Chapter 7

MANAGEMENT OF WATER RESOURCES AND QUALITY

7.1 Water resources

General availability

The territory of Kazakhstan lies in the central and southern latitudes of the moderate climate zone, while the extreme south is adjacent to the subtropical zone (for details see *Features*). This inter-continental position determines the specific hydrography of the region, soil, vegetation cover and fauna. Because of its climate, Kazakhstan's water bodies and systems are of crucial importance for life.

Kazakhstan has one of the smallest available water resources among the States that were part of the former Soviet Union, although the main water bodies of Central Asia, the Caspian Sea and the Aral Sea, are partly situated on its territory. The water stocks are made up of surface water outlets, temporary water flows and groundwaters. They are distributed extremely unevenly and characterized by significant long-term and intra-year dynamics, with an excess of water in the north and northeast, but very limited resources in the south-west and the centre of the country. The average surface water resources per year, taking into account transit waters flowing from neighbouring countries, constitute 100.5 km^3, of which only 56.5 km^3 are formed on Kazakh territory.

River water

Kazakhstan has 7,000 rivers more than 10 km long, 155 rivers more than 100 km long and 7 rivers more than 1,000 km long. There are 2,128 small rivers with average annual flows of less than 10 m^3/s, 40 rivers with flows of 10-50 m^3/s, one river with a flow of 100-200 m^3/s, three with flows of 200-500 m^3/s, and two with flows of more than 500 m^3/s (see Table 7.1).

Kazakhstan's rivers belong to the following basins:

- The Arctic Ocean: Irtysh, Ishim, Tobol
- The Caspian Sea: Ural, Emba
- The Aral Sea: Syr Darya, Sarysu, Shu, Talas
- Lake Balkhash: Ili, Karatal, Lepsy and other Zhetisu rivers
- The Alakol and Sasykol Basins: Rivers of Zhunghar Alatau
- The Chelkar-Tenghiz Basin: Nura, rivers of Irghiz, Turgai and Kurgaldzhin.

The flow of the Irtysh river is regulated by two hydropower stations (Bukhtarma and Shulbinskaya). Part of its flow goes to central Kazakhstan via the Irtysh-Karaganda canal. The Syr Darya river (1,400 km in Kazakhstan) is an important source of water for agricultural production in the south, and its water is almost completely used up during summer. Another very important river is the Ural (1,100 km in Kazakhstan). Rivers such as the Ili, the Karatal, the Lepsy, the Aksu and some others are used for irrigation and water supply. The rivers in northern central Kazakhstan (the Tobol, the Ishim, the Sarysu and the Nura) are typical flatland rivers. They have a very low flow, except during a short period in spring of up to two weeks, and they have almost no flow during the summer.

The total water resources are estimated at around 450 km^3, of which 250 km^3 are made up of freshwater of rivers, lakes and glaciers. The potential use of river water is 100.5 km^3 per year. In the years with average flows (75 per cent of the time) or minimum flows (95 per cent), the potential use is 76 km^3, respectively 58 km^3.

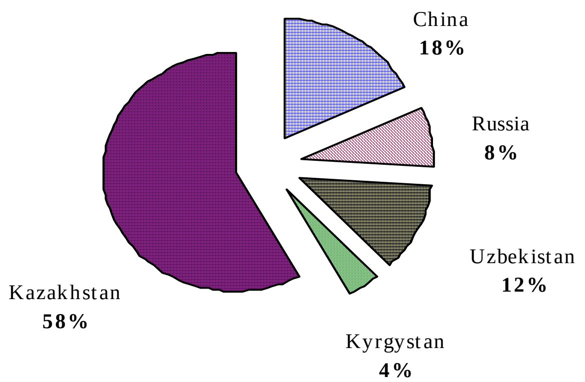
The available volume of water resources for use in the economy is smaller, as losses from evaporation and filtration, transport and power generation, and discharges from reservoirs have to be taken into account, and because these rivers rise abroad. River water availability for abstraction is therefore about 45 km^3 on average, 54.5 km^3 are used for ecological and sanitation needs, 29 km^3 for fish farms and 9 km^3 for power generation.

