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

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

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

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

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

OULANKA RIVER BASIN[1]

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

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

Hydrology

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

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

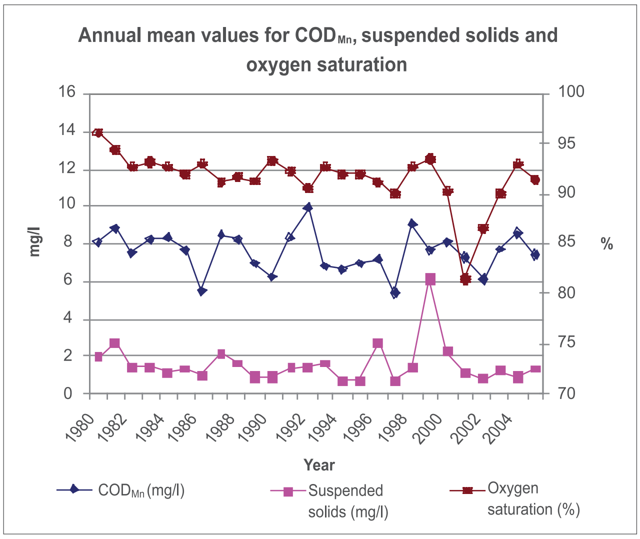
At the Oulankajoki station (Finland), the mean annual runoff was 23.9 m³/s (period 1966–1990) and 25.5 m³/s (period 1990–2000), respectively. Spring floods often occur.

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

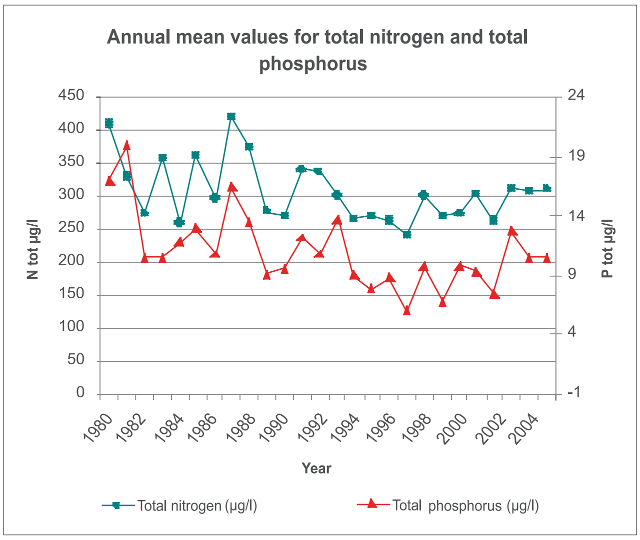
Basin of the Oulanka River upstream of Lake Paanajärvi			
Area	**Country**	**Country's share**	
5,566 km²	Finland	4,915 km²	88%
	Russian Federation	651 km²	12%

Source: Finnish Environment Institute (SYKE).

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



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



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

Pressure factors

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

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

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

Transboundary impact

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

Trends

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

TULOMA RIVER BASIN[2]

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

Basin of the Tuloma River upstream of the Lower Tuloma Dam			
Area	Country	Country's share	
21,140 km^2	Finland	3,285 km^2	16%
	Russian Federation	17,855 km^2	84%

Source: Finnish Environment Institute (SYKE).

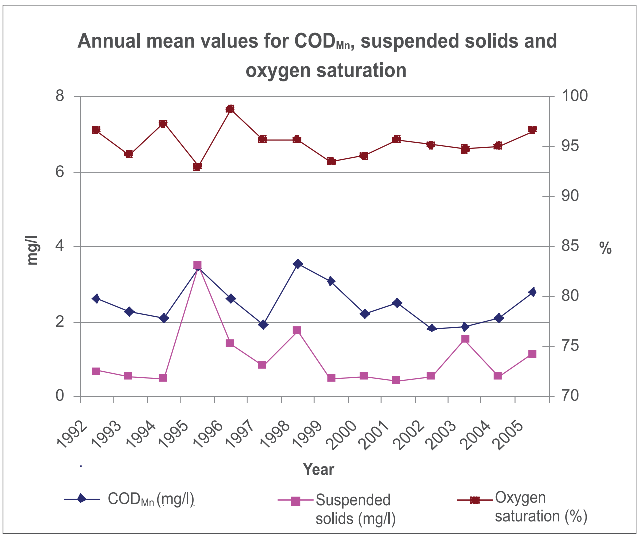
[2] Based on information provided by the Finnish Environment Institute (SYKE).

