douro River			
Area	Country	Country's share	
97,600 km²	Portugal	18,600 km²	19%
	Spain	78,832 km²	81%

Source: Portuguese National Water Plan (Instituto da Agua, INAG,2002).

[22] Based on information submitted by thze Portuguese National Institute of Water (Instituto da Agua, INAG) as well as the publication Freshwater in Europe – Facts, Figures and Maps, United Nations Environment Programme (UNEP/DEWA-Europe, 2004).

DOURO RIVER

Hydrology

The Douro rises in the Sierra de Urbión (2080 m) in central Spain and crosses the Numantian Plateau. The river mouth is at Foz do Douro (city of Porto).

The basin has a pronounced mountainous character with an average elevation of about 700 m above sea level. Major transboundary tributaries include the rivers Tâmega, Rabaçal, Tuela, Sabor, Maças and Águeda. The major Portuguese tributaries are the rivers Sousa, Paiva, Corgo, Távora, Pinhão, Tua and Côa.

The river has extensive barge traffic in its Portuguese section, but silting rapids and deep gorges make the other parts of the Douro un-navigable. The Douro has been harnessed for hydropower production.

Discharge characteristics of the Douro River at the station Crestuma Dam (Portugal)		
Discharge characteristics	**Discharge, m^3/s**	**Period of time or date**
Q_{av}	567	22 January 1998 – 13 December 2007
Q_{max}	8,835	22 January 1998 – 13 December 2007
Q_{min}	0	22 January 1998 – 13 December 2007

Source: Portuguese National Institute of Water (Instituto da Agua, INAG).

Pressure factors

In Portugal, the population density is 98 persons/km².

Agriculture (86% of total water use in the Portuguese part of the basin) relies on the use of fertilizers and pesticides as well as irrigation. In Spain, the middle Douro is also extensively used by irrigational agriculture.

In Portugal, there is a risk of contamination from abandoned ore mines. Untreated or insufficiently treated industrial wastewater is still of concern and breakdowns of municipal wastewater treatment systems are the reasons for significant discharges of polluted water into the river. Due to the many road and railway crossings, there is also a risk of water pollution should traffic accidents occur.

Transboundary impacts

Some Spanish tributaries of the Douro have a high phosphate concentration due to urban and industrial effluents. The local presence of nitrates affects different areas in the Spanish part of the basin, but does not cause significant transboundary impact.

Trends

Since 2002, the status of the Douro on Portuguese territory has improved significantly, mainly due to the measures described in the above chapter on the Mino. Some occasional pollution events still occur due to inappropriate agricultural practices. Transboundary pollution originating from Spain is still significant, and requires more stringent control measures by Spain.

MIRANDA RESERVOIR[23]

The Miranda Reservoir is a man-made lake situated in the Douro River basin on the border between Spain (upstream country) and Portugal. The reservoir was constructed for hydropower purposes. It is also used as a source for water supply and for recreation, especially bathing.

The total surface area of Miranda Reservoir is small, only 1.22 km². The maximum depth is 68 m and mean depth 45 m. Due to its small surface area, the reservoir's water storage capacity is also small (0.0281 km³). The mean water inflow and outflow is relatively high and equals 284 m³/s.

Eutrophication is a particular issue in this hypertrophic reservoir.

[23] Based on Monitoring of International Lakes - Background document for the Guidelines on Monitoring and Assessment of Transboundary and International Lakes (UNECE, 2002).

TAGUS RIVER BASIN[24]

Spain (upstream country) and Portugal (downstream country) share the basin of the Tagus River, known as Tejo (in Portugal) and Tajo (in Spain).

Basin of the Tagus River			
Area	Country	Country's share	
80,600 km²	Portugal	24,800 km²	31%
	Spain	55,800 km²	69%

Source: Portuguese National Water Plan (Instituto da Agua, INAG, 2002).

TAGUS RIVER

Hydrology

The Tagus rises in east-central Spain in the Sierra de Albarracín at an altitude of 1,590 meters and empties into the Atlantic Ocean near Lisbon. The basin has a pronounced lowland character with an average elevation of about 633 m above sea level.

The river is navigable for about 160 km from its mouth.

Dams harness its waters for irrigation and hydroelectric power, creating large artificial lakes.

Transboundary tributaries of the Tagus include the rivers Erges and Sever. In Portugal, the rivers Alviela, Almonda, Zêzere, Ocreza, Ponsul, Nisa and Sorraia are major tributaries to the Tagus.

Discharge characteristics of the Tagus River at the station Almourol (Portugal)		
Discharge characteristics	Discharge, m³/s	Period of time or date
Q_{av}	316	2 October 1973–31 December 2006
Q_{max}	13,103	2 October 1973–31 December 2006
Q_{min}	0	2 October 1973–31 December 2006

Source: Portuguese National Institute of Water (Instituto da Agua, INAG).

[24] Based on information submitted by the Portuguese National Institute of Water (Instituto da Agua, INAG) as well as the publication Freshwater in Europe – Facts, Figures and Maps, (UNEP/DEWA-Europe, 2004).

Pressure factors and transboundary impacts

Two European capitals (Madrid and Lisbon) depend on the river for their water supply and significantly affect the chemical and ecological status of the river.

In upstream Spain, part of the river's flow is diverted to the (national) Segura basin, supplying 1.5 million people in southern Spain with drinking water, and providing irrigation and supporting the ecosystem in the La Mancha Nature Reserve. There is much controversy about this water diversion from an international basin to a national basin, as it has negative consequences on the Tagus itself (increasing concentrations of polluting substances due to decreasing flow and causing a deterioration of the river's ecosystem). [25] All in all, the legal minimum flow in the Spanish part of the Tagus (6 m^3/s) is not respected.

In Portugal, the basin is mainly covered by forests (51%) and used as cropland (44%).

Water use by different sectors is as follows: agriculture – 70%, urban uses – 8%, industrial uses 5%, and the energy[26] sector – 17%. Irrigational agriculture relies on the use of fertilizers and pesticides. Mining activities are carried out at the Pansqueira and Rio Maior mines; however, the risk of contamination is insignificant. On the contrary, there is a high risk of breakdowns of wastewater treatment systems, which can result in significant discharges of polluted water into the river. Due to the many road and railway crossings, there is also a risk of water pollutions should traffic accidents occur.

A multi-product pipeline from Sines to Aveiras crosses several water bodies, among them the Lagoa de Santo André (Santo André lagoon) and the rivers Sado and Tagus. In the event of an accident, contamination of these water bodies by hydrocarbons could occur.

There are no nuclear power plants in the Portuguese part of the basin. However, the nuclear power plant at Almarez (Spain) has a potential to contaminate the Tagus with radioactive substances. Such contamination risk also exists in the Tagus estuary, should an accident involving nuclear powered vessels (submarines and aircraft carriers) occur.

Trends

Since 2002, the status of the Tagus in Portuguese territory has improved significantly, mainly due to the measures described in the above chapter on the Mino. Some occasional pollution events still occur due to inappropriate agricultural practices. Transboundary pollution originating from Spain is still significant, and requires more stringent control measures by Spain.

CEDILLO RESERVOIR[27]

The Cedillo (also known as Cedilho) Reservoir in the Tagus River basin on the border between Spain and Portugal was constructed for hydroelectric power production. With a depth of 117 m, the reservoir is a "deep water body". It has a total surface area of 14 km^2. The total volume of the reservoir is 0.260 km^3; the mean inflow equals 10.265 km^3 and the minimum outflow should not be lower than 2.7 km^3. The total basin area of the reservoir is relatively large (59,000 km^2), from which 55,800 km^2 are located in upstream Spain.

The reservoir has steep banks and occasional cliffs. It is also known as an important bird area and a potential site under the Ramsar Convention on Wetlands. The surrounding vegetation mainly comprises Mediterranean scrub, Quercus woodland, and some olive groves. The main human activities in the vicinity of the reservoir are livestock farming and hunting.

The reservoir has a high, but very varying mean concentration of phosphorus (varying between 97–325 µg/l in 2001–2006). For the same period of time, the BOD_5 concentrations varied between 1.2 and 3.0 mg/l; and NO_3 was between 2.3 and 4 mg/l.

The management of the reservoir is mainly based on the Convention on cooperation for the protection and sustainable use of the waters of the Spanish-Portuguese catchment areas that was signed in 1998 and entered into force in 1999.

[25] Freshwater in Europe – Facts, Figures and Maps (UNEP/DEWA-Europe, 2004).
[26] This figure includes thermoelectric power plants. Although they are classified as a non-consumptive user, the power plants at Pego, Carregado and Barreiro, for example, are a major consumer, as they abstract 477 hm^3/year and discharge only 317 hm^3/year.
[27] Based on information from the Government of Spain as well as the publication Monitoring of International Lakes - Background document for the Guidelines on Monitoring and Assessment of Transboundary and International Lakes (UNECE, 2002).

GUADIANA RIVER BASIN[28]

Spain (upstream country) and Portugal (downstream country) share the basin of the Guadiana River.

Basin of the Guadiana River			
Area	Country	Country's share	
66,800 km²	Portugal	11,500 km²	17%
	Spain	55,300 km²	83%

Source: Portuguese National Water Plan (Instituto da Agua, INAG,2002).

Hydrology

The Guadiana has its source in Spain at Campo Montiel (1700 m) and discharges into the Atlantic Ocean at Vila Real de Santo António. The basin has a pronounced lowland character, with an average elevation of about 237 m above sea level (in Portugal).

Major transboundary tributaries include the rivers Xévora, Caia, Alcarrache, Ardila, Múrtega and Chança. The major Portuguese tributaries are the rivers Degebe, Cobres, Oeiras, Vascão, Foupana and the Beliche.

The Alqueva Dam, the biggest man-made dam on the Portuguese part, became operational in 2002. The reservoir is 82 km long and covers an area of 250 km² (63 km² in Spain). The reservoir's total capacity is 4,150 billion m³, with a useful capacity of 3,150 billion m³.

Discharge characteristics of the Guadiana River at the station Pulo do Lobo (Portugal)		
Discharge characteristics	Discharge, m³/s	Period of time or date
Q_{av}	162	1 October 1946 – 31 January 2007
Q_{max}	10,072	1 October 1946 – 31 January 2007
Q_{min}	0	1 October 1946 – 31 January 2007

Source: Portuguese National Institute of Water (Instituto da Agua, INAG).

[28] Based on information submitted by the Portuguese National Institute of Water (Instituto da Agua, INAG) as well as the publication Freshwater in Europe – Facts, Figures and Maps (UNEP/DEWA-Europe, 2004).

The Sapais de Castro Marim area in Portugal is protected under the Ramsar Convention on Wetlands.

Pressure factors

In Portugal, the basin is mainly covered by forests (29%) and used as cropland (69%).

Approximately 17 persons/km^2 live in the Portuguese part of the basin. Irrigational agriculture relies on the use of fertilizers and pesticides. There is a risk of water contamination by leakages from several abandoned ore mines (S. Domingos and Tinoca). There is also a high risk of breakdowns of wastewater treatment systems, which can result in significant discharges of polluted water into the river. Due to the many road and railway crossings, water pollution in case of traffic accidents may occur.

Trends

Since 2002, the status of the Guadiana in Portuguese territory has improved significantly, mainly due to the measures described in the above chapter on the river Mino. Some occasional pollution events still occur due to inappropriate agricultural practices. Transboundary pollution originating from Spain is still significant, and requires more stringent control measures by Spain.

ERNE RIVER BASIN[29]

Ireland and the United Kingdom share the basin of the River Erne, also known as Ûrn.

The 120-km-long Erne rises from Lough Gowna in County Cavan (Ireland). The river is very popular for trout fishing, with a number of fisheries along both the river itself and its tributaries.

In Northern Ireland, the river expands to form two large lakes: the Upper Lough Erne (16 km long) and the Lower Lough Erne (29 km long). A bilateral flood-control scheme is operational to manage the water level in the lakes. Hydroelectricity is produced along the 46 m drop in the river's course between Belleek and Ballyshannon.

Basin of the River Erne			
Area	**Country**	**Country's share**	
4,800 km^2	United Kingdom	1,900 km^2	59.3%
	Ireland	2,800 km^2	40.7%

Source: United Nations World Water Development Report, 2003.

Water-quality classes and determinands in the UK classification systems for the chemical status			
Class	**Dissolved Oxygen** (% saturation)10-percentile	**BOD** (mg O_2/l) 90-percentile	**Ammonia** (mg N/l) 90-percentile
A (Very Good)	80	2.5	0.25
B (Good)	70	4	0.6
C (Fairly Good)	60	6	1.3
D (Fair)	50	8	2.5
E (Poor)	20	15	9.0
F (Bad)	less than 20	-	-

Following recent analysis[30] of pressures in the Irish part of the basin, the following ranking of pressure factors was established: first, diffuse pressures (agriculture, non-sewered population, urban land use, transport, some industrial activities, peat exploitation and forestry activities); second, morphological pressures (hydroelectric dams, reservoirs, channel alterations, agricultural enhancement and flood defences); third, point pressures (urban wastewater treatment plants, storm overflows, sludge treatment plants, IPPC industries[31] and non-IPPC industries); and fourth, abstraction pressures (public and private water supply, and industrial use). Eutrophication, caused mainly by agricul-

[29] Based on information posted by government agencies from Ireland and United Kingdom on the Internet.
[30] See "Ireland's environment 2004" at www.epa.ie
[31] Industries that fall under the Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control.

tural sources and municipal sewage, has been identified as the single most important problem affecting the quality of surface waters in Ireland. Of Irish rivers, 30% are affected by it.According to UK classifications, the chemical status of the Erne for the period 2002–2005 was classified as "fairly good" to "good".[32] The Erne's biological status has fallen in the same two classes. Zebra mussels are a major problem. They first appeared in the Erne system in 1996.

FOYLE RIVER BASIN[33]

Ireland and the United Kingdom share the basin of the River Foyle.

Basin of the Foyle River			
Area	**Country**	**Country's share**	
2,900 km^2	United Kingdom	2,000 km^2	67.3%
	Ireland	1,000 km^2	32.7%

Source: United Nations World Water Development Report, 2003.

The River Foyle flows from the confluence of the rivers Finn and Mourne at Strabane in County Tyrone, Northern Ireland, to the city of Derry, where it discharges into Lough Foyle and, ultimately, the Atlantic Ocean.

The fertile Foyle basin and valley support intensive and arable farming. Pressure factors in the Irish part of the basin are principally the same as described in the chapter on the River Erne.

According to UK classifications, the chemical status of the Foyle for the period 2002-2005 was classified as "good". Its biological status was also "good".[34]

BANN RIVER BASIN[35]

Ireland and the United Kingdom share the basin of the River Bann

Basin of the Bann River			
Area	**Country**	**Country's share**	
5,600 km^2	United Kingdom	5,400 km^2	97.1%
	Ireland	200 km^2	2.9%

Source: United Nations World Water Development Report, 2003.

The 129 km long river has played an important part in the industrialization of the north of Ireland, especially in the linen industry. Today, salmon and eel fisheries are the most important economic features of the river.

The land around the Lough Neagh (which is, with 396 km^2 the largest freshwater lake in the British Isles) is typified by improved pasture but also includes some important wetland habitats.

The Lower Bann valley is very fertile and supports highly productive farmland. Pressure factors in the Irish part of the basin are principally the same as described in the chapter on the River Erne.

According to UK classifications, the chemical status of the Bann for the period 2002-2005 was classified as "fair" to "good". Its biological status was also "fair" to "good".[36]

[32] Source: Environment and Heritage Service (EHS), United Kingdom, (see http://www.ehsni.gov.uk/).
[33] Based on information posted by government agencies from Ireland and United Kingdom on the Internet.
[34] Source: Environment and Heritage Service (EHS), United Kingdom, (see http://www.ehsni.gov.uk/).
[35] Based on information posted by government agencies from Ireland and United Kingdom on the Internet.
[36] Source: Centre for Ecology and Hydrology, United Kingdom.

DRAINAGE BASIN OF THE BALTIC SEA

This chapter deals with major transboundary rivers discharging into the Baltic Sea and some of their transboundary tributaries. It also includes lakes located within the basin of the Baltic Sea.