Table 7.1: Annual water discharge of main rivers in Kazakhstan

Basins and rivers	Length		Catchment area	Annual water discharge	
	Total	In Kazakhstan		Maximum	During 97% of time
	(km)		(km^2)	(m^3/s)	
Artic Ocean					
Irtysh	4,248	1,200	179,000	895	537
Ishym	2,450	1,089	11,800	70	1.68
Tobol	1,591	800	44,800	13.5	0.28
Nura	978	978	50,800	19.2	3.79
Shiderty	502	502	12,100	1.8	0.02
Sileti	407	407	12,500	7	0.56
Kulanuptes	364	364	13,600	1.97	0.01
Tundyk	318	318	9,200	2.14	0.03
Caspian Sea					
Ural	2,428	1,082	231,000	355	75.6
Uil	800	800	25,800	10.8	1.52
Emba	712	712	38,800	15.5	1.24
Bolshoyi Uzen	650	217	10,700	10.8	1
Small Uzen	638	296	3,900	5.2	0.71
Sagyz	511	511	9,900	1.59	0.11
Aral Sea					
Syr Darya	2,137	1,700	219,000	730	398
Shu	1,186	800	39,500	77	50.7
Torgai	872	872	56,500	9.7	0.02
Sarysu	800	800	65,000	7.5	0.05
Talas	661	661	7,900	3.25	2.3
Balkhash-Alakol					
Ili	1,001	815	111,000	470	334
Ayaguz	492	492	8,200	8.84	0.88
Lepsy	417	417	2,200	25.7	15.4
Karatal	390	390	12,800	66.7	37.5
Aksu	316	316	1,300	11.8	7.79

Source: Kazakhstan National Department of Hydrometeorology, "Report on the Pollution of Environment in Almaty City", 1990.

Figure 7.1: Dependence of Kazakh water resources on neighboring countries



Source: Kazakhstan National Department of Hydrometeorology, "Report on the Pollution of Environment in Almaty City", 1990.

Due to climatic features, about 90 per cent of surface water outflow takes place during spring. In a normal year the water deficit amounts to approximately 6.6 km^3. In dry years, water supply is covered by approximately 60 per cent (Figure 7.1), in a special region like central Kazakhstan to only 5-10 per cent, and in this situation, the deficit is mainly at the expense of irrigated agriculture.

Artificial reservoirs

A total of 180 water reservoirs were constructed on rivers, mainly for irrigation purposes, with an overall capacity of about 50 million m^3 (assessed at normal water level). The biggest for irrigation use alone are the Tashutkulsky reservoir on the Chu river and the Bortogaisky on the Chilik river. The biggest reservoirs of multiple use are: the Bukhtarminskoe and Shulbinskoe reservoirs on the Irtysh river, the Kapchagaiskoye on the Ili river, and the Chardarinskoye and Toktagul reservoirs on the Syr Darya river.

The plans for water mains and district channels have been approved. In the Kizilirad area, there are 286,000 ha of irrigated land of which 215,000 ha of rangeland. 2,575 km of channels, 560 big hydrotechnical works, 2 hydrotechnical knots, the Aiteisk weir and the Karaozek water intake have been built on irrigated land. The Aiteisk weir dam was built on the main stream of the Syr-Darya river to reduce floods, and to provide irrigation water for lands with a water deficit. This construction diverted 50 m^3/s of water from the Aitesk channel and provided irrigation water for about 16,600 ha of land cultivated with rice, alfalfa, wheat and other crops in 1990.

In order to regulate the lake system of the Syr Darya river delta, 2 regulating locks were built 20 years ago, Amanotkel and Aklok, with a capacity of 150 and 60 m^3/s, respectively. The Amanotkel works supply lakes Kanislobask, Laikol, Raim and Karakol. The Aklak works provide water for Tushibas, Akbastu and other lakes. It limits the supply to the Aral Sea. For this reason, when the river discharge exceeds 60 m^3/s, the barrier towards the old river bed is opened and water flows through it. The river bed has deepened by about 10 m, due to erosion.