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

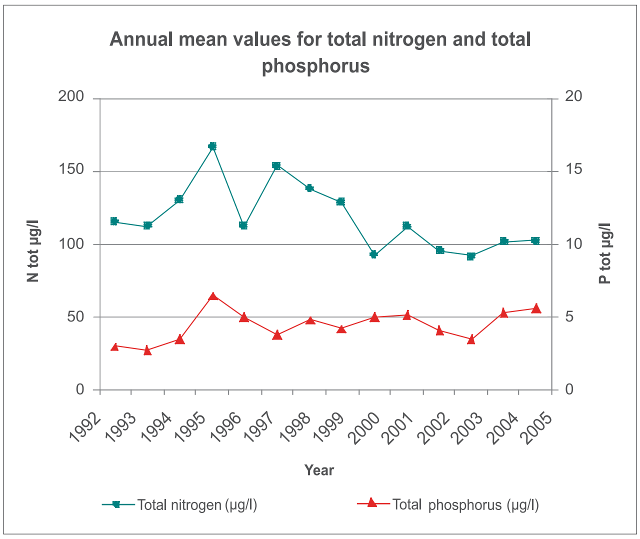
Hydrology

The mean annual discharge of the Lutto River at the Lutto site (Finland) was 22.3 m³/s for the period 1993–2000. For the same period, the maximum and minimum values were as follows: HQ = 348 m³/s, MHQ = 219 m³/s, MNQ = 4.02 m³/s and NQ = 1.76 m³/s. Severe floods are frequent; however they do not have significant impact on human health and safety due to the regulating effect of reservoirs.

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



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



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

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

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

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

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

There is no significant transboundary impact.

Trends in the Lutto and Notta/Girvas sub-basins

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

JAKOBSELV RIVER BASIN[3]

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

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

Source: Finnish Environment Institute (SYKE).

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

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

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

PAATSJOKI RIVER BASIN[4]

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

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

Source: Lapland regional environment centre, Finland.

PAATSJOKI RIVER

Hydrology

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

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

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

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

Pressure factors

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

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

Transboundary impact

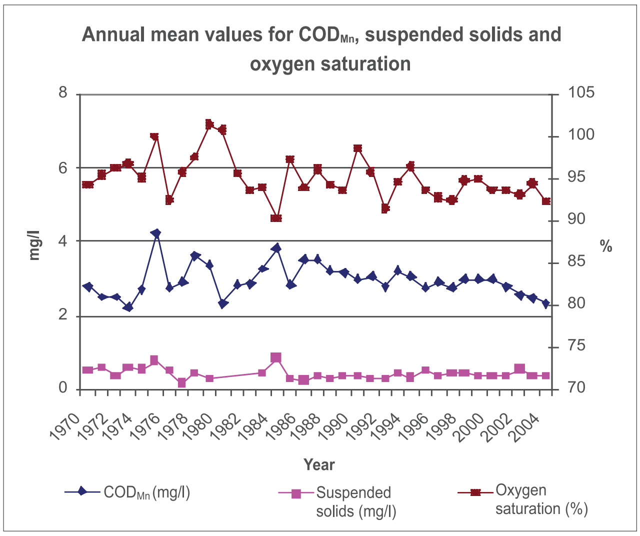
The transboundary impact from human activities on Finnish and Norwegian territory is insignificant.

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

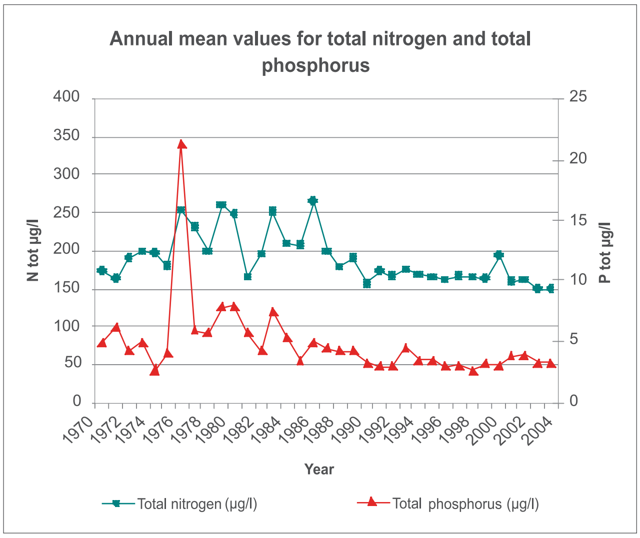
Water regulations by the power plants in Norway and the Russian Federation and introduction of alien species also cause significant transboundary impact.

Trends

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



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



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

LAKE INARI[5]

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

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

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

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

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

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

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

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

NÄÄTÄMÖ RIVER BASIN[6]

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

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

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

Source: Finnish Environment Institute (SYKE).

Hydrology

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

The mean annual discharge of the Näätämö River at the Iijärvi site (Finland) is 8.55 m³/s. For the period 1991–2000, the maximum and minimum values were as follows: HQ = 145 m³/s, MHQ = 62.0 m³/s, MNQ = 1.95 m³/s and NQ = 1.60 m³/s.

