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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

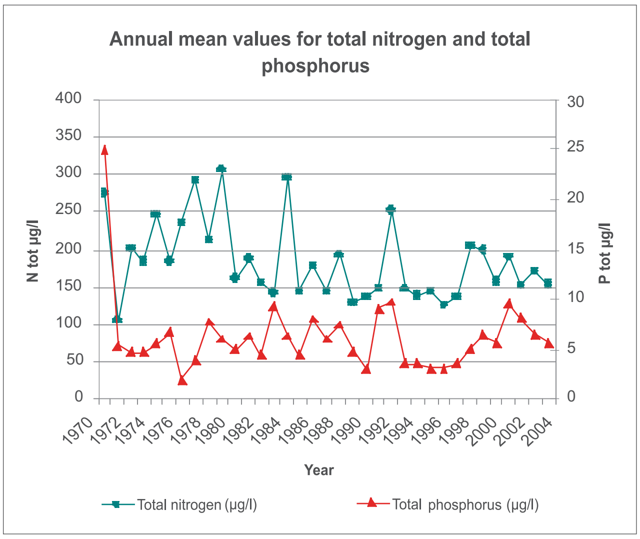
Most of the point sources are urban wastewater treatment plants. In the years 1993–1997, their average discharge was 7,500 kg/a phosphorus, 260,000 kg/a nitrogen and 272,000 kg/a BOD_7.

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 km²	Finland	22,509 km²	98.5%
	Russian Federation	332 km²	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 km²	Finland	759.8 km²	47.6%
	Russian Federation	834.8 km²	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 km²	Finland	1,029 km²	73%
	Russian Federation	386 km²	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.