TRANSBOUNDARY WATERS IN THE BASIN OF THE BALTIC SEA[1]

Basin/sub-basin(s)	Total area (km²)	Recipient	Riparian countries	Lakes in the basin
Torne	40,157	Baltic Sea	FI, NO, SE	
Kemijoki	51,127	Baltic Sea	FI, NO, RU	
Oulujoki	22,841	Baltic Sea	FI, RU	
Jänisjoki	3,861	Lake Ladoga	FI, RU	
Kiteenjoki-Tohmajoki	1,595	Lake Ladoga	FI, RU	
Hiitolanjoki	1,415	Lake Ladoga	FI, RU	
Vuoksi	68,501	Lake Ladoga	FI, RU	Lake Pyhäjärvi and Lake Saimaa
Juustilanjoki	296	Baltic Sea	FI, RU	Lake Nuijamaanjärvi
Rakkonlanjoki	215	Baltic Sea	FI, RU	
Urpanlanjoki	557	Baltic Sea	FI, RU	
Saimaa Canal including Soskuanjoki	*174*	*Baltic Sea*	*FI, RU*	
Tervajoki	*204*	*Baltic Sea*	*FI, RU*	
Vilajoki	*344*	*Baltic Sea*	*FI, RU*	
Kaltonjoki (Santajoki)	*187*	*Baltic Sea*	*FI, RU*	
Vaalimaanjoki	*245*	*Baltic Sea*	*FI, RU*	
Narva	53,200	Baltic Sea	EE, LV, RU	Narva reservoir and Lake Peipsi
Salaca	*2,100*	*Baltic Sea*	*EE, LV*	
Gauja/Koiva	8,900	Baltic Sea	EE, LV	
Daugava	58,700	Baltic Sea	BY, LT, LV, RU	Lake Drisvyaty/ Drukshiai
Lielupe	17,600	Baltic Sea	LT, LV	
- Nemunelis	4,047	Lielupe	LT, LV	
- Musa	5,463	Lielupe	LT, LV	
Venta	14,292[2]	Baltic Sea	LT, LV	
Barta	…	Baltic Sea	LT, LV	
Sventoji	…	Baltic Sea	LT, LV	

Neman	97,864	Baltic Sea	BY, LT, LV, PL, RU	Lake Galadus
Pregel	15,500	Baltic Sea	LT, RU, PL	
Prohladnaja	*600*	*Baltic Sea*	*RU, PL*	
Vistula	194,424	Baltic Sea	BY, PL, SK, UA	
- Bug	39,400	Vistula	BY, PL, UA	
- Dunajec	4726.7	Vistula	PL, SK	
-Poprad	2,077	Dunajec	PL, SK	
Oder	118,861	Baltic Sea	CZ, DE, PL	
- Neisse	…	*Oder*	*CZ, DE, PL*	
- Olse	…	*Oder*	*CZ, PL*	

[1] The assessment of water bodies in italics was not included in the present publication.
[2] For the Venta River Basin District, which includes the basins of the Barta/Bartuva and Sventoji rivers.

TORNE RIVER BASIN[1]

Finland, Norway and Sweden share the basin of the Torne River, also known as the Tornijoki and the Tornio.

Hydrology

The river runs from the Norwegian mountains through northern Sweden and the north-western parts of Finnish Lapland down to the coast of the Gulf of Bothnia. It begins at Lake Torneträsk (Norway), which is the largest lake in the river basin. The length of the river is about 470 km. There are two dams on the Torne's tributaries: one on the Tengeliönjoki River (Finland) and the second on the Puostijoki River (Sweden).

At the Karunki site, the discharge in the period 1961–1990 was 387 m^3/s (12.2 km^3/a), with the following minimum and maximum values: MNQ = 81 m^3/s and MHQ = 2,197m^3/s. Spring floods may occasionally cause damage in the downstream part of the river basin.

[1] Based on information provided by the Finnish Environment Institute (SYKE), the Ministry of the Environment of Norway, and the Ministry of the Environment of Sweden.

Basin of the Torne River			
Area	Country	Country's share	
40,157 km²	Finland	14,480 km²	36.0%
	Norway	284 km²	0.7%
	Sweden	25,393 km²	63.3%

Source: Finnish Environment Institute (SYKE).

Pressure factors

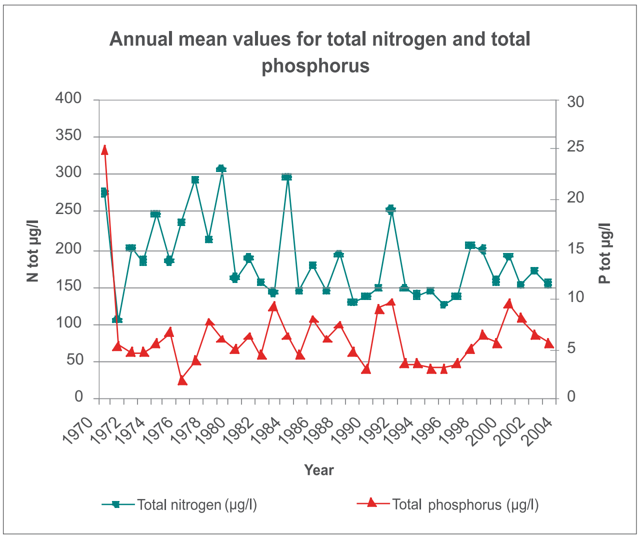
Most of the point sources are urban wastewater treatment plants. In the years 1993–1997, their average discharge was 7,500 kg/a phosphorus, 260,000 kg/a nitrogen and 272,000 kg/a BOD_7.

There is also non-point loading from the scattered settlements and summerhouses, which amounted to approximately 8,900 kg/a of phosphorus and 61,700 kg/a of nitrogen in 1995. 60% of this discharge stems from the lower part of the Torne River basin, where the share of scattered settlement is the largest.

Some small peat production areas as well as a couple of fish farms add to the nutrient loading. In addition, felling trees, tilling the land and draining caused phosphorus and nitrogen discharges of approximately 4,400 kg/a (phosphorus) and 41,000 kg/a (nitrogen) in 1997. 72%–76% of these discharges stems from the lower part of the Torne River basin.

The discharge from cultivated fields was about 9,700 kg/a of phosphorus (1995) and 193,000 kg/a of nitrogen (1990). In 1998, these figures were approximately 1,800 kg/a (phosphorus) and 38,000 kg/a (nitrogen).

More recent data on the total phosphorus and nitrogen content are given in the figure below:



Annual mean values for total nitrogen and total phosphorus in the Torne River (Tornionjoki-Pello site)

Transboundary impact

Currently, the transboundary impact is insignificant. Most of the nutrients transported to the river originate from background and non-point loading. For instance, 77% of the phosphorus transport is from natural background sources and only 13% from anthropogenic sources, 10% originates from wet deposits.

Trends

Currently the Torne is in a high/good ecological and chemical status. The ongoing slow eutrophication process may cause changes in the future, especially in the biota of the river.

KEMIJOKI RIVER BASIN[2]

The major part of the river basin is in Finland; only very small parts of headwater areas have sources in the Russian Federation and in Norway.

Basin of the Kemijoki River			
Area	**Country**	**Country's share**	
51,127 km²	Finland	49,467 km²	96.8%
	Russian Federation	1,633 km²	3.2%
	Norway	27 km²	0.05%

Source: Lapland regional environment centre, Finland.

Hydrology

The Kemijoki is Finland's longest river. It originates near the Russian border and flows generally southwest for about 483 km to the Gulf of Bothnia at Kemi. The river system is harnessed for hydroelectric power production and is important for salmon fishing and for transporting logs.

For 1971–2000, the mean annual discharge at the Isohaara site was 566 m^3/s with a minimum discharge of 67 m^3/s and a maximum discharge of 4,824 m^3/s. Spring floods cause erosion damage on the bank of the Kemijoki. The river has been regulated since the 1940s for hydroelectric power generation and flood protection. Before damming, the river was an important nursery area for migratory salmon and trout.

Pressure factors

The waters in the transboundary section of the river are in a natural state. There are no anthropogenic pressures. In the main course of the river, the water quality is affected by non-point loading (humus) of the big reservoirs Lokka and Porttipahta. Wastewater discharges occur from some settlements, such as Rovaniemi (biological/chemical sewage treatment plant), Sodankylä and Kemijärvi. Industrial wastewater of a pulp and paper mill is discharged to the river just above Lake Kemijärvi. Other human activities in the basin include forestry, farming, husbandry and fish farming.

Transboundary impact

There is no transboundary impact on the borders with Norway and the Russian Federation. These transboundary areas of the river are in high status.

Trends

Currently, the main course of the river and Lake Kemijärvi as well as the two big reservoirs (Lokka and Porttipahta) are in good/moderate status. With more effective wastewater treatment at the Finnish pulp mill in Kemijärvi, the status of the river is expected to further improve.

[2] Based on information provided by the Finnish Environment Institute (SYKE) and the Ministry of the Environment of Norway.

OULUJOKI RIVER BASIN[3]

The major part of the river basin is on Finnish territory; only very small parts of the headwater areas have sources in the Russian Federation.

Basin of the Oulujoki River			
Area	**Country**	**Country's share**	
22,841 km^2	Finland	22,509 km^2	98.5%
	Russian Federation	332 km^2	1.5%

Source: Finnish Environment Institute (SYKE).

Hydrology

The Oulujoki basin is diverse, having both heavily modified water bodies and natural waters. The coastal area of the Oulujoki basin represents unique brackish waters.

At the Merikoski monitoring site (Finland), the mean annual discharge for the period 1970–2006 was 259 m^3/s (8.2 km^3/a).

Pressure factors

In the transboundary section, there are no significant pressure factors.

On Finnish territory, pressures are caused by point and non-point sources as follows:

- Agriculture is concentrated on the lower reaches of the basin, where it has a major impact on water quality. Forestry including clear-cutting, drainage and tillage do have a significant impact on the ecology in small upstream lakes and rivers. Locally, also peat production may deteriorate water quality and ecology;
- A large pulp and paper mill is located on the shore of the major lake (Lake Oulujärvi) within the basin. The mill has an impact on water quality and ecology in its vicinity; however, the area of the affected parts of the lake became much smaller due to pollution control measures in the 1980s and 1990s.

The Oulujoki River discharges 3,025 tons/a of nitrogen (1995–2000) and 161 tons/a of phosphorus (1995–2000) into the Gulf of Bothnia.

Transboundary impact and trends

There is no transboundary impact on the Russian/Finnish border.

[3] Based on information provided by the Finnish Environment Institute (SYKE).

JÄNISJOKI RIVER BASIN[4]

Finland (upstream country) and the Russian Federation (downstream country) share the basin of the Jänisjoki River.

Hydrology

The river rises in Finland; its final recipient in the Baltic Sea basin is Lake Ladoga (Russian Federation). At the Ruskeakoski discharge station, the mean annual discharge is nowadays 17.0 m^3/s (about 0.50 km^3/a). The discharge of the river fluctuates considerably. It is greatest during spring floods whereas in low precipitation seasons, the water levels can be very low.

At the Ruskeakoski station, the mean and extreme discharges for the period 1961–1990 are as follows: MQ = 15.5 m^3/s, HQ = 119 m^3/s, MHQ = 72.5 m^3/s, MNQ = 4.11 m^3/s, NQ = 0 m^3/s. For the last recorded decade, 1991–2000, the figures indicate an increase in the water flow as follows: MQ = 17.0 m^3/s, HQ = 125 m^3/s, MHQ = 80.6 m^3/s, MNQ = 1.84 m^3/s, NQ = 0 m^3/s.

Pressure factors

On Finnish territory, anthropogenic pressure factors include wastewater discharges from villages, which apply biological/chemical treatment, and the peat industry. Additionally, there is non-point loading mainly caused by agriculture, forestry and settlements. The river water is very rich in humus; the brownish color of the water originates from humus from peat lands.

Basin of the Jänisjoki River			
Area	**Country**	**Country's share**	
3,861 km^2	Finland	1,988 km^2	51.5%
	Russian Federation	1,873 km^2	48.5%

Source: Finnish Environment Institute (SYKE).

Transboundary impact

On the Finnish side, the water quality in 2004 was assessed as "satisfactory", mainly due to the high humus content of the river waters. The transboundary impact on the Finnish-Russian border is insignificant.

Trends

Over many years, the status of the river has been stable; it is to be expected that the river will keep its status.

[4] Based on information provided by the Finnish Environment Institute (SYKE) and North Karelia Regional Environment Centre.

KITEENJOKI-TOHMAJOKI RIVER BASINS[5]

Finland (upstream country) and the Russian Federation (downstream country) share the basin of the Kiteenjoki-Tohmajoki rivers.

Basin of the Kiteenjoki-Tohmajoki rivers			
Area	**Country**	**Country's share**	
1,594.6 km^2	Finland	759.8 km^2	47.6%
	Russian Federation	834.8 km^2	52.4%

Source: Finnish Environment Institute (SYKE).

Hydrology

The Kiteenjoki discharges from Lake Kiteenjärvi; 40 km of its total length (80 km) is on Finnish territory.

The Kiteenjoki flows via Hyypii and Lautakko (Finland) into the transboundary Lake Kangasjärvi (shared by Finland and the Russian Federation), and then in the Russian Federation though several lakes (Lake Hympölänjärvi, Lake Karmalanjärvi) into the Tohmajoki River just a few kilometres before the Tohmajoki runs into Lake Ladoga.

The river Tohmajoki discharges from Lake Tohmajärvi and runs through Lake Rämeenjärvi (a small lake shared by Finland and the Russian Federation) and the small Russian Pälkjärvi and Ruokojärvi lakes to Lake Ladoga (Russian Federation) next to the city of Sortavala.

For the Kiteenjoki (Kontturi station), the discharge characteristics are as follows: mean annual discharge 3.7 m^3/s, HQ = 14.7 m^3/s, MHQ = 9.54 m^3/s, MNQ = 1.36 m^3/s and NQ = 0.90 m^3/s. These data refer to the period 1991–2000.

Pressure factors

Lake Tohmajärvi, the outflow of the Tohmajoki River, receives wastewater from the sewage treatment plant of the Tohmajärvi municipality. In the sub-basin of the Kiteenjoki River, the wastewater treatment plant of Kitee discharges its waters into Lake Kiteenjärvi. A small dairy is situated near Lake Hyypii, but its wastewaters are used as sprinkler irrigation for agricultural fields during growing seasons. A small fish farming plant in Paasu was closed down in 2001.

Transboundary impact

On the Finnish side, the water quality is assessed as "good" for the Kiteenjoki and due to the humus-rich water "satisfactory" for the Tohmajärvi. The transboundary impact on the Finnish-Russian border is insignificant.

Trends

The status of the river has been stable for many years and is expected to remain so.

HIITOLANJOKI RIVER BASIN[6]

Finland (upstream country) and the Russian Federation (downstream country) share the basin of the Hiitolanjoki River, also known as the Kokkolanjoki.

On the Russian side, the Hiitolanjoki serves as a natural environment for spawning and reproduction of Lake Ladoga's unique population of Atlantic salmon.

Basin of the Hiitolanjoki River			
Area	**Country**	**Country's share**	
1,415 km^2	Finland	1,029 km^2	73%
	Russian Federation	386 km^2	27%

Source: Finnish Environment Institute (SYKE).

[5] Based on information provided by the Finnish Environment Institute (SYKE) and North Karelia Regional Environment Centre.
[6] Based on information provided by the Finnish Environment Institute (SYKE).

Hydrology

The Hiitolanjoki has a length of 53 km, of which 8 km are on Finnish territory. Its final recipient is Lake Ladoga (Russian Federation). At the Kangaskoski station (Finland), the mean daily discharges have been varied between 2.2 m^3/s (3 October 1999 and 12 December 2000) and 26.4 m^3/s (23 April 1983 and 22 to 26 May 2005). The mean annual discharge during the recorded period 1982–2005 was 11.3 m^3/s (0.36 km^3/a).

On the Finnish side, there are five sets of rapids of which four have hydropower stations. In the Russian part of the basin there are no power stations.

Pressure factors

Urban wastewater, originating in the Finnish municipalities, is being treated at three wastewater treatment plants. Another pressure factor is the M-real Simpele Mill (pulp and paper mill), which is equipped with a biological effluent treatment plant.

The amount of wastewater discharged into the Finnish part of the river basin of the Hiitolanjoki River is presented below.