In 1997, total dam capacity (not only for hydropower) was 88,750 million m^3, and total harnessed hydropower capacity around 3 GWh, in comparison with the economically feasible hydropower potential of 35,000 GWh/year.

Glaciers

In the mountains of Kazakhstan, there are 200,724 glaciers, covering a total area of 1,963 km^2. Most of the individual glaciers cover up to 1 km^2. The largest glaciers of an area of about 10 km^2 or more are the Korzhenevsky, the Bogatyr in Zaili Alatau, the Kolesnik, the Berge and the Nekrasov in Jungar Alatau, the Great Bukhtarmy Glacier in South Altai, etc.

Lakes

Kazakhstan has about 48,262 lakes with a total volume of 190 km^3 and a total area of 45,000 km^2. The largest are the lakes Balkhash (area of 106-112 km3, and depth of 5-6 m), Alakol, Tenghiz, Markakol and Borovoye.

The Republic's lakes are generally shrinking, which is explained by over-regulation of river outlets and by natural fluctuations in their water level. Many of them are an important source of municipal water supply, especially in northern Kazakhstan. Lakes are used for fish farming, medical and recreation purposes and serve as animal habitat and for bird nesting. Most are small lakes fed from snow. During the summer, small lakes often dry out.

The steppe lakes of central and northern Kazakhstan, including the Tenghiz, Kurgaldzin, Aksuat, Selety, Chany, Stanovoye, and Shagly-Teniz, are the habitat of hundreds of bird species, many of which are listed in the International and the Republic’s Red Data Books. In 1975, the Tenghiz-Kuldzhi lake system was included in the Ramsar List. Currently, documents are being drafted jointly with the German Union of Nature Protection to organize the Tenghiz-Kurgaldzhi biosphere reserve as an example of a stable eco-socio-economic development region.

Groundwater

The operational reserves of groundwater resources are estimated at 61 km^3, including about 40 km^3 of freshwater. The water volume with mineralization below 1.0 mg/l is estimated at 10.5 km^3. The largest reserves are found in the mountainous regions of the northeast, the east and the south. The smallest reserves are in the northern and central regions, and the zones of the Caspian and Aral Seas. Groundwater is used, especially in desert territories, for water supply (about 2.2 km^3) and for irrigation (about 0.35 km^3).

7.2 Water quality

Ambient water quality

Most surface-water-quality standards are included in SNIP 2.1.4.559-96, Moscow 1996, which is applied in Kazakhstan. SNIP (Basic Standards, Norms and Regulations) was originally established during the period of the former USSR. It covers economic activities, in addition to environmental issues such as water, air, soil, flora and fauna. In addition to SNIP, the GOST standards are also used. Table 7.2 reproduces the water-quality classes of SNIP 2.1.4.559-96.

Table 7.2: Water Pollution Index

Code	Water category	Range of Water Pollution Index (WPI)
I	Very clean	WPI< = 0.3
II	Clean	0.3<WPI< = 1
III	Moderately Polluted	1.0<WPI< = 2.5
IV	Polluted	2.5<WPI< = 4.0
V	Dirty	4.0<WPI< = 6.0
VI	Very Dirty	6.0<WPI< = 10
VII	Extremely Dirty	WPI > 10

Source: Kazakhstan National Department of Hydrometeorology, “Report on the Pollution of Environment in Almaty City”, 1990.

An overall water pollution index is calculated. It is defined on the basis of the ratios of measured values and the maximum permitted concentration (MPC) of the water-quality parameters. Maximum permitted concentrations are shown in Table 7.3. There are also norms concerning the content of harmful chemicals reaching water-supply sources, which are shown in Table 7.4. The favourable organoleptic properties of water, conditioned by its conformity with the respective norms, are listed in Table 7.5. There are also norms for α and β activity.