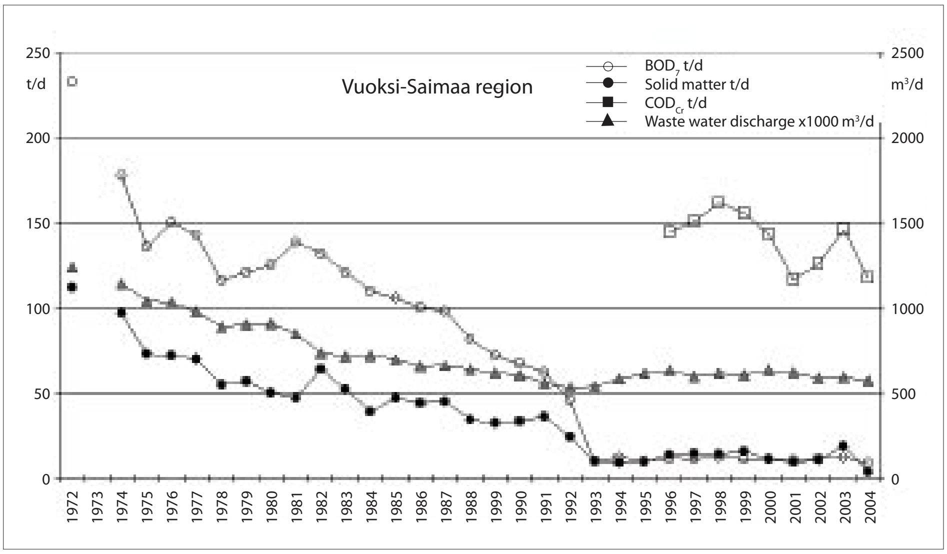
Transboundary impact

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

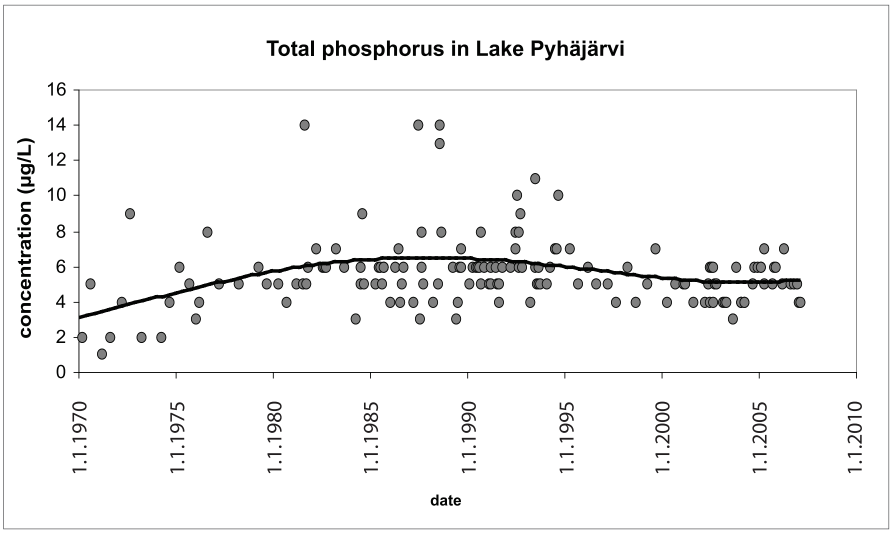
Source: Suomen ryhmän ilmoitus vuonna 2004 suoritetuista toimenpiteistä rajavesistöjen veden laadun suojelemiseksi likaantumiselta (Announcement by the Finnish party of Finnish-Russian transboundary water commission of the measures to protect the quality of transboundary waters in year 2004).

LAKE PYHÄJÄRVI

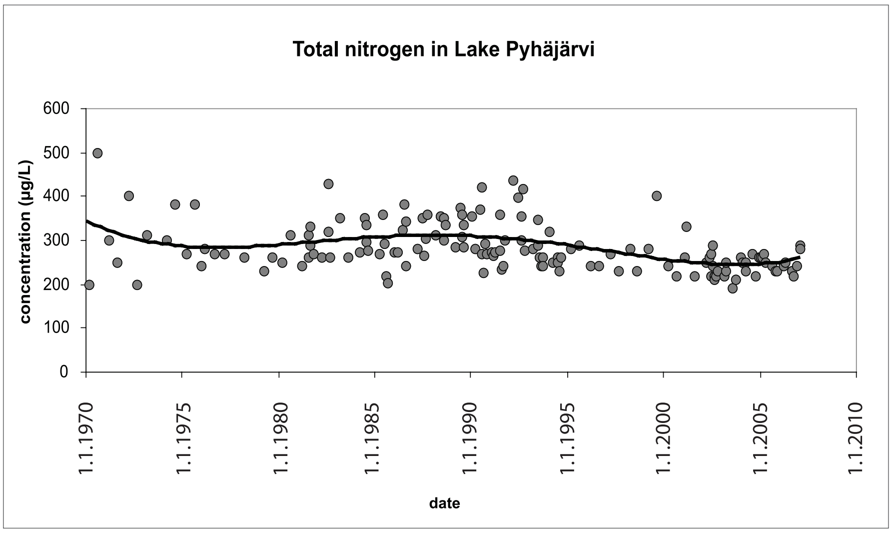
Lake Pyhäjärvi (total surface area 248 km²) in Karelia is part of the Vuoksi River basin. The lake is situated in North Karelia approximately 30 km northwest of Lake Ladoga, the largest lake in Europe. Of the total lake surface area, 207 km² of Lake Pyhäjärvi lies in Finland and 41 km² in the Russian 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.