Wastewater discharged to the Hiitolanjoki River basin in Finland

Year	Amount of wastewater (m^3/d)	BOD_7 (t/d)	Suspended solids (t/d)	Nitrogen (kg/d)	Phosphorus (kg/d)
1990–1994	15,880	540	560	85	11.3
1995–1999	13,920	205	243	71	7.0
2000	14,000	181	170	61	4,7
2001	13,900	180	270	62	5.7
2002	14,900	102	141	65	5.4
2003	13,200	84	109	62	5.3
2004	12,000	77	74	63	5.2

Felling of trees too close to the river was the reason for the silting of the river bed and disturbs the spawn of the Ladoga salmon on Finnish territory.

The relative high mercury content, originating from previously used fungicides, is still a problem for the ecosystem. The mercury content of fish was at its highest at 1970, but it has decreased since then.

Transboundary impact

In Finland, the total amounts of wastewater, BOD, suspended solids and phosphorus have been substantially reduced; only the nitrogen discharges remained at the same level. Thus, the water quality is constantly improving and the transboundary impact decreasing.

However, eutrophication is still a matter of concern due to the nutrients in the wastewaters and the non-point pollution from agriculture and forestry.

Trends

On Finnish territory, water quality in the Hiitolanjoki is assessed as good/moderate. With further planned measures related to wastewater treatment, the quality is expected to increase.

VUOKSI RIVER BASIN[7]

Finland and the Russian Federation share the basin of the Vuoksi River, also known as the Vuoksa. The headwaters are situated in the Russian Federation and discharge to Finland. After leaving Finnish territory, the river runs through the Russian Federation and ends up in Lake Ladoga.

Basin of the Vuoksi River			
Area	**Country**	**Country's share**	
68,501 km^2	Finland	52,696 km^2	77%
	Russian Federation	15,805 km^2	23%

Source: Finnish Environment Institute (SYKE).

VUOKSI RIVER

Hydrology

In the recorded period 1847–2004, the annual mean discharges at the Vuoksi/Tainionkoski station have varied between 220 m^3/s (1942) and 1,160 m^3/s (1899). The mean annual discharge is 684 m^3/s (21.6 km^3/a).

There are hydroelectric power plants in Imatra (Finland) as well as Svetogorsk and Lesogorsk (Russian Federation). Thus, the shore areas of the Vuoksi are affected by hydropower production. Although there are no major water-quality problems, the biggest issues are exceptionally low water levels and water level fluctuations.

Pressure factors

There are no pressure factors in the area of the headwaters, located in the Russian Federation.

In Finland, urban wastewaters are discharged to the river from two cities, Imatra and Joutseno; both cities are equipped with sewage treatment plants.

Other pressure factors are wastewater discharges from the Imatra Steel Oy[8] (steel plant, waste water treatment plant), from Stora Enso Oy Imatra (pulp and paper mill, waste water treatment plant), the Mets-Botnia Oy Joutseno mill (pulp and paper mill, biological treatment plant) and the UPM Kaukas paper mill (pulp and paper mill, biological treatment plant). Due to improved technology and new wastewater treatment plants, the wastewater discharges from the pulp and paper industry have been significantly reduced.

Total nitrogen and total phosphorus contents in the Vuoksi River						
Determinands	**Country**	**1994–2003**				
		Number of measurements	**Minimum**	**Maximum**	**Average**
Total nitrogen µg/l	FI	120	330	900	452
	RU	116	200	950	453
Total phosphorus µg/l	FI	121	5	24	8.8
	RU	116	<20	91	<20

[7] Based on information provided by the Finnish Environment Institute (SYKE).
[8] In Finland, the abbreviation Oyj is used by public companies which are quoted on the Stock Market, and Oy for the other ones.

Heavy metal contents in the Vuoksi River					
Determinands	Country	1994–2003			
		Number of measurements	Minimum	Maximum	Average
As µg/l	FI	36	0.12	0.3	0.225
Cd µg/l	FI	28	<0.03	0.05	<0.03
Cr µg/l	FI	28	0.05	0.7	0.439
Cu µg/l	FI	36	0.8	5.08	1.192
Hg µg/l	FI	23	<0.002	0.01	0.003
Ni µg/l	FI	28	0.76	2.8	1.130
Pb µg/l	FI	28	<0.03	0.65	0.104
Zn µg/l	FI	36	1	5.1	2.210

Other smaller industries, settlements, agriculture, the increasing water use for recreation and the rising number of holiday homes pose pressure on the basin and its water resources.

The significant reduction of pollution loads (BOD_7, COD_{Cr} and suspended solids) in the lower part of the river basin (Vuoksi-Saimaa area) during the period 1972–2004 is illustrated in the figure below.

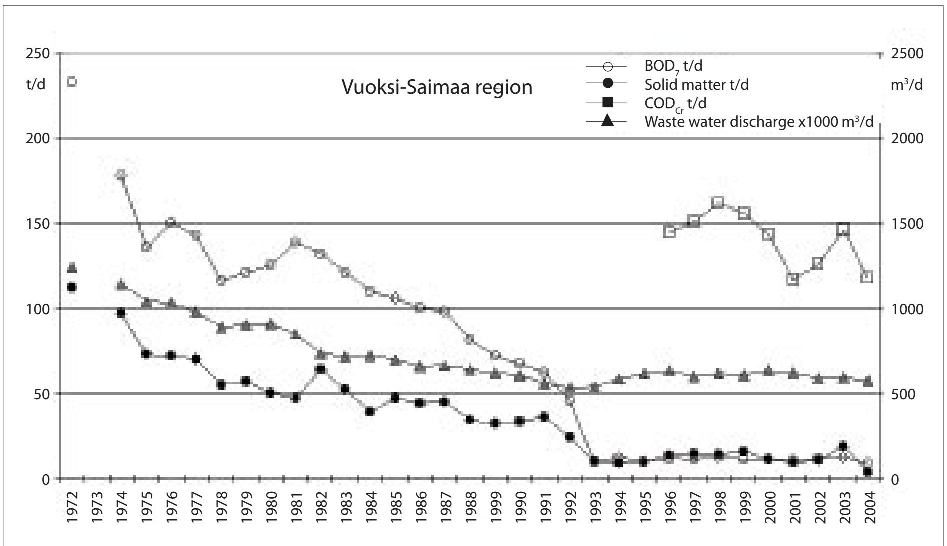
Transboundary impact

The headwaters in the Vuoksi River basin situated in Russian Federation and discharging to Finland are in natural status.

Most of the water-quality problems arise in the southern Finnish part of the river basin, in Lake Saimaa and in the outlet of the river basin. However, in 2004 the water quality of river Vuoksi was classified as "good".

Trends

The Vuoksi is in good status; it is stable and slightly improving.



Pollution loads in the lower part of the Vuoksi River

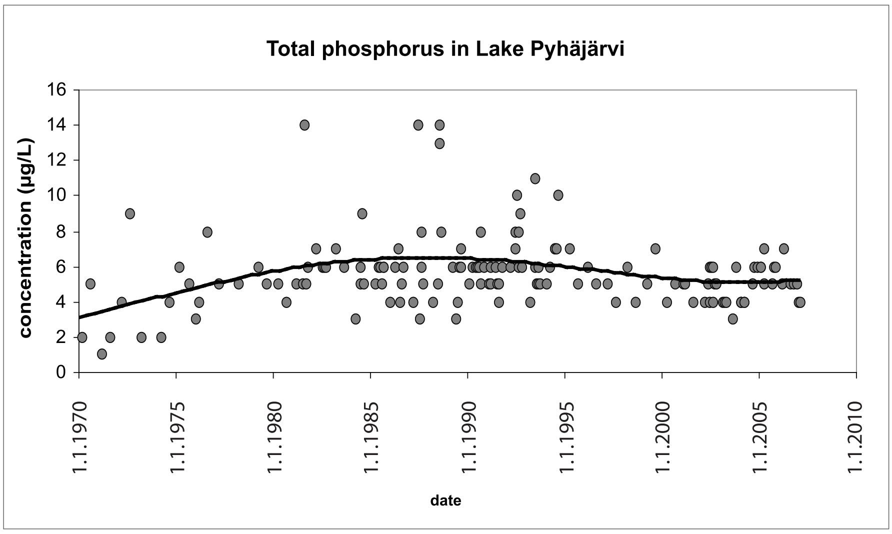
Source: Suomen ryhmän ilmoitus vuonna 2004 suoritetuista toimenpiteistä rajavesistöjen veden laadun suojelemiseksi likaantumiselta (Announcement by the Finnish party of Finnish-Russian transboundary water commission of the measures to protect the quality of transboundary waters in year 2004).

LAKE PYHÄJÄRVI

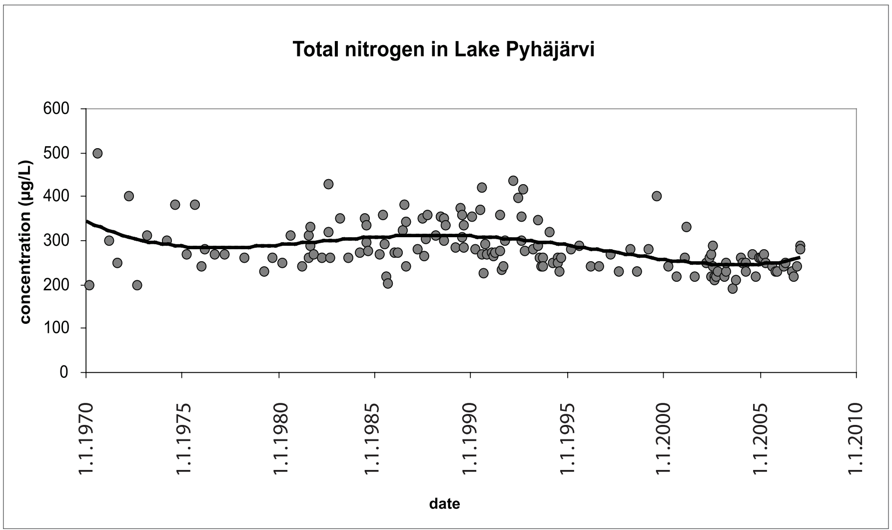
Lake Pyhäjärvi (total surface area 248 km²) in Karelia is part of the Vuoksi River basin. The lake is situated in North Karelia approximately 30 km northwest of Lake Ladoga, the largest lake in Europe. Of the total lake surface area, 207 km² of Lake Pyhäjärvi lies in Finland and 41 km² in the Russian Federation. The drainage basin of the lake is also divided between Finland (804 km²) and the Russian Federation (215 km²). The mean depth is 7.9 m on the Finnish side, and 7.0 m on the Russian side, and the maximum depth of the lake is 26 m (on the Finnish side). The theoretical retention time is long, approximately 7.5 years. Almost 83% of the drainage basin on the Finnish side is forested and about 13.5% of covered by arable land. The population density is approximately 9 inhabitants/km².

Lake Pyhäjärvi is a clear water lake valuable for fishing, recreation, research and nature protection. The anthropogenic impact is evident on the Finnish side, whereas the Russian side is considered almost pristine. The lake has been monitored since the 1970s.

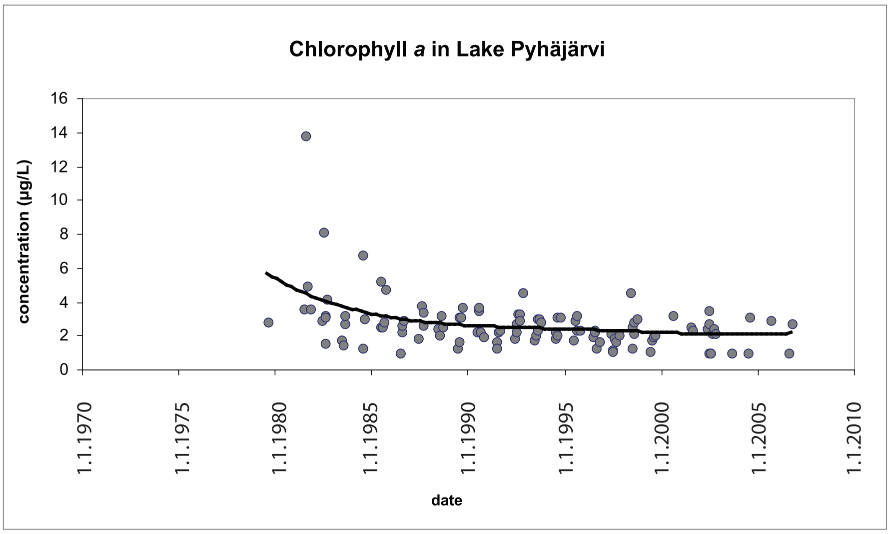
The estimated nutrient load into Lake Pyhäjärvi has decreased since 1990. The phosphorus load has decreased by 55% and nitrogen by 12%. In particular, the phosphorus load from point sources has diminished. Some loading sources have closed or are closing. The decrease of phosphorus and nitrogen loading are also reflected as changed nutrient concentrations of the lake.



Total phosphorus concentration in the surface layer of Lake Pyhäjärvi in 1970–2006



Total nitrogen concentration in the surface layer of Lake Pyhäjärvi in 1970–2006



Chlorophyll a in the surface layer of Lake Pyhäjärvi in 1980–2006

The lake is very vulnerable to environmental changes. Because of the low nutrient status and low humus concentration, an increase in nutrients causes an immediate increase in production, and the long retention time extends the effect of the nutrient load.

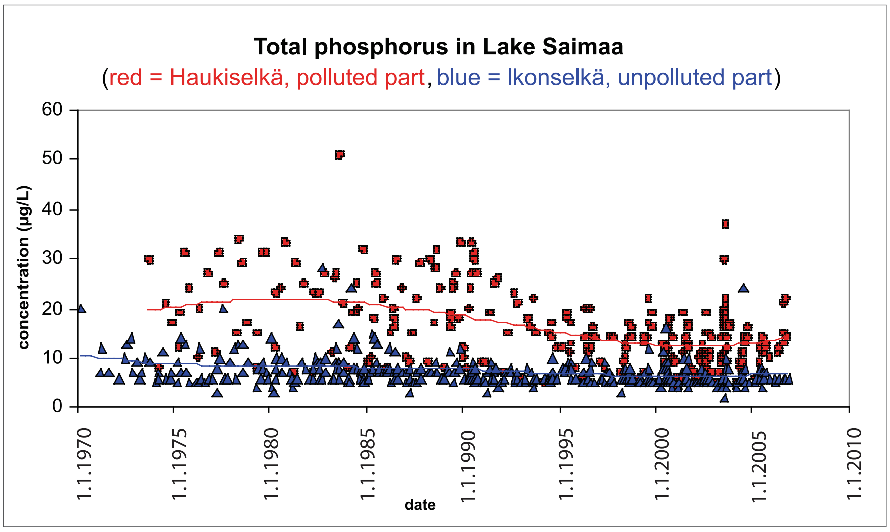
The main problem is incipient eutrophication because of non-point and point source loading, especially during the 1990s. However, chlorophyll a has shown a slight decrease during the last years. The overall quality of the lake's water is classified as excellent, although some small areas, subject to more human interference, receive lower ratings.

LAKE SAIMAA

Lake Saimaa, the largest lake in Finland, is a labyrinthine watercourse that flows slowly from north to south, and finally through its outflow channel (the Vuoksi River) over the Russian border to Lake Ladoga. Having a 15,000 km long shoreline and 14,000 islands, Lake Saimaa is very suitable for fishing, boating and other recreational activities. The lake is well known for its endangered population of Saimaa ringed seals, one of the world's two freshwater seal species.