Water quality by basin

The measurement of surface water pollution is based on self-monitoring by the water users, as well as samples occasionally taken by Kazhydromet (see also Chapter 1 on current problems with monitoring). Surface water pollution, in 1999, was monitored in the following river basins: the Ural (Atiran region), the Ishim (north), the Talas, the Shu and the Assa (Jambil region), the Syr-Darya (and its tributaries). The data regarding the quality of water resources before 1990 are stored in Moscow and not available in Kazakhstan.

The characteristics of water pollution depend on the economic activity within a region. The most important economic sectors are the mining industry, extensive cattle breeding and agriculture. They were developed with no particular regard to environmental protection measures or to environmental restoration possibilities. Military bases, the Baikonur cosmodrome and weapon testing sites, including for nuclear weapons, occupied vast territories. The consequences for the water environment include pollution with heavy metals, pesticides, radioactive materials, rocket fuel and other toxins. The quality of the main rivers in Kazakhstan is shown in Table 7.6.

The most ecologically hazardous industries are the lead-zinc industry in Ust-Kamenogorsk, the lead-phosphate industry in Shymkent, the phosphorus industry in Taraz, the chromium enterprises of Aktyubinsk and the oil and gas industries of west Kazakhstan. In spite of decreases in pollution levels in the late 1980s, the quality of the country’s water has remained poor. In 1990, water quality tests revealed that 14 per cent of samples did not meet public health norms for chemical content.

The Caspian Sea and the Aral Sea suffer from serious environmental problems (see Chapter 8). Other surface waters are also polluted with oil products, phenols, heavy metals and nitrites. In general, the major water pollutants are generated by ionizing waste (over 28,000 tonnes generated in 1994, 23,000 tonnes in 1995), nitric organic compounds (around 1,800 tonnes), phosphor compounds (over 1,300 tonnes in 1994 and 800,000 tonnes in 1995), and zinc (42,600 and 24,900 tonnes, respectively). Practically all chemicals enter the water through industrial sewage from light, food, chemical, machine-building, oil-processing and non-ferrous metallurgy industries.

Over-regulation of big rivers, such as the Irtysh, the Ili, and the Syr-Darya, has had a negative impact on the ecology of their lower reaches. The most unsound ecologically is the Irtysh river basin. Its water is highly contaminated by mercury from a caustic soda plant, kerosene from contaminated groundwaters, heavy metals, such as copper (average MPC of 3.4 during 1990-1994), zinc (up to 1 MPC), cadmium, lead, arsenic, which penetrate into Irtysh water through industrial sewage, and oil

Table 7.4: Standards for harmful chemicals in industrial effluents

	Unit of measure	MSc	Index of hazard	Class of danger
pH value	pH units	Within 6-9		
Total mineralization (dry residue)	mg/l	1000 (1500)		
Total hardness	nmol/l	7.0 (10)		
Permanganate oxidizabiity	mg/l	5		
Oil products, total	mg/l	0.1		
Surfactants, anion-active	mg/l	0.5		
Phenol index	mg/l	0.25		
Inorganic substances				
Aluminum (Al3+)	mg/l	0.5	Low toxic	2
Barium (Ba2+)	mg/l	0.1	"	2
Berillium (Be2+)	mg/l	0.0002	"	1
Boron (B,total)	mg/l	0.5	"	2
Iron (Fe, total)	mg/l	0.3(1.0) org.	"	3
Cadmium (Cd, total)	mg/l	0.001	"	2
Manganese (Mn, total)	mg/l	0.1(0.5)	Org.	3
Copper (Cu, total)	mg/l	1	Org.	3
Molybdenum (Mo, total)	mg/l	0.25	Low toxic	2
Arsenic (As, total)	mg/l	0.05	Low toxic	2
Nickel (Ni, total)	mg/l	0.1	Low toxic	3
Nitrates (for NO_3)	mg/l	45	Org.	3
Mercury (Hg, total)	mg/l	0.0005	Low toxic	1
Lead (Pb, total)	mg/l	0.03	"	2
Selenium (Se, total)	mg/l	0.01	"	2
Strontium (Sr2+)	mg/l	7	"	2
Sulfates (SO42-)	mg/l	500	Org.	4
Fluorides (F) for climatic area I and I	mg/l	1.5	Low toxic	2
Fluorides (F) for climatic area III	mg/l	1.2	"	2
Chlorides (Cl-)	mg/l	350	Org.	4
Chromium (Cr6+)	mg/l	0.05	Low toxic	3
Cyanides (CN-)	mg/l	0.035	"	2
Zinc (Zn2+)	mg/l	5	Org.	3
inainte de ultimul gama, sci)(lindane)	mg/l	0.002	Low toxic	1
DT (sum of isomers)	mg/l	0.002	Low toxic	2
2,4- D	mg/l	0.03	Low toxic	2
Chlorine -residual free		Within 0.3-0.5	Org.	3
-residual fixed		Within 0.8-1.2	"	3
Chloroform (with chlorination of water)		0.2	Low toxic	2
Residual ozone		0.2	Org.	