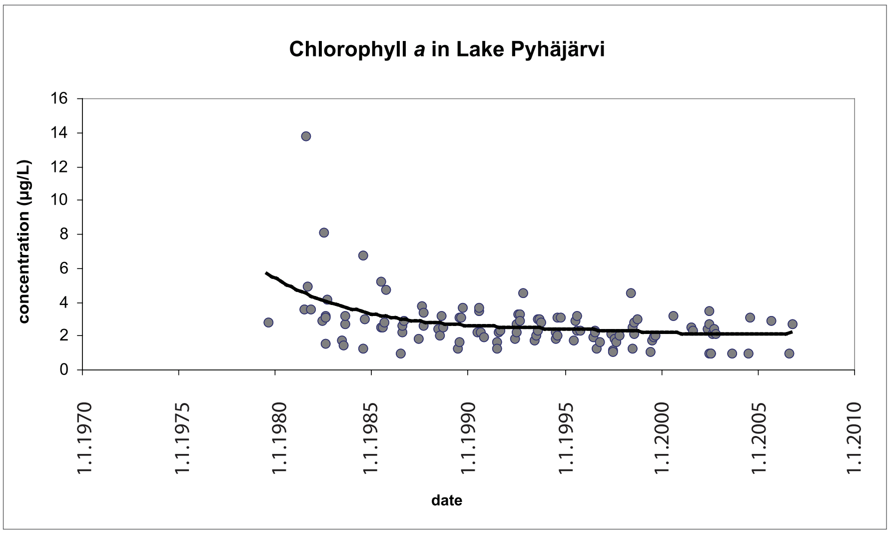
The estimated nutrient load into Lake Pyhäjärvi has decreased since 1990. The phosphorus load has decreased by 55% and nitrogen by 12%. In particular, the phosphorus load from point sources has diminished. Some loading sources have closed or are closing. The decrease of phosphorus and nitrogen loading 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.

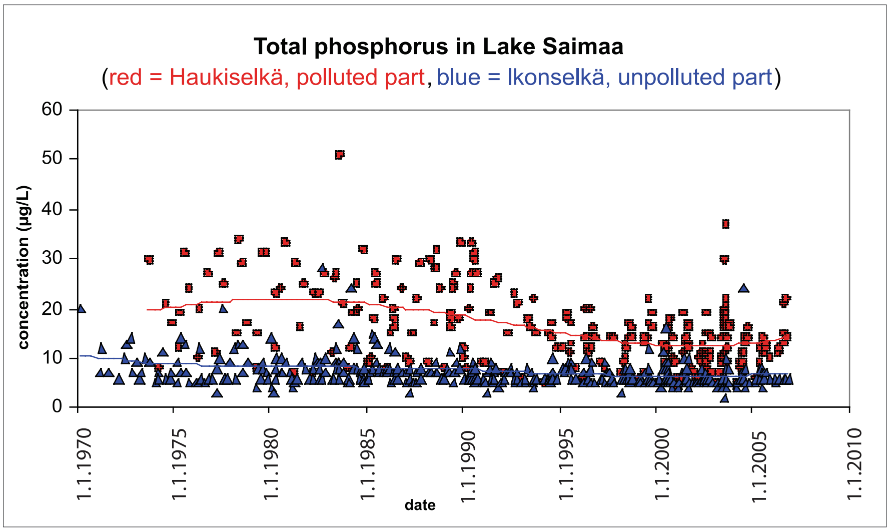
The main problem is incipient eutrophication because of non-point and point source loading, especially during the 1990s. However, chlorophyll a has shown a slight decrease during the last years. The overall quality of the lake's water is classified as excellent, although some small areas, subject to 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.