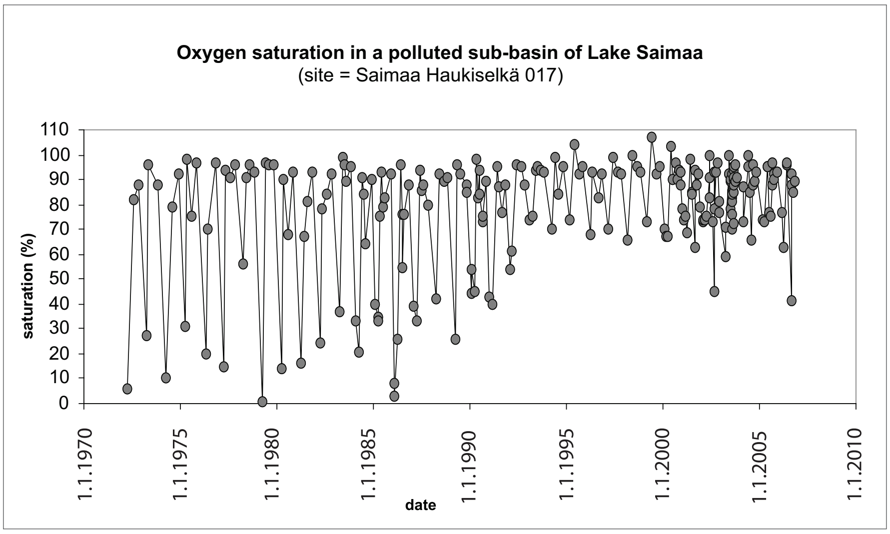
Due to its complexity with approximately 120 sub-basins lying on the same water level (76 m above sea level), the definition on what basins are in fact included in Lake Saimaa is not clear. In many cases, "Lake Saimaa" only refers to Lake Southern Saimaa (386 km^2), a smaller part of the entire Lake Saimaa system/Lake Greater Saimaa (4,400 km^2). On a broad scale, Lake Saimaa starts from the north-eastern corner of the city of Joensuu in the North Karelia province and from the north-western end of Varkaus. Whatever the definition is, Lake Saimaa is a relatively deep (maximum depth 86 m, mean depth 10 m) and by far the largest and most widely known lake in Finland.

The catchment area of the whole Lake Saimaa water system is 61,054 km^2 of which 85% lies in Finland and 15% in the Russian Federation. Even though there are several nationally important cities on the shores of Lake Saimaa in Finland, the main portion of nutrients comes from diffuse sources, especially from agriculture and forestry. In the southernmost part of the lake, the pulp and paper industry has had a pronounced effect on water quality. During the last two decades, however, effective pollution control methods implemented in municipal and industrial wastewater treatment system have substantially improved the quality of the southernmost part of Lake Saimaa. Especially the loading of phosphorus, the algal growth limiting nutrient in the lake, and loading of organic substances have remarkably diminished. Up to the mid-1980s, oxygen saturation was occasionally very low in the bottom layer of the polluted southern sub-basin of the lake; but since then no oxygen deficiency have been recorded. This is especially true for sites close to the pulp and paper mills.



Total phosphorus concentration in polluted (red) and more pristine (blue) sub-basins in the southernmost part of Lake Saimaa in 1970–2006

According to the general classification of Finnish surface waters, a major part of Lake Saimaa was in excellent or good condition at the beginning of 2000s. Only some restricted areas close to the pulp and paper mills in the Lappeenranta, Joutseno and Imatra regions were classified as "satisfactory or acceptable in quality". There is no finalized classification of Lake Saimaa's ecological status according to the classification requirements set by the Water Framework Directive. However, it is probable that no major changes compared to the general classification are to be expected in the near future.



Oxygen saturation (%) in the near-bottom water of a polluted sub-basin in the southernmost part of Lake Saimaa in 1970–2006

JUUSTILANJOKI RIVER BASIN[9]

Finland (upstream country) and the Russian Federation (downstream country) share the basin of the Juustilanjoki River.

Basin of the Juustilanjoki River			
Area	**Country**	**Country's share**	
296 km²	Finland	178 km²	60%
	Russian Federation	118 km²	40%

Source: The Joint Finnish-Russian Commission on the Utilization of Frontier Waters.

JUUSTILANJOKI RIVER

On the Finnish side, the Juustilanjoki basin includes the Mustajoki River, the catchment of the Kärkjärvi River and part of the Saimaa canal, including the Soskuanjoki River. The Juustilanjoki has its source in Lappee, runs from the Finnish side through Lake Nuijamaanjärvi south-east to Lake Juustila (Bol'shoye Zvetochnoye[10]) in the Vyborg region (Russian Federation), and discharges to the bay of Vyborg.

Random measurements by current meter at the Mustajoki site showed an average discharge of 0.8 m³/s, and at the Kärkisillanoja site of 0,2 m³/s.

LAKE NUIJAMAANJÄRVI

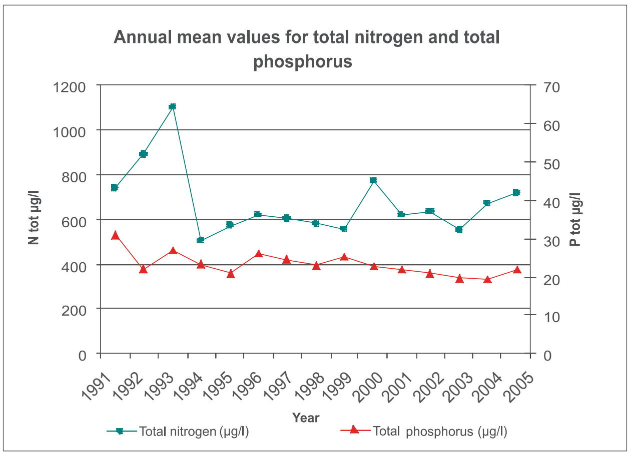
Lake Nuijamaanjärvi (total lake surface 7.65 km²) is part of the Juustilanjoki river basin. The lake is situated south of the Salpausselk ridge at the border of Finland and the Russian Federation. From the total lake area, 4.92 km² are in Finland and 2.73 km² in the Russian Federation. The theoretical retention time of the lake is only about 100 days. The population density in the basin area is 24 persons/km².

It should be noted that the Saimaa canal, an intensively used shipping route from Finland to the Russian Federation, runs from Lake Saimaa (see separate assessment above) and through Lake Nuijamaanjärvi to the Gulf of Finland.

Transboundary monitoring has been carried out regularly since the 1960s. The sampling activity in stationary monitoring takes place twice a year (February/March and August), and there are two sampling stations. National transboundary monitoring is carried out once a month at one sampling station.

Some 28.2% of the catchment consists of agricultural land. In addition to the impact from agriculture, pollution by the pulp and paper industry affects Lake Nuijamaanjärvi through the Saimaa Canal. However, the Canal's traffic and harbour activity are the most important pressure factors.

Eutrophication, caused mainly by nutrient loading from agriculture and the pulp and paper industry, is the most significant water-quality problem of the lake. Since the beginning of 1990s, total nitrogen content has varied from year to year without any clear upward or downward trends, but the total phosphorus content has decreased slightly. The amounts of suspended solids and organic matter have decreased slightly during the last 15 years. The electrical conductivity values have increased slightly. The basic levels of total nitrogen and total phosphorus concentrations suggest that Lake Nuijamaanjärvi is mesotrophic. However, the lake's ecological status is good and the situation is stable.



Annual mean values for total nitrogen and total phosphorus in Lake Nuijamaanjärvi, the Finnish territory

[9] Based on information provided by the Finnish Environment Institute (SYKE).
[10] Озеро Большое Цветочное.

RAKKOLANJOKI RIVER BASIN[11]

Finland and the Russian Federation share the basin of the Rakkolanjoki River with a total area of only 215 km^{2}.

Basin of the Rakkolanjoki River			
Area	**Country**	**Country's share**	
215 km^2	Finland	156 km^2	73%
	Russian Federation	59 km^2	27%

Source: Finnish Environment Institute (SYKE).

Hydrology

The Rakkolanjoki River, a transboundary river in Finland and the Russian Federation, is a tributary of the Hounijoki. The final recipient of the Hounijoki is the Gulf of Finland (Baltic Sea).

The mean annual discharge at the border with the Russian Federation is very small (1.3 m^3/s) and varies between 0.2 and 7.4 m^3/s (1989 – 2001).

Pressure factors

The main pollution sources on Finnish territory are treated wastewaters from the town Lappeenranta (40%–60%), agriculture (20%–40%) and natural leaching (15%–20%). Another pressure factor is the limestone industry (Nordkalk OYj, Lappeenranta). The internal load of Lake Haapajärvi also contributes to the pressures; this load originates from nutrients, which have been accumulated during a long period of time.

The overall pollution load is too big compared to the size of the watercourse and its run-off. This is one reason for its poor water quality.

Transboundary impact

The water quality in the river is poor and there is a significant transboundary impact. Wastewater treatment, although improved over the years, was not yet sufficient enough, and other pollution control measures are needed.

There is strong eutrophication in the river.

Trends

The poor water quality is a long-lasting problem, and it will take a long time and more effective water protection measures to improve the situation in this relatively small river with a discharge of only 1.3 m^3/s. The Joint Finnish–Russian Commission has emphasized the need for these protection measures.

BOD_7, COD_{Mn}, total nitrogen and total phosphorus contents in the Rakkolanjoki River

Determinands	Country	1994–2003			
		Number of measurements	Minimum	Maximum	Average
BOD_7 mgO_2/l	FI	118	<3	16	4.2
	RU	94	1.0	13.9	3.8
COD_{Mn} mg/l	FI	120	5.7	33	14.8
	RU	90	5.7	33	16.0
Total nitrogen µg/l	FI	119	1,100	17,000	3,940
	RU	94	500	12,000	2,410
Total phosphorus µg/l	FI	119	53	470	121
	RU	95	24	300	106

[11] Based on information provided by the Finnish Environment Institute (SYKE).

Heavy metal contents in the Rakkolanjoki River					
Determinands	Country	1994–2003			
		Number of measurements	Minimum	Maximum	Average
As µg/l	FI	38	0.40	1.72	0.75
Cd µg/l	FI	30	<0.005	0.05	<0.03
Cr µg/l	FI	30	0.85	4.13	1.98
Cu µg/l	FI	38	<1	7.9	1.81
Hg µg/l	FI	11	<0.002	<0.01	<0.002
Ni µg/l	FI	29	1.48	7.8	2.60
Pb µg/l	FI	30	0.06	1.4	0.40
Zn µg/l	FI	38	0.4	12.8	5.4

Amount of wastewater discharged to the river basin of the Rakkolanjoki River					
Year	Amount of waste water (m^3/d)	BOD_7 (t/d)	Solid matter (t/d)	Nitrogen (kg/d)	Phosphorus (kg/d)
1990–1994	18,900	140	273	295	6.2
1995–1999	19,500	140	227	321	7.4
2000	16,400	86	80	307	5.3
2001	15,000	130	50	320	7.9
2002	14,300	97	59	300	5.0
2003	13,200	150	51	304	9.6
2004	18,500	122	56	324	6.7

URPALANJOKI RIVER BASIN[12]

Finland (upstream country) and the Russian Federation (downstream country) share the basin of the Urpalanjoki River, also known as the Serga River.

Basin of the Urpalanjoki River			
Area	Country	Country's share	
557 km^2	Finland	467 km^2	84%
	Russian Federation	90 km^2	16%

Source: Finnish Environment Institute (SYKE).

Hydrology

The Urpalanjoki River flows from Lake Suuri-Urpalo (Finland) to the Russian Federation and ends up in the Gulf of Finland. Its mean annual discharge at the gauging station in Muurikkala is 3.6 m^3/s (0.11 km^3/a).

In the river basin, the Joutsenkoski and the Urpalonjärvi dams regulate the water flow. Altogether there are also 11 drowned weirs.

[12] Based on information provided by the Finnish Environment Institute (SYKE).

Pressure factors

Agriculture is the most important pressure factor in the Urpalanjoki.

Currently, urban wastewater is discharged from the municipality of Luumäki (sewage treatment plant of Taavetti with biological/chemical treatment) and the municipality of Luumäki (sewage treatment plant of Jurvala, not operational, see *"Trends"* below). Both wastewater treatment plants are located in Finland.

Transboundary impact

In 2004, the river water quality was classified as "moderate (class 4)". The permissible limits of manganese, iron, copper, zinc and phenols were often exceeded. The BOD values were too high and the concentration of dissolved oxygen was too low.

Trends

Improvements on the Finnish side are expected: Wastewater treatment is being centralized and made more effective at a wastewater treatment plant at Taavetti and measures are being examined to reduce pollution load from agriculture.

NARVA RIVER BASIN[13]

Estonia, Latvia and the Russian Federation share the basin of the Narva River.

[13] Based on information provided by the Ministry of the Environment of Estonia.

Basin of the Narva River			
Area	**Country**	**Country's share**	
56,200 km²	Estonia	17,000 km²	30%
	Latvia	3,100 km²	6%
	Russian Federation	36,100 km²	64%

Source: **Ministry of the Environment, Estonia.**

Lake Peipsi and the Narva reservoir, which are transboundary lakes shared by Estonia and the Russian Federation, are part of the Narva River basin. The sub-basin of Lake Peipsi (including the lake area) covers 85% of the Narva River basin.

NARVA RIVER

Hydrology

The Narva River is only 77 km long, but its flow is very high, ranging between 100 m^3/s and 700 m^3/s. Its source is Lake Peipsi (see below).

Discharge characteristics of the Narva River at the Narva city monitoring station			
Maximum discharge, m^3/s	**Average discharge, m^3/s**	**Minimum discharge, m^3/s**	**Month**
480	311	86.6	January 2006
545	290	149	February 2006
367	231	111	March 2006
749	424	184	April 2006
621	311	188	May 2006
542	341	216	June 2006
537	289	183	July 2006
311	193	136	August 2006
383	177	85	September 2006
479	279	125	October 2006
453	310	154	November 2006
494	380	195	December 2006

Source: Ministry of the Environment, Estonia.

Pressure factors

The construction of the dam on the Narva River and the Narva reservoir had significant impact on the river flow and the ecological status: several smaller waterfalls disappeared, some areas were flooded and the migration of salmon was no longer possible.

On the river, there is the Narva hydropower plant, which belongs to the Russian Federation. In Estonia, the Narva provides cooling water for two thermal power plants.

Transboundary impact and trends

The transboundary impact is insignificant as shown by the good ecological status of the Narva River. Owing to this good status, the river is used as a source of drinking water, particularly for the 70,000 inhabitants of the city of Narva. The water intakes are located upstream of the Narva reservoir (see below).

It is expected that the water will maintain its good quality.

NARVA RESERVOIR

The Narva reservoir was constructed in 1955–1956. Its surface area at normal headwater level (25.0 m) is 191 km^2 and the catchment area is 55,848 km^2. Only 40 km^2 (21%) of the reservoir fall within the territory of Estonia.

The Narva reservoir belongs to the "medium-hardness, light water and shallow water bodies" with a catchment area located on "predominantly mineral land". Its water exchange is very rapid (over 30 times a year), but there are also areas with slower exchange rates and even with almost stagnant water.

The ecological status of the Narva reservoir is "good".

LAKE PEIPSI

Lake Peipsi/Chudskoe is the fourth largest and the biggest transboundary lake in Europe (3,555 km^2, area of the lake basin 47,815 km^2). It is situated on the border between Estonia and the Russian Federation. Lake Peipsi belongs to the basin of the Narva River, which connects Lake Peipsi with the Gulf of Finland (Baltic Sea). The lake consists of three unequal parts: the biggest is the northern Lake Peipsi *s.s.* (*sensu stricto*); the second biggest is Lake Pihkva/Pskovskoe, south of Lake Peipsi; and the narrow, strait-like Lake Lämmijärv/Teploe connects Lake Peipsi *s.s.* and Lake Pskovskoe. Lake Peipsi is relatively shallow (mean depth 7.1 m, maximum depth 15.3 m).

There are about 240 rivers flowing into Lake Peipsi. The largest rivers are the Velikaya (sub-basin area 25,600 km^2), the Emajõgi (9,745 km^2), the Võhandu (1,423 km^2), and the Zhelcha (1,220 km^2). Altogether, they make up about 80% of the whole basin area of Lake Peipsi and account for 80% of the total inflow into the lake. The mean annual water discharge via the Narva River into the Gulf of Finland is 12.6 km^3 (approximately 50% of the average volume of Lake Peipsi).

The pollution load into Lake Peipsi originates mainly from two different sources:

- Point pollution sources, such as big towns (Pskov in the Russian Federation and Tartu in Estonia); and
- Agriculture and other diffuse sources (nutrient leakage from soils).

Agriculture is responsible for 60% of the total nitrogen load (estimated values are 55% in Estonia and 80% in the Russian Federation) and 40% of the phosphorus load in Estonia, and for 75% of phosphorus load in the Russian Federation.