Pressure factors and transboundary impact

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

Trends

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

TENO RIVER BASIN[7]

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

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

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

Source: Lapland regional environment centre, Finland.

Hydrology

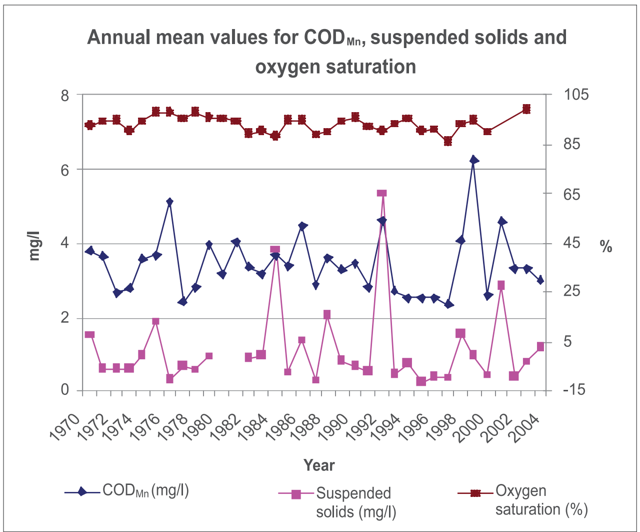
The Teno River flows along the border of Finland and Norway and discharges into the into the Barents Sea. The Teno's headwaters are the Inarijoki River (mostly in Norway) and Kaarasjoki (in Norway); their sources are in the Ruija fjeld highland.

The river's mean annual discharge at the Polmak station (Norway) is 163 m³/s (5.14 km³/a). The average maximum discharge is 1,767 m³/s with an absolute maximum in 2002 of 3,544 m³/s. At Alaköngäs (Finland), the discharge values for the period 1976–2005 were: MQ = 177 m³/s (5.6 km³/a), NQ = 21 m³/s and HQ = 3147 m³/s. Spring floods are common.

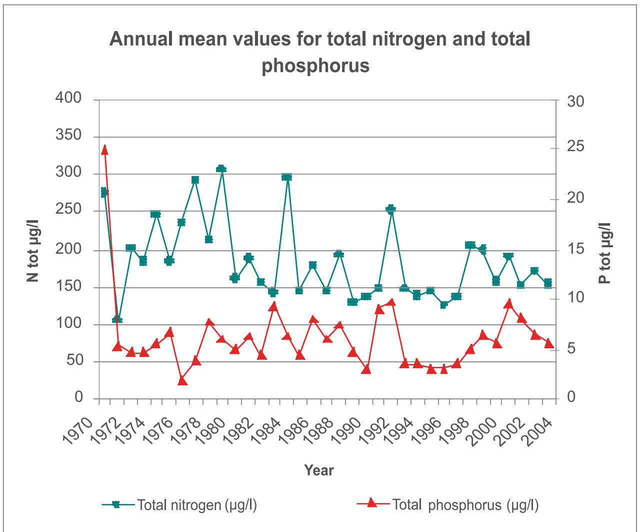
[6] Based on information provided by the Finnish Environment Institute (SYKE) and Ministry for Environment, Norway.
[7] Based on information provided by the Finnish Environment Institute (SYKE) and Ministry for Environment, Norway.

Pressure factors

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



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



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

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

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

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

Transboundary impact

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

Trends

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

YENISEY RIVER BASIN[8]

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

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

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

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

Hydrology

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

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

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

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

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

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

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

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

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

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

Transboundary impact

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

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

Trends

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

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

OB RIVER BASIN[9]

OB RIVER[10]

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

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

Source: Ministry of Environmental Protection of Kazakhstan.

Hydrology

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

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

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

Pressure factors

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

Transboundary impact and trends

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

IRTYSH RIVER

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

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

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

Hydrology

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

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

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

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

Source: Ministry of Environmental Protection of Kazakhstan.

Pressure factors

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

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

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

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

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

Transboundary impact

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

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

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

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

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

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

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

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

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

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

Trends

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

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

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

TOBOL RIVER

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

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

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

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

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

Hydrology

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

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

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

Source: Ministry of Environmental Protection of Kazakhstan.

Pressure factors

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

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

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

Transboundary impact

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

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

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

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

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

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

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

Source: Ministry of Environmental Protection of Kazakhstan.

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

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

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

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

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

Trends

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

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

Flooding will also remain a problem.

ISHIM RIVER

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

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

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

Hydrology

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

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

Source: Ministry of Environmental Protection of Kazakhstan.

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

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

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

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

Transboundary impact

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

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

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

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

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

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

Trends

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

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