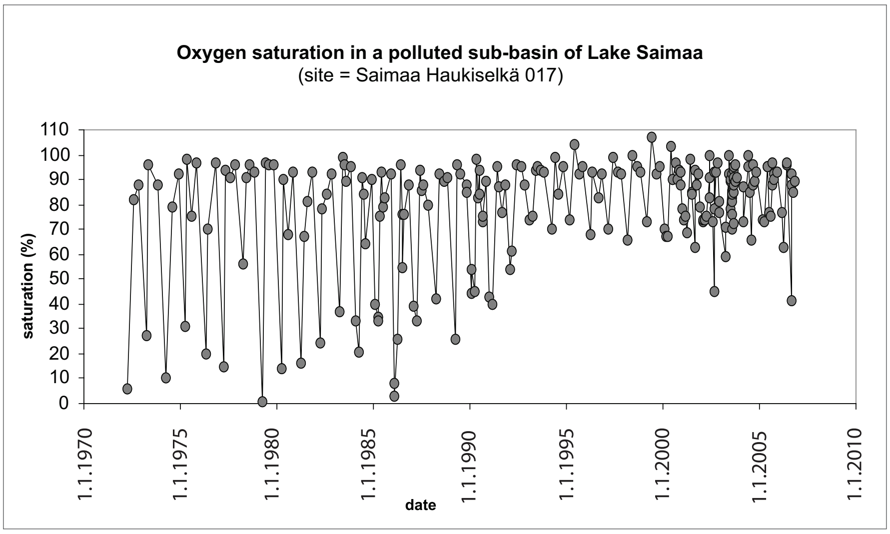
Due to its complexity with approximately 120 sub-basins lying on the same water level (76 m above sea level), the definition on what basins are in fact included in Lake Saimaa is not clear. In many cases, "Lake Saimaa" only refers to Lake Southern Saimaa (386 km^2), a smaller part of the entire Lake 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 km^2	Finland	178 km^2	60%
	Russian Federation	118 km^2	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 m^3/s, and at the Kärkisillanoja site of 0,2 m^3/s.

LAKE NUIJAMAANJÄRVI

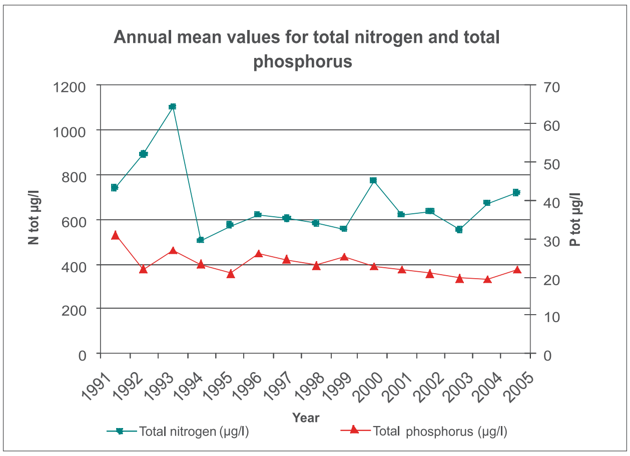
Lake Nuijamaanjärvi (total lake surface 7.65 km^2) is part of the Juustilanjoki river basin. The lake is situated south of the Salpausselk ridge at the border of Finland and the Russian Federation. From the total lake area, 4.92 km^2 are in Finland and 2.73 km^2 in the Russian Federation. The theoretical retention time of the lake is only about 100 days. The population density in the basin area is 24 persons/km^2.

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 (m³/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 km²	Finland	467 km²	84%
	Russian Federation	90 km²	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 m³/s (0.11 km³/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 km²	Latvia	8,662 km²	49.2%
	Lithuania	8,938 km²	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, m^3/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, m^3/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 km^2 reservoir area) and 11 lakes (>0.5 km^2 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, m^3/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, m^3/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:

[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 km^2 with the following countries' shares: Belarus 45,395 km^2; Latvia 98 km^2; Lithuania 46,695 km^2; Poland 2,544 km^2 and Russian Federation (Kaliningrad Oblast) 3,132 km^2.

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, m³/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, m³/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-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-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 km^2	Poland	4368.8 km^2	92.4%
	Slovakia	357.9 km^2	7.6%

Source: Institute of Meteorology and Water Management (Poland).

Sub-basin of the Poprad River			
Area	**Countries**	**Countries' share**	
2,077 km^2	Poland	483 km^2	23.3%
	Slovakia	1,594 km^2	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 m^3/s.