The total annual load of nutrients N and P to Lake Peipsi depends greatly on fluctuations in discharges during long time periods, and is estimated as 21,000–24,000 tons of nitrogen and 900–1,400 tons of phosphorus. Diffuse pollution has increased in recent years, partially because of drastic changes in economy that sharply reduced industrial production (and deriving pollution). Another factor influencing non-point pollution is forest cutting.

Lake Peipsi is particularly vulnerable to pollution because it is relatively shallow. Water quality is considered to be the major problem due to eutrophication. The first priority for the management of the lake is to slow the pace of eutrophication, mostly by building new wastewater treatment facilities. The expected future economic growth in the region, which is likely to increase the nutrient load into the lake, must be taken into account. Eutrophication also poses a threat to the fish stock of the lake, as economically less valuable fish endure eutrophication better. The pollution load from point sources, the poor quality of drinking water and ground water quality are other important issues to be addressed in the basin.

GAUJA/KOIVA RIVER BASIN[14]

Estonia and Latvia share the basin of the Gauja/Koiva River.

Basin of the Gauja/Koiva River			
Area	**Country**	**Country's share**	
8,900 m^2	Estonia	1,100 km^2	12%
	Latvia	7,800 km^2	88%

Source: Koiva Water Management Plan. Ministry of the Environment, Estonia.

Hydrology

The length of the Koiva River is 452 km, of which 26 km are in Estonia. In Estonia, run-off data are not available.

The biggest rivers in the Koiva basin are the Koiva itself and the Mustjõgi, Vaidava, Peetri and Pedetsi rivers.

Transboundary tributaries to the Koiva River				
Tributaries	**River's length**		**Area of the sub-basin**	
	Total	**Estonia's share**	**Total**	**Estonia's share**
Mustjõgi	84 km	…	1,820 km^2	994 km^2
Vaidava	71 km	14 km	597 km^2	204 km^2
Peetri	73 km	25 km	435 km^2	42 km^2
Pedetsi	159 km	26 km	1,960 km^2	119 km^2

Source: Ministry of Environment, Estonia.

The Koiva basin has many lakes (lake percentage 1.15%); 116 of these lakes are bigger than 1 ha (77 lakes have a surface between 1 and 5 ha, 18 lakes between 5 and 10 ha, and 21 lakes over 10 ha). The biggest lake is Lake Aheru (234 ha).

The Karula National Park with an area of 11,097 ha is the biggest nature protection area in Estonia.

The number of fish species in the Koiva River in Estonia reaches is probably 32. Thus, the river is of significant importance for breeding of fish resources for the Baltic Sea.

Pressure factors

The biggest settlements on the Estonian side are Varstu, Rõuge, Meremäe, Mõniste, Misso and Taheva.

There are no big industrial enterprises in the basin. Agriculture and forestry are the main economic activities. For example, there are many farms in the sub-basins of the Peetri and Pärlijõgi rivers. However the diffuse pollution from these farms is unlikely to significantly affect the fish fauna of these rivers.

[14] Based on information provided by the Ministry of the Environment of Estonia.

Small dams on the Koiva's tributaries have an adverse effect on the fish fauna. Most of these small dams do not have anymore a water management function. These dams (and also the reservoirs) are in a relatively bad state and "ruin" the landscape. Unlike in other river basins in Estonia, the dams in the Koiva basin are probably not a big obstacle for achieving good ecological status: good conditions for fish fauna in the rivers could be easily achieved by dismantling some of them (which do not have important water management functions or are completely ruined) and by relatively moderate investments to improve the physical quality of the river at the remaining dams and their reservoirs Some tributaries, or sections thereof, are endangered by the activities of beaver.

Transboundary impact

The ecological status of the Koiva River in Estonia is "good" (water-quality class 2).

Unfavourable changes in the temperature regime present a problem to fish fauna in some watercourses.

DAUGAVA RIVER BASIN[15]

Belarus, Latvia, the Russian Federation and Lithuania share the basin of the Daugava River, also known as Dauguva and Western Dvina.

Basin of the Daugava River			
Area	**Country**	**Country's share**	
58,700 km²	Belarus	28,300 km²	48.1%
	Latvia	20,200	34.38%
	Russian Federation	9,500 km²	16.11%
	Lithuania	800 km²	1.38%

Source: United Nations World Water Development Report, first edition, 2003.

[15] Based on information provided by the Ministry of Natural Resources and Environmental Protection of Belarus, the Environmental Protection Agency of Lithuania and the report of the "Daugavas Project", a bilateral Latvian - Swedish project, "Daugava river basin district management plan", 2003.

DAUGAVA RIVER

Hydrology

The Daugava rises in the Valdai Hills (Russian Federation) and flows through the Russian Federation, Belarus, and Latvia into the Gulf of Riga. The total length of the river is 1,020 km.

Long-term average discharge characteristics of the Daugava in Belarus	
Monitoring station Vitebsk; upstream catchment area 23,700 km²	
Discharge characteristics	**Discharge, m³/s**
Q_{av}	226
Q_{max}	3,320
Q_{min}	20.4
Monitoring station Polosk; upstream catchment area 41,700 km²	
Discharge characteristics	**Discharge, m³/s**
Q_{av}	300
Q_{max}	4,060
Q_{min}	37

Source: State Water Information System of Belarus, 2005 and 2006

Pressure factors in the Russian Federation [16]

Pollution sources in the Russian part of the basin cause transboundary impact on downstream Belarus due to increased concentrations of iron, zinc compounds and manganese.

Pressure factors in Belarus [17]

The man-made impact is "moderate"; it is mainly caused by industry, the municipal sector and agriculture. Actual and potential pollution sources include: wastewater treated at municipal treatment plants, wastewater discharges containing heavy metals from the galvanic industry, wastewater from livestock farms and the food industry, pollution due to inappropriate disposal of industrial and communal wastes and sludge from treatment plants, accidents at oil pipelines, and pesticides and fertilizers from cropland.
In most significant impact originates from industrial enterprises and municipalities (Vitebsk, Polosk, Novopolosk and Verkhnedvinsk). Characteristic pollutants include ammonium-nitrogen, nitrite-nitrogen, iron, oil products, copper and zinc.

Given water classifications by Belarus, the chemical regime of the river over the past five years was "stable".

Pressure factors in the Lithuanian part of the basin[18]

There are a number of small transboundary tributaries that cross the border between Lithuania and Latvia. Due to its small share, however, Lithuania only modestly contributes to the pollution load in the basin.

According to Lithuanian statistics, the percentage of household-industrial effluents, which were not treated according to the standards and treated according to standards, remained similar in 2003-2005.

[16] Based on information by the Central Research Institute for the Complex Use of Water Resources, Belarus.
[17] Based on information by the Central Research Institute for the Complex Use of Water Resources, Belarus.
[18] Based on information from the Environmental Protection Agency, Lithuania.

Household-industrial wastewater (1000 m³/year) and its treatment in the Lithuania part of the Daugava basin					
Year	Total wastewater amount (1000 m³/year)	Does not need treatment	Not treated to the standards	Without treatment	Treated to the standards
2003	3,050,063**	3,045,867	3,610 (86 %*)	0	586 (14 %*)
2005	1,860,153**	1,856,718	2,921 (85 %*)	0	514 (15 %*)

Source: Environmental Protection Agency, Lithuania.
* The percentage from the amount of wastewater that needs to be treated.
** Almost all the wastewater is produced by the Ignalina nuclear power station, whose water is used for cooling purposes): This wastewater does not need treatment. The closure of reactor of the Ignalina nuclear power station resulted in significantly decreased amounts of wastewater in 2005 comparing to 2003.

Pressure factors in the Latvian part of the basin and trends[19]

In the Latvian part of the basin, the main point pollution sources are wastewaters, storm waters, large animal farms, waste disposal sites, contaminated sites and fish farming.

Most of the phosphorus load comes from municipal wastewater treatment facilities. Municipal wastewaters also contain dangerous substances discharged from industrial facilities. Most of the diffuse pollution - nitrogen and phosphorus - comes from agriculture.

The measured load in the Daugava is approximately 40,000 tons of total-nitrogen and 1,300 tons of total-phosphorus per year. Taking retention into consideration, about 50% of this nutrient load originates in Latvia and the rest in upstream countries.

The most important human impact on the hydrological state of waters comes from land melioration, deepening and straightening of rivers and building of dams. These impacts caused changes in the hydromorphology of the rivers and lakes in the basin.

It is likely that the continuation of the present economic development in Latvia will significantly increase human impact on the basin.

LAKE DRISVYATY/DRUKSIAI

Lake Drisvyaty (approximately 49 km²) is one of the largest lakes in Belarus (some 7 km²) and the largest in Lithuania (some 42 km²). The lake surface is difficult to determine as approximately 10% of the lake is overgrown with vegetation. The deepest site of the lake is approximately 30 m. The lake is of glacial origin and was formed during the Baltic stage of the Neman complex. The lake basin has an area of 613 km².

The water resources of the lake are of great value. The lake enables the functioning of the Ignalina nuclear power station and the Drisvyata hydroelectric station. On the Lithuanian side, the lake is used as a water-cooling reservoir for the Ignalina station. On the Belarusian side, the lake is used for commercial and recreational fishing.

Adjacent forests are exploited by the Braslav state timber industry enterprise. A tree belt approximately 1 km wide surrounding the lake plays an important role in water protection. The trees are cut down seldom and very selectively.

Scientific investigation of Lake Drisvyaty and its wetlands began in the early twentieth century. Regular monitoring of the wetlands was initiated before the construction of the nuclear plant in 1980. Studies focused on hydrochemistry and hydrobiology, and the results were published in numerous scientific papers.

The lake is deep and is characterized by a large surface area and thermal stratification of water masses, oxygen-saturated bottom layers of water, moderately elevated con-

[19] Based on information from the report of the "Daugavas Project", a bilateral Latvian - Swedish project, "Daugava river basin district management plan", 2003.

centrations of phosphorus compounds, slightly eutrophic waters and the presence of a complex of glacial relict species. Altogether 95 species of aquatic and semi-aquatic plants are found in the lake. Blue-green algae dominate the phytoplankton community. The micro- and macrozooplankton are composed of 250 taxons. The communities of macrozoobenthos number 143 species. The most noteworthy is a complex of relict species of the quaternary period, among them *Limnocalanus macrurus, Mysis relicta, Pallasea quadrispinosa* and *Pontoporea affinis* (all entered into the Red Data Book of Belarus).

The ichtyofauna of the lake is rich and diverse. The 26 species of fish include some especially valuable glacial relicts such as *Coregonus albula typica*, the white fish *Coregonus lavaretus maraenoides*, and the lake smelt *Osmerus eperlanus relicta*. The raccoon dog, the American mink, beavers, weasels, ermine and polecats are common in the areas surrounding the lake, though the otter is rare. Almost all mammals economically valuable for hunting purposes are found in the adjacent forests.

The discharge of industrial thermal waters from the Ignalina power plant and non-purified sewage from the Lithuanian town of Visaginas are a potential problem. Lithuania detected heavy metals (Cu, Zn, Cr, Ni, Pb, Cd, Hg) in the bottom sediments in the western part of the lake. However, the concentrations were similar to the concentrations of these elements in the sediments of rivers nearby the lake.

Thermal pollution affects the lake negatively, resulting in eutrophication and subsequent degradation of the most valuable relict component of a zoo- and phytocenosis complex.

LIELUPE RIVER BASIN[20]

The Lielupe River basin is shared by Latvia and Lithuania.

Lielupe River Basin			
Area	**Country**	**Country's share**	
17,600 km^2	Latvia	8,662 km^2	49.2%
	Lithuania	8,938 km^2	50.8%

Source: Environmental Protection Agency, Lithuania.

Hydrology

The Lielupe River originates in Latvia at the confluence of two transboundary rivers: the Musa River and the Nemunelis River, also known as the Memele.

The Musa has its source in the Tyrelis bog (Lithuania) and the Memele River in the Aukstaitija heights west of the city of Daugavpils (Latvia). The Lielupe River ends in the Baltic Sea. It has a pronounced lowland character.

Besides the Musa and Nemunelis, there are numerous small tributaries of the Lielupe River, whose sources are also in Lithuania.

[20] Based on information provided by the Environmental Protection Agency of Lithuania.

Main Lielupe River tributaries						
River	**Length**			**Sub-basin area**		
	Total	**In Lithuania**	**In Latvia**	**Total**	**In Lithuania**	**In Latvia**
Nemunelis	199	75 km	40 km	4,047 km^2	1,892 km^2	2,155 km^2
		84 km along the border				
Musa	157	133 km	18 km	5,463 km^2	5,297 km^2	166 km^2
		7 km along the border				

Source: Environmental Protection Agency, Lithuania.

In the Lithuanian part of the basin, there are six reservoirs (> 1.5 km length and > 0.5 km^2 area) and 11 lakes (> 0.5 km^2 area).

During the last 30 years, four droughts occurred in Lithuania, which have fallen into the category of natural disasters. As a consequence, a decrease of water levels in rivers, lakes and wetlands was registered. The droughts also resulted in losses of agriculture production, increased amounts of fires, decreased amount of oxygen in water bodies and other effects.

Discharge characteristics of the Musa and Nemunelis rivers, tributaries to the Lielupe (in Lithuania just upstream the border of Latvia)		
Musa monitoring station below Salociai		
Discharge characteristics	**Discharge, m³/s***	**Period of time or date**
Q_{av}	19.56	2001–2005
Q_{max}	82.50	2001–2005
Q_{min}	1.90	2001–2005
Nemunelis monitoring station below Panemunis		
Discharge characteristics	**Discharge, m³/s***	**Period of time or date**
Q_{av}	2.54	2001–2004
Q_{max}	12.00	2001–2004
Q_{min}	0.17	2001–2004

* The discharge was either measured or calculated from the water levels.
Source: Environmental Protection Agency, Lithuania.

Pressure factors in the Lithuanian part of the basin

Lithuania's estimates show that some 9% of the water resources in the Lithuanian part of the basin are used for agriculture and fisheries, 75% for households and services, 13% for industry and 2% for energy production.

The basin's soils make up the most fertile land in Lithuania, thus agriculture activities are widespread, especially in the sub-basins of the small tributaries of the Lielupe (78% agricultural land, except pastures) and the Musa (68% agricultural land, except pastures). Agricultural activities include the cultivation of such crops as cereals, flax, sugar beet, potatoes and vegetables, and the breeding of livestock like pigs, cows, sheep and goats, horses and poultry. All these activities cause widespread pollution by nutrients, especially by nitrogen.

Intensive agriculture also required considerable melioration works in the upstream areas of the basin: small streams have been straightened to improve drainage and riparian woods were cut. This has significantly changed the hydrological regime and the state of ecosystems.

The main types of industrial activities in the Lithuanian part of the Lielupe basin are food industry, grain processing, preparation of animal food, timber and furniture production, agrotechnological services as well as concrete, ceramics and textile production and peat extraction. The main industrial towns in Lithuania are Siauliai, Radviliskis, Pakruojis, Pasvalys, Birzai, Rokiskis and Joniskis.

It is impossible to separate the loads to surface waters coming from industry and households as their wastewaters are often treated together in municipal treatment plants. In Lithuania, according to the statistics, the percentage of "household-industrial effluents not treated according to the standards" is decreasing, while "household-industrial effluents treated according to standards" is increasing. The changes of wastewater amounts and treatment in 2003-2005 are presented in the table below. The positive developments during these years were largely due to improved wastewater treatment technology in the Lithuanian cities of Siauliai, Pasvalys, Birzai and Kupiskis.

Household-industrial wastewater (in 1,000 m^3/year) and its treatment in the Lielupe basin
(data refer to Lithuania only)

Year	Total wastewater	Does not need treatment	Not treated to the standards	Without treatment	Treated to the standards
2003	14,258	85	11,530 (81 %*)	0	2,634 (19 %*)
2005	14,443	61	3,850 (27 %*)	89 (1 %*)	10,443 (72 %*)

* Percentage of the amount of wastewater that needs to be treated.
Source: Environmental Protection Agency, Lithuania.

Transboundary impact, based on data from Lithuania[21]

According to 2005 monitoring data, the concentrations of all nutrients exceeded the water-quality requirements in the Musa River below Salociai (close to the border of Latvia). The values of BOD_7 were lower than the water-quality requirements at this monitoring station.