Table 7.3: Surface water pollution criteria

	Maximum allowable value	High level of pollution
Dissolved Oxygen (DO)	6.0 mg O_2/l	3.0 mg O_2/l
BOD_5	3.0 mg/l	15.0 mg/l
Phenol	0 mg/l	0.03 mg/l
Petroleum products	0.05 mg/l	1.5 mg/l
Nitrate ions	9.0 mg/l	10 PDK
Nitrite ions	0.02 mg/l	10 PDK
Ammonium saline	0.39 mg/l	10 PDK
Fluoride	0.75 mg/l	10 PDK
Copper (Cu)	0 mg/l	0.03 mg/l
Zinc (Zn)	0.0 mg/l	11 PDK

Sources: Kazakhstan National Department of Hydrometeorology, “Report on the Pollution of Environment in Almaty City”, 1990.

Table 7.5: Water standards of organoleptic properties

Parameters	Unit of measure	Maximum
Odor	points	2
Flavor	"	2
Chromaticity	degrees	20(35)
Turbidity	EMF* or mg/l for kaolin	1.5(2)

Source: Kazakhstan National Department of Hydrometeorology, “Report on the Pollution of Environment in Almaty City”, 1990.

* Formazine turbidity unit.

Table 7.6: Water quality index for the main rivers, 1994-1996

Rivers	Main pollutants	1994	1995	1996
Ural	Phenols, oil products,heavy metals	2.6	7.2	11.5
Irtysh	Heavy metals, oil products	8.1	6.6	6.0
Sarysu	Phenols, oil products,heavy metals	3.8	3.6	5.4
Nura	Oil products,nitrogen ammonia,nitrates ions	2.9	2.1	2.8
Ili	Nitrats ions, BOD, oil products,fluorides	1.7	1.3	1.4
Syr Darya	BOD, nitrites ion, Cu, sulphates,oil products	0.8	1.6	1.7
Ishim	BOD, nitrites ion, sulphates, tensio-activ sub.	1.6	1.2	0.8

Source: Kazakhstan National Department of Hydrometeorology, “Report on the Pollution of Environment in Almaty City”, 1990.

products (5.0 MPC) flowing into Kazakhstan with the Black Irtysh.

The Ili-Balkhash river is heavily polluted by non-ferrous metallurgy and agriculture. Substantive prevention measures have been taken in the basins of the Ili and the Balkhash. The main water polluters are industrial, mining and refinery enterprises, animal farms and irrigated farming. Of the nearly 1,200 major industrial plants in the country, less than half have functioning pretreatment facilities. Municipal waste-water treatment facilities are frequently overloaded or out of order. Yearly more than 200 million m^3 of polluted waste water is discharged into surface water.

Several big cities located in the Aral Sea basin (Shymkent, Kyzylorda, Turkestan, Aralsk, Kazalinsk, Arys, Taraz and many others) both draw water from and discharge municipal waste directly into rivers, sometimes without any treatment. The situation is complicated by the fact that the Syr Darya River is already highly polluted with pesticides when it arrives in Kazakhstan and cannot be used for domestic purposes without special treatment.

The over-exploitation of the Ili River contributed to an increase in the salinity of water in the west of the country, putting the water supply of the city of Balkhash in jeopardy. Also, the Balkhash copper smelter heavily pollutes lake Balkhash with heavy metals and sulphites.