Discharge characteristics of the Poprad River at the Chme nica monitoring station in Slovakia		
Discharge characteristics	**Discharge, m^3/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/km^2 in Poland and 135 persons/km^2 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 m^3/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 km²	Czech Republic	7,246 km²	5.9%
	Germany	7,987 km²	6.5%
	Poland	107,279 km²	87.6%

* The total area of the Oder River Basin District includes the area of the Szczecinski Lagoon (3,622 km² with its tributaries, from which 2,400 km² are in Germany (Kleines Haff and the Uecker, Randow and Zarow rivers) and 1,222 km² 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 km²) has varied between 234 m³/s and 1,395 m³/s. The mean average discharge was 527 m³/s with an absolute maximum of 2,580 m³/s (in 1930) and an absolute minimum of 111 m³/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 m³/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 m³). 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.

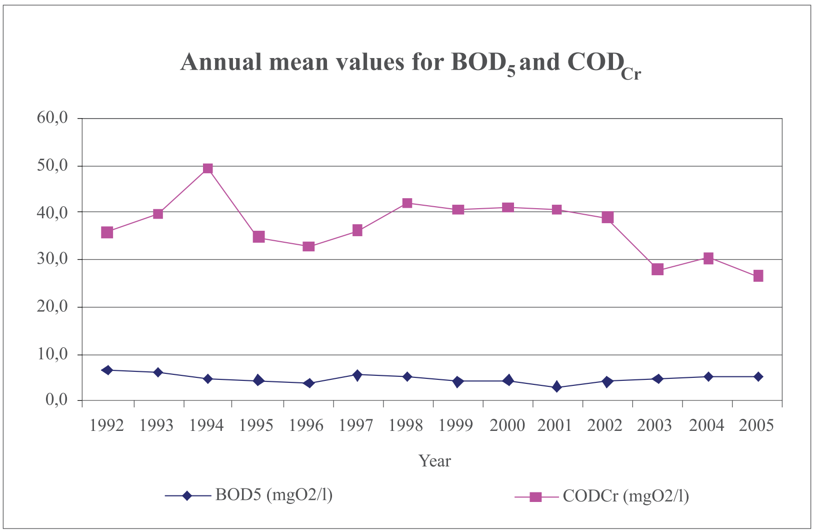
Water-quality determinands for the period 1992–2005 at the Krajnik station (Poland, river kilometre 690)

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

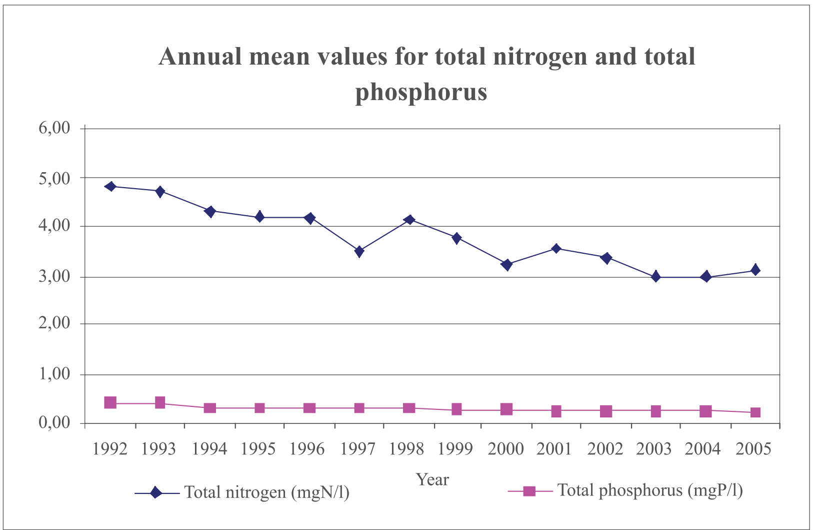
In the Oder River Basin District, 741 significant municipal point sources of pollution (over 2,000 p.e.) have been identified, among them 56 in the Czech Republic, 635 in Poland, and 50 in Germany. In 2002, the pollution load was as follows: BOD_5 = 11.2 tO_2/year, COD_{Cr} = 37.9 tO_2/year, nitrogen 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.