In 2005, the water quality satisfied the quality requirements according to BOD_7, ammonium, total phosphorus and phosphates in the Nemunelis River at Rimsiai (close to the border with Latvia), but did not satisfy the requirements for total nitrogen and nitrates. Any dangerous substances exceeding the maximum allowable concentrations were not found at both monitoring stations in 2005.

According to the biotic index, the water at both monitoring stations in 2005 was "moderately polluted".

[21] In order to assess chemical status, the following main indicators, best reflecting the quality of water, were used in Lithuania: nutrients (total nitrogen, total phosphorus, nitrates, ammonium, phosphates) and organic substances. An evaluation of dangerous substances in water was also made. For the assessment of the biological status, the biotic index was used. This index indicates water pollution according to the changes of macrozoobenthos communities. According to the values of this index, river water quality is divided into 6 classes: very clean water, clean water, moderately polluted water, polluted water, heavily polluted water and very heavily polluted water.

Mean annual concentration of BOD_7, N and P in the Lielupe basin in Lithuania					
Determinands	**Year**				
	2001	**2002**	**2003**	**2004**	**2005**
Musa monitoring station below Salociai(just upstream the border of Latvia)					
BOD_7 in mg/l	2.8	3.8	3.8	3.5	3.3
N total in mg/l	6.258	3.428	3.733	4.553	4.291
P total in mg/l	0.567	0.194	0.243	0.118	0.161
Nemunelis monitoring station below Panemunis (just upstream the border of Latvia)					
BOD_7 in mg/l	2.1	1.8	2.4	2.4	n.a.
N total in mg/l	2.542	1.716	2.433	1.968	n.a.
P total in mg/l	0.258	0.209	0.276	0.252	n.a.

Source: Environmental Protection Agency, Lithuania.

Trends, based on data from Lithuania

As monitoring data have shown, there were no clear trends for the period 2001 to 2005 as to total nitrogen, total phosphorus and BOD_7 in the Musa below Salociai and the Nemunelis below Panemunis.

The envisaged further improvement of wastewater treatment, the implementation of the planned non-structural measures in agriculture and water management as well as better policy integration among various economic sectors will reduce transboundary impact and improve water quality. However, it is difficult to ensure the achievement of good status of rivers in the Lielupe basin as the majority of rivers are small and low watery (especially during dry period of the year), hence pollutants are not diluted and high concentrations of these pollutants persist in water.

VENTA, BARTA/BARTUVA AND SVENTOJI RIVER BASINS[22]

The basins of the Venta, Barta/Bartuva and Sventoji rivers are shared by Latvia and Lithuania. Following the provisions of the WFD, these basins have been combined in Lithuania into one River Basin District (RBD),[23, 24] the Venta River Basin District.

Venta River Basin District			
Area	**Country**	**Country's share**	
14,292 km²	Latvia	8,012 km²	56.1%
	Lithuania	6,280 km²	43.9%

Source: Environmental Protection Agency, Lithuania.

Hydrology [25]

The Venta River's source is Lake Parsezeris in the Zemaiciu Highland in Lithuania; its final recipient is the Baltic Sea. The Barta/Bartuva River has its source in the highlands of Zemaitija in Lithuania and discharges into Lake Liepoja (Latvia), which has a connection to the Baltic Sea. The Sventoji River's source is in the West Zemaitija plain in Lithuania; its final recipient is the Baltic Sea. All three rivers – the Venta, Barta/Bartuva and Sventoji – are typical lowland rivers.

[22] Source: Environmental Protection Agency of Lithuania.
[23] Following the Water Framework Directive, a River Basin District means the area of land and sea, made up of one or more neighbouring river basins together with their associated groundwaters and coastal waters, which is identified under Article 3 (1) as the main unit for management of river basins.
[24] According to information provided by Lithuania.
[25] From a hydrological point of view, the Venta River basin covers an area of 11,800 km², with 6,600 km² in Latvia and 5,140 km² in Lithuania. The Barta River basin with 2,020 km² is also shared by Latvia (1,272 km²) and Lithuania (748 km²). The Sventoji River is shared between these two countries as well; its area in Latvia is 82 km² and 472 km² in Lithuania.

In the Lithuanian part of these river basins, there are altogether nine reservoirs for hydropower production (>1.5 km reservoir length and >0.5 km² reservoir area) and 11 lakes (>0.5 km² area). The hydropower stations significantly influence the river flow and the rivers' ecological regime.

Discharge characteristics of the Venta and Barta/Bartuva rivers in Lithuania just upstream of the border with Latvia		
Venta monitoring station below Mazeikiai		
Discharge characteristics	**Discharge, m³/s***	**Period of time or date**
Q_{av}	23.161	2001–2005
Q_{max}	135.000	2001–2005
Q_{min}	2.700	2001–2005
Barta/Bartuva monitoring station below Skuodas		
Discharge characteristics	**Discharge, m³/s***	**Period of time or date**
Q_{av}	6.851	2001–2005
Q_{max}	51.000	2001–2005
Q_{min}	0.390	2001–2005

* The discharge was either measured or calculated from water levels.
Source: Environmental Protection Agency, Lithuania.

During the last 30 years, four droughts occurred in Lithuania, which fell into the category of natural disasters. Their consequences were the same as described above under the Lielupe River assessment.

Pressure factors in Lithuania

Lithuania's estimates show that some 28% of the water resources are used for agriculture and fisheries, 31% for households and services, 32% for industry and 7% for enregy production.

Agricultural activities are widespread and significantly influence the quality of water bodies. Agricultural land (without pastures) covers about 59% of the Lithuanian share of the RBD.

It is impossible to separate the loads to surface waters coming from industry and households as their wastewaters are often treated together in municipal treatment plants.

There is a clear tendency in decreasing of percentage of "household-industrial effluents not treated according to the standards" and the increasing of "household-industrial effluents treated according to standards" in Venta basin. The data on changes of wastewater amount and treatment in 2003-2005 is presented in the table below.

Household-industrial wastewater (in 1,000 m3/year) and its treatment in the Venta RBD (data refers to Lithuania only)					
Year	**Total wastewater**	**Does not need treatment**	**Not treated to the standards**	**Without treatment**	**Treated to the standards**
2003	15,429	4,722	7,400 (69 %*)	49 (<1%*)	3,258 (30 %*)
2005	14,959	4,723	6,271 (61 %*)	14 (<1 %*)	3,951 (39 %*)

* Percentage of the amount of wastewater that needs to be treated.
Source: Environmental Protection Agency, Lithuania.

Transboundary impact[26]

Both chemical and biological determinands were used to assess the status of the Venta and Barta/Bartuva rivers at the monitoring stations Venta below Mazeikiai (Lithuania, just upstream of the border with Latvia) and Barta/Bartuva below Skuodas (Lithuania, just upstream of the border with Latvia).

Mean annual concentration of BOD_7, N and P in the Venta and Barta/Bartuva rivers					
Determinands	**Year**				
	2001	**2002**	**2003**	**2004**	**2005**
Venta monitoring station below Mazeikiai (Lithuania)					
BOD_7 in mg/l	3.0	2.2	2.2	2.0	2.0
N total in mg/l	2.948	2.644	2.950	4.283	3.267
P total in mg/l	0.099	0.094	0.098	0.095	0.087
Barta/Bartuva monitoring station below Skuodas (Lithuania)					
BOD_7 in mg/l	3.4	3.9	3.0	2.3	3.5
N total in mg/l	1.825	1.500	2.188	2.129	1.847
P total in mg/l	0.125	0.206	0.112	0.095	0.048

Source: Environmental Protection Agency, Lithuania.

According to the 2005 monitoring data, the water quality satisfied quality requirements for ammonium, nitrates, total phosphorus and phosphates concentrations in the Venta below Mazeikiai; the water quality did not satisfy the requirements for BOD_7 and total nitrogen. The concentrations of all nutrients did not exceed the water quality requirements in the Barta/Bartuva below Skuodas; just the BOD_7 values were higher than the water-quality requirements at this monitoring station. Any dangerous substances exceeding maximum permitted concentrations were not found at both sites.

According to the biotic index, the water at both monitoring stations was "clean".

Trends

According to BOD_7, the water quality in the Venta River below Mazeikiai has improved from 2001 to 2005. There were no clear trends in the state of this river according to total phosphorus and total nitrogen.

The water quality in the Barta/Bartuva River below Skuodas was similar according to BOD_7 and total nitrogen. From 2001 to 2005, it has improved for total phosphorus.

The envisaged further improvement of wastewater treatment, the implementation of the planned non-structural measures in agriculture and water management as well as better policy integration among various economic sectors will reduce transboundary impact and improve water quality.

[26] For the methods used to assess the chemical and biological status, see the assessment of the Lielupe RBD above.

NEMAN RIVER BASIN[27]

The basin of the Neman River, also known as the Nemunas, is shared by Belarus, Latvia, Lithuania, Poland and the Russian Federation (Kaliningrad Oblast).

Following the provisions of the Water Framework Directive, the basins of the Neman and Pregel (also known as Preglius and Pregolya)[28] have been combined in Lithuania into one River Basin District, the Neman River Basin District. This RBD also includes a number of coastal rivers and coastal and transitional waters.[29]

Lake Galadus (also known as Lake Galadusys), a transboundary lake shared by Lithuania and Poland, is part of the Neman River Basin District.

Neman River and other transboundary rivers in the Neman River Basin District.

Hydrology

The Neman River has its source in Belarus (settlement Verkhnij Nemanec) and ends up in the Baltic Sea. The basin has a pronounced lowland character.

Major transboundary tributaries to the Neman River (shared by Lithuania) include the Merkys, Neris/Vilija and Sesupe rivers. The lengths and catchments of these rivers are as follows:

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[27] Based on information provided by the Environmental Protection Agency of Lithuania.
[28] In Lithuania, the Pregel river basins and coastal rivers' basin were combined with the Nemunas basin, as their share in the overall Neman river basin was relatively small, and the development of management plans for those small basins and setting appropriate management structures was not a feasible option.
[29] From a hydrological point of view, the basin of the Neman River has an area of 97,864 km² with the following countries' shares: Belarus 45,395 km²; Latvia 98 km²; Lithuania 46,695 km²; Poland 2,544 km² and Russian Federation (Kaliningrad Oblast) 3,132 km².

River and riparian countries	Length		Area	
	Total	In Lithuania	Total	In Lithuania
Merkys: Belarus and Lithuania	203 km	185 km	4,416 km²	3,781 km²
Neris: Belarus, Latvia and Lithuania	510 km	228 km	24,942 km²	13,850 km²
Sesupe: Lithuania, Poland, Russian Federation (Kaliningrad Oblast)	298 km	158 km	6,105 km²	4,899 km²

Discharge characteristics of the Neman and Neris rivers in Lithuania		
Nemunas monitoring station above Rusne (close to the mouth)		
Discharge characteristics	**Discharge, m^3/s***	**Period of time or date**
Q_{av}	322.74	2001–2004
Q_{max}	1,050.00	2001–2004
Q_{min}	92.60	2001–2004
Neris monitoring station above Kaunas (close to the junction with the Neman)		
Discharge characteristics	**Discharge, m^3/s***	**Period of time or date**
Q_{av}	151.08	2001–2005
Q_{max}	500.00	2001–2005
Q_{min}	60.30	2001–2005

* The discharge is either measured or calculated from the water levels.
Source: Environmental Protection Agency, Lithuania.

In Lithuania, there are 48 reservoirs (> 1.5 km length and > 0.5 km² area) and 224 lakes (> 0.5 km² area) in the RBD.

The many dams with hydropower installations are a significant pressure factor due to their water flow regulation. However, pressure by hydropower is of lesser concern as pressure by point and non-point pollution sources.

In the lower reaches of Neman, floods appear every spring (melting snow, ice jams in the Curonian Lagoon) and very rarely during other seasons. The flood (1% probability) prone area covers about 520 km², of which about 100 km² are protected by dikes and winter polders and about 400 km² are covered by agricultural lands (80% of them pastures). About 4,600 people live in the flood-prone area.

Four droughts events, which were assigned as natural disasters, occurred in Lithuania over the last 30 years. Their consequences were the same as described above under the Lielupe River assessment.

Pressure factors

Water abstraction by the energy sectors amounts to 93% of the water resources in the RBD in Lithuania. Taking this amount out of the use statistics, Lithuania's estimate shows that some 34% of the water resources are used for agriculture and fisheries, 51% for households and services, and 15% for industry.

Agricultural activities significantly influence the status of water bodies in the Neman basin, especially in the sub-basins of the Sesupe and Nevezis rivers.

A big part of point source pollution comes from industry. In Lithuania, the industry is mainly located in Alytus, Kaunas and Vilnius. The dominating industrial sectors are food and beverages production, wood and wood products, textiles, chemicals and chemical products, metal products, equipment and furniture production. However, it is not possible to separate the loads to surface waters coming from industry and households as their wastewaters are often treated together in municipal treatment plants. Similarly to other basins in Lithuania, the percentage of "household-industrial effluents not treated according to the standards" is decreasing, while the percentage of "household-industrial effluents treated according to standards" is increasing in the Neman basin. The changes of wastewater amount and treatment in 2003-2005 are presented in the table below.

The positive developments during this period were mostly due to the reduction of pollution from big cities (Vilnius, Kaunas, Klaipeda, Marijampole).

Household-industrial wastewater (in 1,000 m^3/year) and its treatment in the Neman RBD (data refer to Lithuania only)

Year	Total wastewater	Does not need treatment	Not treated to the standards	Without treatment	Treated to the standards
2003	2,897,228	2,759,694	51,669 (38 %*)	1,507 (1 %*)	84,358 (61 %*)
2005	2,010,462	1,846,985	42,917 (26 %*)	636 (<1 %*)	119,924 (73 %*)

* Percentage of the amount of wastewater that needs to be treated.
Source: Environmental Protection Agency, Lithuania.

In the Kaliningrad Oblast (Russian Federation), industrial sites and the cities of Sovetsk and Neman are significant point pollution sources. As to non-point pollution, estimates show that one third of the organic and total nitrogen loads of the river can be attributed to the Kaliningrad Oblasts.

Transboundary impact [30]

According to 2005 monitoring data, the concentration of nutrients did not exceed the water-quality requirements at the station Skirvyte above Rusne (branch on Neman close to the mouth). The BOD_7 values were higher than the water-quality requirements at this monitoring station. In 2005, the water quality satisfied the quality requirements as to total nitrogen, nitrates and ammonium at the Neris site above Kaunas (close to the junction with the Nemunas); and did not satisfied the requirements as to BOD_7, total phosphorus and phosphates. Dangerous substances exceeding maximum allowable concentrations were not found at both monitoring stations in 2005.

According to the biotic index, the water at Neris above Kaunas was in 2005 "moderately polluted", while the water in Skirvyte above Rusne was "polluted".

Mean annual concentration of BOD_7, N and P in the Nemunas and Neris rivers

Determinands	Year				
	2001	2002	2003	2004	2005
Nemunas monitoring station above Rusne (close to the mouth)					
BOD_7 in mg/l	6.5	7.1	7.0	6.2	n.a.
N total in mg/l	1.003	1.096	1.314	1.698	n.a.
P total in mg/l	0.149	0.161	0.144	0.147	n.a.
Neris monitoring station above Kaunas (close to the junction with the Nemunas)					
BOD_7 in mg/l	3.3	4.1	4.3	3.6	4.2
N total in mg/l	2.05	2.383	2.117	1.969	2.268
P total in mg/l	0.114	0.114	0.138	0.095	0.190

Source: Environmental Protection Agency, Lithuania.

[30] For the methods used to assess the chemical and biological status, see the assessment of the Lielupe RBD above.

Trends

As water-quality monitoring data from 2001 to 2004 have shown, there is no clear indication of a water-quality change in the Nemunas above Rusne for total phosphorus and BOD_7; water pollution by total nitrogen slightly increased. There is also no clear indication of a water-quality change in the Neris above Kaunas (2001–2005): total phosphorus, BOD_7 and total nitrogen remained at the same levels.

The envisaged further improvement of wastewater treatment, the implementation of the planned non-structural measures in agriculture and water management as well as better policy integration among various economic sectors in Lithuania will improve water quality.