The Nura-Sarysu basin water resources are completely depleted, and the Nura River is extremely polluted with mercury (the river has some 50 tonnes of mercury in its sediments) below Temirtau, preventing use of the Nura-Ishim canal for the water supply of the new capital, Astana. In general, the water resources are very polluted by industries and mines, and the degradation of technology and of waste-water treatment plants put the population and ecosystems at risk. An additional problem is that the development of the surface water resources in that area requires international cooperation, precise evaluation and forecast of the water needs, if problems with the neighbouring countries are to be avoided.

Groundwater pollution with oil, heavy metals, fluorine, pesticides, radioactive contamination and other toxic substances is widespread, and therefore drinking-water quality does not meet standards in most of the populated areas. In large areas, the abstraction of groundwater has caused surface depression.

Over the past 30 years, extensive irrigation works mainly for cotton crops in Uzbekistan and Turkmenistan, with excessive use of fertilizers and pesticides, have caused the pollution of groundwater, a reduction in agricultural yield, and extensive salination of the whole area. The most adversely affected regions in Kazakhstan are the Aralsk and the Kazalinsk *rayons* in the Kyzylorda *oblast*. There are local problems regarding the pollution of groundwaters. In the Semipalatinsk area, the accumulation of oil in the soil of the military airport (6,460 tonnes in an area of about 42 ha) affects the Irtysh river. In the Pavlodarsk area, waste waters are polluted with mercury (900 tonnes on 50 ha).

The quality of drinking water is described in Chapter 14.

7.3 Water use

Abstraction and major use categories

The total volume of water available for use is about 49.7 km^3. The future development of groundwater resources may increase this amount to 61.5 km^3. Surface freshwater is primarily abstracted from the Syr Darya (31 per cent), the Irtysh (14.7 per cent), the Ili (12.9 per cent), the Schu (8 per cent), the Nura (4.1 per cent), and Lake Balkash (0.7 per cent).

Four river basins (with eight River Basin Management Offices reporting to the Water Resource Committee) provide water totalling 32.5 billion m^3 per year, including 27.5 from surface waters, to consumers in Kazakhstan. The remaining water needed is taken from underground sources, the Caspian Sea (for industrial use), or recycled from waste-water treatment. Industries use up to 5.0 billion m^3 per year. The largest water-using sectors are electricity generation, the ferrous and non-ferrous metal industries, and oil production and exploration. These industries are also the biggest water polluters. About 2-3 per cent per year of the total amount of water used becomes irreversibly polluted by industry and is kept in special reservoirs to avoid reuse.

Oil exploration and production is the dominant industry in the Ural-Caspian River Basin (Caspian Sea Basin). The main consumers of oil are the municipalities of Atyrau, Aktubinsk, Uralsk and the industries of their *oblasts*. The most difficult problem in the area is the water supply of the capital of Mangystau *oblast*, the city of Aqtau. The nuclear power plant was used for sea-water desalinization until 1990, but desalinization has been discontinued for economic reasons.

In the Balkhash-Alakol River basin (Balkhash Lake Basin), the main water users are the big municipalities of Almaty, Taldy-Kurgan and several others. The water is used primarily for agriculture and for domestic use. The Ili River, an affluent of Lake Balkhash, originates in China and is very much used for irrigation (cultivation of rice, watermelons and onions). As a result, it does not reach Lake Balkhash. The unique characteristic of this lake is that its western part contains freshwater, while the water in the eastern part is salty.

In the Nura-Sarysu, Tobol-Torgai, Ishim and Irtysh River Basins (Arctic Ocean Basin, except Sa-su River, which belongs to the Aral Sea Basin), the main water users are in industry. The Syr Darya and Shy-Talas River Basins (Aral Sea Basin) provide water primarily to agricultural enterprises. Several big cities are also located in the Aral Sea basin, i.e. Shymkent, Kyzylorda, Turkestan, Aralsk, Kazalinsk, Arys, Taraz and others.