LAKE GALADUS/GALADUSYS

Lake Galadus (7.37 km^2) lies in the Podlasie region in north-eastern Poland and in the western part of the Lithuanian Lake District. The mean depth of the lake is 12.7 m (the maximum is 54.8 m). The theoretical retention time is 5.7 years. The border between Poland (5.6 km^2) and Lithuania (1.7 km^2) runs through the lake. Some 60% of the lake basin is agricultural land. About 1,800 people live in over a dozen villages in the area (about 20 people/km^2). The lake is used for recreational fishing, and there are also recreation residential plots around the lake.

In the 1990s there was well-organized monitoring activity by the Polish and Lithuanian environment protection services. The monitoring was first carried out throughout 1991–1995, and the research is to be repeated regularly every couple of years. Samples were collected at three locations on the lake and at three locations on the tributaries. Originally the samples were collected four times a year, but finally, according to the Polish methodology, the samples were collected twice a year (spring circulation and summer stagnation).

A normal set of physical and chemical analyses, as well as some biological analyses (e.g. for chlorophyll *a*, macrozoobenthos and phytoplankton) have been carried out. Also, some microbiological and radiological analyses were conducted in the monitoring programme.

The main problem for the lake is eutrophication due to agricultural activities. The status of the lake can be considered as “mesotrophic”. An oxygen-saturated bottom layer of water and an enhanced productivity level characterize the lake. According to Polish classification, it belongs to water-quality class 2.

PREGEL RIVER BASIN[31]

Lithuania, Poland and the Russian Federation (Kaliningrad Oblast) share the basin of the Pregel River, also known as the Prieglius or Pregolya.

Basin of the Pregel River			
Area	**Country**	**Country’s share**	
15,500 km^2 *	Lithuania *	65 km^2	0.4%
	Poland **	7,520 km^2	48.5%
	Russian Federation	7,915 km^2	51.1%

Sources: * Environmental Protection Agency, Lithuania.
** National Water Management Authority, Poland.

[31] Based on information provided by the National Water Management Authority of Poland.

Hydrology

The Pregel River has two transboundary tributaries: the Lava River (also known as the Lyna River) and the Wegorapa (or Angerapp) River. The confluence of the Wegorapa and Pisa rivers in the Kaliningrad Oblast (Russian Federation) is usually considered as the beginning of the Pregel River. The Pregel's main tributaries (the Wegorapa and Lava) have their sources in Poland. Poland also shares a very small part of the Pisa with the Russian Federation.

On Polish territory, there are 133 lakes in the Pregel basin with a total area of 301.2 km^2. There are also six NATURA 2000 sites, including the Lake of Seven Islands, a combined NATURA 2000 and Ramsar site of 10 km^2 situated very close to the Polish-Russian border.

Hydrology of the transboundary tributaries to the Pregel

The Lava (Lyna) River has a length of 263.7 km, of which 194 km are in Poland. From the sub-basin's total area (7,126 km^2), altogether 5,719 km^2 are in Poland. On Polish territory, there are 97 lakes with a total surface of 154,6 km^2. The main left tributaries include the Polish Marozka, Kwiela, Kortowka and Elma rivers. The Wadag, Krisna, Symsarna, North Pisa and Guber rivers are the main right tributaries in Poland.

The Wegorapa River has its source in Lake Mamry (Poland), at an altitude of 116 m above sea level. From its total length (139.9 km), 43.9 km are in Poland. Of the sub-basin's total area (3,535 km^2), 1,511.8 km^2 are in Poland. On Polish territory, there are also 28 lakes with a total surface of 140.1 km^2. The Wegorapa River's main tributaries are the Goldapa and Wicianka rivers and the Brozajcki Canal.

Discharge characteristics of the Lava (Lyna) and Wegorapa rivers in Poland		
Lava (Lyna) River at Bukwald (Poland) upstream of the border with the Russian Federation		
Discharge characteristics	**Discharge, m^3/s**	**Period of time or date**
Q_{av}	155	1951–1985
Q_{max}	34.9	1951–1985
Q_{min}	10.4	1951–1985
Wegorapa River at Mieduniszki (Poland) upstream of the border with the Russian Federation		
Discharge characteristics	**Discharge, m^3/s**	**Period of time or date**
Q_{av}	51.4	1991–1995
Q_{max}	11.9	1991–1995
Q_{min}	3.3	1991–1995

Source: National Water Management Authority, Poland.

Pressure factors

In Poland, agriculture (54%) and forests (29%) are the main form of land use in the Pregel basin.

In the sub-basin of the Lava River, sewage discharge mainly originates from the municipal wastewater treatment plant at Olsztyn with an amount of 36,000 m^3/d. Other, smaller municipal discharges originate at Bartoszyce (3,400 m^3/d), Lidzbark Warminski (3,400 m^3/d), Dobre Miasto (1,200 m^3/d), Stawigud (250 m^3/d), Sepopol (200 m^3/d) and Tolek (90 m^3/d). Industrial wastewaters are discharged from the dairy production plant at Lidzbark Warminski (1,100 m^3/d).

Water quality of the Lava (Lyna) River at the border profile at Stopki (Poland) for the period 18 January to 13 December 2006			
Determinands	**Average**	**Observed maximum**	**Observed minimum**
Total suspended solids in mg/l	10.79	29.00	5.7
$N\text{-}NH_4$ in mg/l	0.22	0.32	0.14
Total nitrogen in mg/l	2.72	5.00	1.42
Total phosphorus in mg/l	0.20	0.32	0.14
COD_{Cr} in mg O_2/l	28.48	33.80	23.60
COD_{Mn} in mg O_2/l	9.31	13.20	3.45
BOD_5 in mg O_2/l	1.61	2.50	0.90

In the sub-basin of the Wegorapa River, major wastewater discharges stem from the municipal wastewater treatment plant at Wegorzewo, which discharges 1,400 m^3/d.

Water quality of the Wegorapa River at the border profile at Mieduniszki (Poland) for the period 9 January to 4 December 2006			
Determinands	**Average**	**Observed maximum**	**Observed minimum**
Total suspended solids in	8.71	35.10	…
$N\text{-}NH_4$ in mg/l	0.17	0.49	0.03
Total nitrogen in mg/l	2.59	5.90	1.55
Total phosphorus in mg/l	0.13	0.19	0.08
COD_{Cr} in mg O_2/l	33.82	50.80	15.90
COD_{Mn} in mg O_2/l	9.59	12.70	6.30
BOD_5 in mg O_2/l	2.51	6.20	0.40

Transboundary impact and trends

The Lava (Lyna) used to be one of the most polluted rivers flowing out of Polish territory; its status is improving.

The overall status of the Wegorapa River is still poor, because of the high pollution levels in its tributaries (Goldapa River and Brozajcki Canal).

The envisaged further improvement of wastewater treatment, the implementation of the planned non-structural measures in agriculture and water management as well as better policy integration among various economic sectors will significantly reduce transboundary impact and improve water quality.

VISTULA RIVER BASIN[32]

Belarus, Poland, Slovakia and Ukraine share the Vistula basin with a total area of 194,424 km² (199,813 km² including the delta).

The most important transboundary river in the Vistula basin is the Bug River, shared by Belarus, Poland and Ukraine. The Poprad and Dunajec rivers, whose sub-basins are shared by Poland and Slovakia, are smaller transboundary tributaries to the Vistula.

BUG RIVER[33]

Belarus, Poland and Ukraine share the Bug River basin. The river's sub-basin is around 19% of the entire Vistula basin.

Hydrology

The Bug River, sometimes called the Western Bug to distinguish it from the Southern Bug in Ukraine, has its source in the northern edge of the Podolia uplands in the L'viv region (Ukraine) at an altitude of 310 m. The river forms part of the border between Ukraine and Poland, passes along the Polish-Belarusian border, flows within Poland, and empties into the Narew River near Serock (actually the man-made Lake Zegrzynskie, a reservoir built as Warsaw's main source of drinking water).

Sub-basin of the Bug River			
Area	**Country**	**Country's share**	
39,400 km²	Belarus	9,200 km²	23.35%
	Poland	19,400 km²	49.24%
	Ukraine	10,800 km²	27.41%

Source: National Water Management Authority, Poland.

The Bug River is 772 km long, of which 587 km are in Poland. Except in its upper stretch in Ukraine (Dobrotvirsk and Sokalsk dams), the main watercourse of the Bug River is not regulated, but its tributaries are heavily regulated, in particular in Ukraine (more than 218 dams) and Poland (more than 400 dams). The reservoirs are mainly used for irrigation. The Bug is connected through the Dnieper-Bug canal with the Pripyat in Ukraine.

The Bug's long-term average discharge is 157 m³/s (5.0 km³/a), measured upstream of Lake Zegrzynskie (Wyszkow station, Poland).

[32] Based on information provided by the National Water Management Authority (Poland), the Institute of Meteorology and Water Management (Poland), the Slovak Hydrometeorological Institute, and the State Committee for Water Management of Ukraine.
[33] Based on information provided by the National Water Management Authority (Poland) and the State Committee of Ukraine for Water Management.

Discharge characteristics at selected sites in the sub-basin of the Bug River									
				Water discharge in m³/s *					
River km	Station	Area in 1,000 km²	Period	HQ	MHQ	MQ	MNQ	NQ	Q_{max}/Q_{min}
602.0	Lythovetz (UA)	…	1980–1998	216	…	30.3	…	8.2	26.3
536.6	Strzyzow (UA-PL border)	8.945	1961–1990	692	230	40.9	11.5	3.20	216
378.3	Wlodawa (PL)	14.410	1951–1990	769	271	54.4	16.8	8.01	96
163.2	Frankopol (below BY-PL border)	31.336	1951–1990	1,480	487	119.0	38.9	12.40	119
33.8	Wyszkow (PL)	39.119	1951–1990	2,400	678	157.0	50.5	19.80	121

* Over the last 50 years

There are 13 tributaries with a length of more than 50 km, including five in Ukraine, two in Belarus and six in Poland. Four of them are transboundary rivers: the Solokiia and Rata between Poland and Ukraine and the Pulva and Lesnaya between Poland and Belarus.

Floods are frequent in the upper and middle parts of the river's catchment area (Ukraine) and at the border between Poland and Belarus. Significant variations in the flow regime due to melting snow in spring and low discharges in autumn greatly affect the quality of water.

Pressure factors

The whole sub-basin of the Bug River is a region with poorly developed water-supply networks and an even less developed sewage systems, especially in the rural areas. In some regions, villages and small towns do not have sewage systems at all. The sewage collected from water users is discharged to wastewater treatment plants (total number 304). Many of them are located in Poland (224, of which 165 municipal), 45 in Belarus (including 42 municipal) and 35 in Ukraine (including 18 municipal). There are 94 municipal wastewater treatment plants with a capacity greater than 150 m³/day. Of these, 64 are in Poland, 14 in Belarus, and 16 in Ukraine.

Thus, the water quality of the Bug is mainly affected by municipal wastewater discharges. Pollution from agriculture and the food-processing industry is an additional pressure factor.

Municipal wastewater treatment plants (MWWTP) in the sub-basin of the Bug River and treatment technology used			
Item	**Ukraine**	**Belarus**	**Poland**
Number of MWWTP	18	42	165
Technology of treatment:			
Mechanical			29
Mechanical-biological	16	9	127
Mechanical-biological-chemical			4
With advanced biogenic removal			5
Others:			
Cesspool	1		
Filter field	1	31	
Biological ponds		1	
Oxidation ditch		1	

Transboundary impact

A high percentage of the population not connected to sewage system (especially in the rural areas and small towns), the dominating agricultural character of the sub-basin and the dominating food industry producing organic loads, together with the bad technical conditions of existing sewage treatment plants, are main reasons of organic pollution.

The consequences of high organic pollution load are reflected in low dissolved oxygen concentration, which adversely affect the river's self-purification capacity and the ecosystem of the river. In the last few years, there is a downward tendency of organic pollution in the border stretch of the Bug River. However, in the lower part of the Bug River and in its tributaries, high concentrations of BOD_5 and COD_{Cr} are measured, which exceed the concentrations given in the Council Directive of 16 June 1975 concerning the quality required of surface water intended for the abstraction of drinking water in the Member States (75/440/EEC).

The share of diffuse sources in the total estimated load of organic pollution (BOD_5) is very high (>80%). The greatest part (about 90%) originates from the Polish territory due to the size of the area, the high percentage of the population unconnected to sewerage systems, the cattle density and the greater use of fertilizers.

The sources of bacteriological pollution are sewage discharge from municipal treatment plants as well as rainwater from built-up areas and raw sewage discharged from households that are not connected to sewage systems. The waters of the whole border stretch of the Bug River have been highly polluted by faecal coliforms, which caused disqualification of these waters for recreation, prevented cyprinid and salmonid fish living, and in some places prevented their use for drinking water preparation. Particularly in the vicinity of L'viv (Ukraine) and Krzyczew and Popow (Poland), significant faecal contamination of water has been found. Bad sanitary conditions have also been observed in the tributaries of the Bug River, according to Ukrainian, Belarusian and Polish data.

Eutrophication processes are the result of the long-lasting presence of high concentrations of biogenic compounds in the waters, which mainly influence the ecological functions as well as water use for drinking purposes and recreation.
Existing data show that water quality in some places has deteriorated due to the presence of heavy metals (Pb, Cu, Ni, Cd, Cr) as well as phenols, detergents and oil compounds.

Trends

As a result of the activities to regulate sewage management in the basin and the widespread regression in agriculture, a decrease in the concentrations of nitrogen compounds is observed, especially in the lower part of the Bug. The concentrations of phosphorus have hardly decreased yet, in spite of the investments in the water sector and regression of the economy in the whole basin.

Without strong pollution control measures, the water quality of the Bug River will slowly but systematically decrease. Fortunately, many actions are being taken to improve water management (including monitoring and assessment), and with the financial support of the EU many wastewater treatment plants are being built.

DUNAJEC AND POPRAD RIVERS[34]

The sub-basins of the Dunajec and Poprad are both shared by Slovakia (upstream country) and Poland (downstream country). The Poprad is a transboundary tributary to the Dunajec, which is also transboundary and ends up in the Vistula River.

Sub-basin of the Dunajec River (without the Poprad sub-basin)			
Area	Country	Country's share	
4,726.7 km²	Poland	4368.8 km²	92.4%
	Slovakia	357.9 km²	7.6%

Source: Institute of Meteorology and Water Management (Poland).

Sub-basin of the Poprad River			
Area	Countries	Countries' share	
2,077 km²	Poland	483 km²	23.3%
	Slovakia	1,594 km²	76.7%

Sources: Institute of Meteorology and Water Management (Poland) and Slovak Hydrometeorological Institute.

POPRAD RIVER

Hydrology

The Poprad River, a right-hand side tributary of the Dunajec, has its source in the Tatra Mountains in Slovakia and ends up in Poland in the Dunajec River. The river's length is 169.8 km (62.6 km in Poland and 107.2 km in Slovakia); for 38 km the river forms the border between Poland and Slovakia.

The sub-basin has a pronounced mountain character with an average elevation of about 826 m above sea level. It is classified as "High Mountain River", with low flow rates in winter (January, February) and high flows in summer (May, June). The average discharge of the Poprad River at the boundary section at Piwniczna is 22.3 m³/s.

Discharge characteristics of the Poprad River at the Chme nica monitoring station in Slovakia		
Discharge characteristics	Discharge, m³/s	Period of time or date
Q_{av}	14.766	1962–2000
Q_{max}	917.0	1931–2005
Q_{min}	2.240	1931–2005

Source: Slovak Hydrometeorological Institute.

There are only small glacier lakes in the sub-basin. The Tatras National Park is a NATURA 2000 site in Slovakia. Six NATURA 2000 sites are located in the Polish area of the Poprad sub-basin.

One small hydropower station is in operation on the Poprad River.

Pressure factors and transboundary impact

The population density is 92 persons/km² in Poland and 135 persons/km² in Slovakia.

In Slovakia, forests (42%), grassland (28%) and cropland (25%) are the main forms of land use. Water use by industry is around 47% and 53% is used for drinking water

[34] Based on communications by the Slovak Hydrometeorological Institute as well as the National Water Management Authority and the Institute of Meteorology and Water Management (Poland).

supply and other domestic purposes. Crop and animal production is limited to small farms with potato and cereals growing and cattle and sheep husbandry. Manufacturing is also limited to mechanical engineering (refrigerators and washing machines), small chemical and textile companies and several other small manufactures. Large settlements and towns discharge treated wastewaters. Presently, solid wastes are delivered to controlled dumpsites; however, there are several small old uncontrolled dumpsites from the past.

Water quality in the Poprad River in Slovakia in 2000–2005	
Determinands	**Water-quality class***
Oxygen regime	2–3
Basic physical-chemical parameters	3–3
Nutrients	3–4
Biological parameters	2–3
Microbiological parameters	4–5
Micro-pollutants (heavy metals)	3

* In accordance with Slovak national technical standards, the water-classification system is made up of five classes, ranging from class 1 (very clean water) to class 5 (very polluted water).
Source: Slovak Hydrometeorological Institute.

In Poland, the town of Muszyna causes the biggest pressure on water resources. The town is equipped with a municipal wastewater treatment plant, which discharges 2,727 m³/d. Agriculture terrains are usually covered with grass or herbage and suitable for grazing by livestock (19% of land use) or destined for tillage (14% of land use). In general, the whole agricultural production stems from small farms.

Water quality is measured at two boundary profiles (Czercz and Piwniczna, Poland). The following table shows the results for the Czercz station.

Water quality of the Poprad River in 2005 at the transboundary profile Czercz (Poland)		
Determinands	**Unit**	**Value**
Temperature	°C	16.3
pH	pH	7.9–8.4
Dissolved oxygen	mg/l	8.2
Oxygen saturation	%	72
Dissolved substances	mg/l	281
Total suspended solids	mg/l	56
$N\text{-}NH_4$	mg/l	0.85
$N\text{-}NO_2$	mg/l	0.071
$N\text{-}NO_3$	mg/l	2.66
Total nitrogen	mg/l	3.86
Phosphates [PO_4]	mg/l	0.27
Total phosphorus	mg/l	0.23
COD_{Cr}	mgO_2/l	28.9
BOD_5	mgO_2/l	3.6
Organic nitrogen [N_{org}]	mg/l	0.73
Mercury	mg/l	< 0.00005
Cadmium	mg/l	< 0.0003
Chlorophyll a	mg/l	2.8
Faecal coliform	Most probable number (MPN)	8,084
Total coliform	Most probable number (MPN)	42,486

The waters of the Poprad River are currently not at risk of eutrophication.

In Slovakia, organic matter from wastewater discharges, pathogens in wastewater discharges, nitrogen species and heavy metals are of particular concern as they cause transboundary impact

In 2005, an industrial accident occurred near the town of Kežmarok (Slovakia) that polluted the river with mineral oil.

Trends

In the 1980s and the beginning of the 1990s, the Poprad River was among the most polluted small watercourses. Achieving the current level of water quality in the Poprad River, which mostly ranks between classes 2 and 3, was possible as a result of investments made in the basin. In the period 1990–2001, the most important measures included:

- Building mechanical-biological wastewater treatment plants in Muszyna and three other tows in Poland;
- Building mechanical-biological wastewater treatment plants in 17 towns and major settlements Slovakia;
- Building wastewater pipelines from not canalized settlements to wastewater treatment plants; and
- Closing the factories TESLA S.A. and SKRUTKAREN.

Currently, the status of the Poprad River is assessed as "moderate".

The programme of measures to be developed by 2009 and implemented by 2015 is based on the requirements of the WFD in both countries (Slovakia and Poland).

ODER RIVER BASIN[35]

The Czech Republic, Germany and Poland share the basin of the Oder River.

Basin of the Oder River			
Area	**Countries**	**Countries' share**	
118,861 km²	Czech Republic	6,453 km²	5.4%
	Germany	5,587 km²	4.7%
	Poland	106,821 km²	89%

Source: International Commission for the Protection of the Oder River against Pollution.

[35] Information provided by the Voivodeship Inspectorate of Environmental Protection, Szczecin, in consultation with the International Commission for the Protection of the Oder River against Pollution.

The Oder River Basin District[36] differs from the hydrological basin of the Oder as follows:

Oder River Basin District*			
Area	**Country**	**Country's share**	
122,512 km^2	Czech Republic	7,246 km^2	5.9%
	Germany	7,987 km^2	6.5%
	Poland	107,279 km^2	87.6%

* The total area of the Oder River Basin District includes the area of the Szczecinski Lagoon (3,622 km^2 with its tributaries, from which 2,400 km^2 are in Germany (Kleines Haff and the Uecker, Randow and Zarow rivers) and 1,222 km^2 in Poland (Zalew Wielki/Grosses Haff and the catchment areas of the Gowienica and Świna rivers and the other subordinate coastal waters).
Source: Report for International Basin District Odra on the implementation of the Article 3 (2004) and Article 15 (2005) of the Water Framework Directive.

Hydrology

The Oder River with a total length of 855 km has its source at an altitude of 632 m in Góry Odrzańskie (Czech Republic), the south-eastern part of the Central Sudety mountain range.

In the recorded period 1921 – 2003 (without 1945), the annual mean discharge at the Hohensaaten-Finow station (Germany, upstream basin area 109,564 km^2) has varied between 234 m^3/s and 1,395 m^3/s. The mean average discharge was 527 m^3/s with an absolute maximum of 2,580 m^3/s (in 1930) and an absolute minimum of 111 m^3/s (in 1921).

The Oder is navigable over a large part of its total length, as far upstream as to the town of Koźle, where the river connects to the Gliwicki Canal. The upstream part of the river is canalised and permits larger barges (up to CEMT Class 4) to navigate between the industrial sites around the Wrocław area. Further downstream, the river is free flowing, passing the German towns of Frankfurt/Oder and Eisenhüttenstadt (where a canal connects the river to the Spree River in Berlin). Downstream of Frankfurt/Oder, the Warta River forms a navigable connection with Poznań and Bydgoszcz for smaller vessels. At the German town of Hohensaaten, the Oder-Havel-Waterway connects the Oder again with the Berlin's watercourses. The river finally reaches the Baltic Sea through the Szczecinski Lagoon and the river mouth at Świnoujście.

Transboundary tributaries to the Oder are the Olse River (right tributary, sub-basin shared by the Czech Republic and Poland) and the Neisse River (left tributary, sub-basin shared by the Czech Republic, Germany and Poland). The biggest tributary, entirely located in Poland, is the Warta River that occupies almost half of the entire Oder basin area. With a mean annual discharge of 224 m^3/s, the Warta provides for some 40% of the mean annual discharge of the Oder River.

In the entire basin, there are 462 lakes, each with an area over 50 hectares. There are 48 dams and reservoirs, mostly in Poland, used for water supply and flood protection (useable volume: 1 million m^3). The inventory of significant ecological barriers shows that in the Czech part of the basin 1,254 such barriers exist (Czech criterion >30 cm drop), in the Polish part 705 barriers (Polish criterion >100 cm drop), and in the German part 307 barriers (German criterion >70 cm drop).

Different types of floods occur. Floods caused by precipitation and ice melting are characteristic for the Upper and Middle Oder; winter floods are characteristic for the Lower Oder; and floods caused by storms, for the Oder delta.

The biggest flood caused by ice melting was recorded in 1946; the biggest flood event caused by heavy rainfall was recorded in summer 1997. A characteristic feature of big floods in the Upper and Middle Oder is a long-lasting state of alert. During the summer flood in 1997, it took 19 days for the peak flood wave to proceed from the Czech border to Slubice (upstream of Szczecin). In the Lower Oder region, the basic flood threat is caused by ice and ice-jams.

[36] Following the Water Framework Directive (Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for European Community action in the field of water policy), a "River Basin District" means the area of land and sea, made up of one or more neighbouring river basins together with their associated groundwaters and coastal waters, which is identified under Article 3(1) as the main unit for management of river basins.

Pressure factors

The Oder River basin belongs to the most densely populated and industrialized areas (85 million people) in the Baltic Sea basin.

The basin area is characterised by diverse level of land development and urbanization; thus a diversity of human impact occurs along the river.

In its upper course, the Oder flows through the most industrialized and urbanized areas of Poland. This area is rich in mineral resources, such as coal and metal ores. Accordingly, heavy industry like steelworks, mining and energy production dominate.

The area of the Middle Oder basin is, on the one hand a strongly urbanized and industrialized (copper industry) region, and on the other, a typical agricultural and forest area. The Polish side of the border region with the German Federal State of Brandenburg is covered by forest, and weakly industrialized and urbanized. The German side, however, is an industrial region, with the cities of Frankfurt/Oder and Eisenhüttenstadt.

The lower part of the Oder basin includes the agglomeration of Szczecin (Poland) with harbours and shipyards industry, chemical and paper industry and energy production. Fishery and tourism also represents an important part of the economy in this part of the basin, especially in the Szczecinski Lagoon and the Pomeranian Bay.

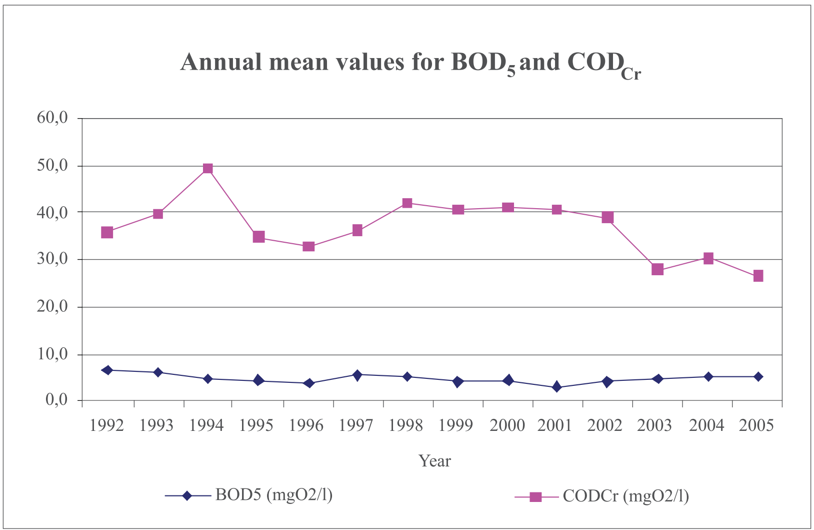
Water-quality determinands for the period 1992–2005 at the Krajnik station (Poland, river kilometre 690)

Determinands	Unit	Number of measurements	Minimum	Maximum	Average
Total suspension	mg/l	26	6.9	9.5	8.6
Oxygen	mgO_2/l	26	3.3	18.4	12.2
BOD_5	mgO_2/l	26	1.0	17.2	7.2
COD_{Mn}	mgO_2/l	26	4.6	16.0	10.5
COD_{Cr}	mgO_2/l	26	7.8	93.0	45.3
Total nitrogen	mgN/l	26	1.1	9.0	4.8
Total phosphorus	mgP/l	26	0.0	1.0	0.4
Number of faecal coli bacteria	ml/bact.	26	0.0	4.0	0.9

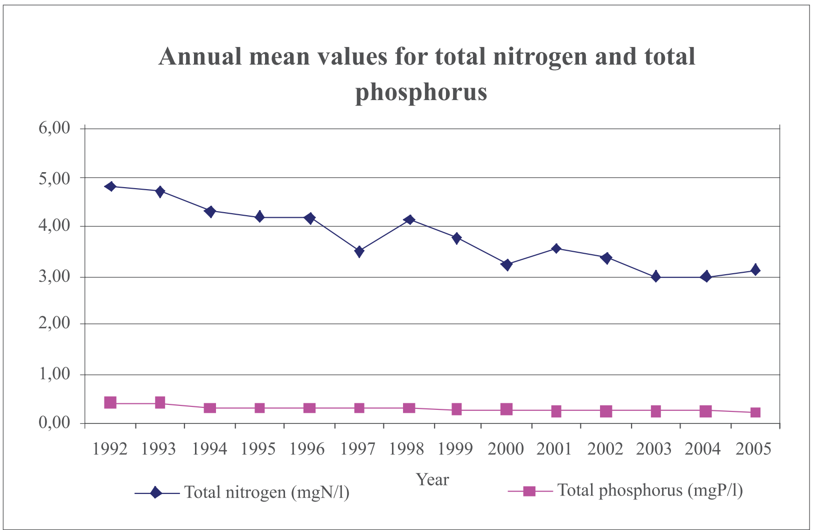
In the Oder River Basin District, 741 significant municipal point sources of pollution (over 2,000 p.e.) have been identified, among them 56 in the Czech Republic, 635 in Poland, and 50 in Germany. In 2002, the pollution load was as follows: BOD_5 = 11.2 tO_2/year, COD_{Cr} = 37.9 tO_2/year, nitrogen 12.1 t/year and phosphorus 1.3 t/year. The total amount of wastewater was 606,739,000 m^3/year.

Diffuse pollution sources in the German and Polish part of the basin release 78,520 t/year (Polish share 74,482 t/year) nitrogen and 5,229 t/year (Polish share 4,912 t/year) phosphorus. It is estimated that 3,213 tons nitrogen and 45 tons phosphorus are discharges every year from Czech sources.

Due to a lack of Polish data, the total discharge of toxic substances into the Oder River Basin District is unknown.



Annual mean values for BOD_5 and COD_{Cr} at the Krajnik station (Poland)



Annual mean values for total nitrogen and total phosphorus at the Krajnik station (Poland)

Transboundary impact by heavy metals and other hazardous substances

Given the location of the metal-processing industry, the metal concentrations in water and sediment samples vary along the river. In water, they usually do not exceed the values of Polish and German standards for drinking water. In sediments, however, high and relatively high concentration of heavy metals occur in the upper and middle part of the basin as a consequence of the wastewater discharges from mines and steelworks (also from metal industry, engineering industry, electronic and chemical industry). An important share of the heavy metal load stems from the Oder tributaries, which carry polluted sediments. Untreated wastewater from the Szczecin agglomeration is another source of heavy metal loads.

Polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs) and chlorinated pesticides are present in the sediments in the upper and middle part of the basin. Pollution by PAHs occurs in discharges from the large industries, which process rocks, rich in organic substances, at high temperature. Chlorinated pesticides are also present in the sediments of the Warta River, resulting from intensive agriculture as an important economic sector in the Warta River's sub-basin. High concentrations of PCBs in sediments were also discovered in this sub-basin. Investigations of pesticides in the water phase showed concentrations below 50 ng/l; concentrations exceeding this value were found in the lower Oder River at Mescherin and in the Szczecin region.

Additionally, the harbour and shipbuilding industries located in the Oder mouth have contributed to the accumulation of pollutants in the sediments, not only of heavy metals, but also PAH and PCB compounds. Maintaining the traffic of ships from the Swinoujscie harbour to the Szczecin harbour requires continuous dredging of the fairway, which results in a release and transport of these pollutants. The results of examinations indicated the presence of tin compounds in the sediments of the Szczecinski Lagoon is a concern.

Impact on the marine environment

The marine ecosystem of the Baltic Sea is very sensitive, partly due to the natural conditions and partly due to pressure from human activities in the basin.

The Oder River releases significant pollution loads through the Szczecinski Lagoon into the Baltic Sea. Eutrophication is recognized as the most alarming issue. The nutrient pollution stimulates excessive algae growth and threatens to deplete the bottom waters of oxygen. Unfavourable changes in the species composition of game fish are a result of the progressive eutrophication in the Szczecinski Lagoon and the Pomeranian Bay waters. The long periods of algae blooming discourage tourists from recreation. Chemical pollution and spills have moderate impact on the Baltic Sea environment.

Trends

Under the *Short Term Programme for the Protection of the Oder River against Pollution* (1997–2002), prepared under the auspices of the International Commission for the Protection of the Oder River against Pollution, 41 municipal and 20 industrial wastewater treatment plants were constructed in 1997–1999. Thanks to these investments, the targets for pollution reduction were already partly achieved as follows: 17% for BOD_5, 50% for nitrogen, 20% for phosphorus and 44% for COD. Structural changes in industry and agriculture, although gradual and slow, will contribute to improving water quality.

Although sanitary conditions have improved over the last decade in the whole river basin, the excessive concentration of faecal bacteria remains a major problem.

Regarding eutrophication, the concentration of nutrients is decreasing. This decrease is especially noticeable for phosphorous compounds. The concentration of nitrogen compounds is also decreasing, but more slowly.