Agriculture uses about 75 per cent of all the water in Kazakhstan. Irrigation technologies are very water-intensive, and half of the used water filters into the ground, causing waterlogging and salinization. It is estimated that some 60 per cent of

Kazakhstan is affected by desertification (see Chapter 12). Water is particularly required for the cultivation of cotton (Syr Darya, Shu, Talas), rice (Syr Darya, Ili), cereals (Irtysh, Tobol), potatoes (Tobol, Ishim) and fodder. Water use in agriculture is not subject to any water-saving scheme (be it economic or administrative), so there is considerable wastage. Also, land reform and the privatization of the State and collective farms did not give rise to the development of a special programme for water use for irrigation by small farmers.

The availability of water differs between *oblasts*. The regions Aktynbinsk, Jeskajgans, Koksytau and Semipalatinsk are in the group of regions with few resources. Starting in 1994, there was a decrease in the volume of water used in the main economic sectors, irrigation and households. The volume used for make-up water in closed circuits has also decreased.

Drinking water

Kazakhstan is divided into 14 administrative regions and 158 administrative districts. It has 84 cities, 198 urban settlements, 2,456 rural districts, and 7,071 rural settlements. In many areas, less than 50 per cent of the water needed by the population is available. The situation is extremely difficult in the Aral Sea area.

In 1997, 93 per cent of the urban population was connected to a piped water supply, and 26 per cent of the rural population enjoyed a piped water-supply system. The percentage of the urban and rural population that has a safe water supply for more than 300 days a year is unknown. Most of the water – up to 90 per cent – is available in spring, making groundwater of great importance for Kazakhstan. Groundwaters meet 56 per cent of the population's needs, and about 45-55 per cent of the industrial needs. The water needs of many southern cities are satisfied by mixing groundwater of good quality (without treatment) with water from artesian wells and mountain rivers and lakes in water-mixing units.

Municipal water use stands at 1.3 billion m^3 per year. Water networks are developed in 82 towns with a population above 50,000, and in 186 small townships. The officially calculated average national water use is 220 litres per capita a day. However, the large quantities of water lost in distribution are not included in this figure.

The water supply for the Aralsk and the Kazalinsk *rayons* in the Kyzylorda *oblast* depends on the Syr Darya and its system of irrigation canals, artesian groundwater bores and highly saline shallow wells. The majority of the villages in these two districts had big waterworks installed in the late eighties or early nineties, with water-treatment plants, including desalinization equipment, reservoirs, water towers, generators, etc. Some of the villages were supposed to be served by the Aralsk-Sarybulak Water Supply (ASWS) system. Construction of the well field in Kosoman and Berdykol and the pipeline system started in 1977. Some of the villages are actually connected to the system, but only very few are getting their water from it, as the cost is too high (60 tenge or 80 tenge per m^3), the system is very big, it is difficult to operate and to maintain, and there are many leaks in distribution.

Water use from decentralized, open sources (including irrigation channels) for drinking-water purposes has increased. For example, in the Akmola *oblast* in 1998, the population using water from open sources doubled. In 1999, 26.4 per cent (23.5 per cent in 1998) of water samples from the piped networks did not meet sanitary-hygiene requirements, for lack of sanitary protection areas or of facilities for disinfection and neutralization.

7.4 Water policies and management responsibilities

Legal provisions

The Law on Environmental Protection is the principal regulatory instrument for managing water resources. The Water Code, adopted on 31 March 1993, regulates water management in detail, provides the framework for the regulation of domestic, industrial and agricultural water use, and ensures the respect of environmental requirements. It allows the creation of water associations for irrigation at farm level, and privatization of the district water organizations. The irrigation infrastructure (on-farm network, inter-farm secondary network, and equipment/machinery) may also be privatized.

The Water Code’s water protection provisions against pollution, littering and depletion do not cover the standardization of water quality and the maximum admissible discharges of harmful substances into water, specific features of the legal protection of seas from pollution, or the oil contamination of water bodies. Only sanitary rules and standards of coastal sea water protection from pollution at places of water use by the population were approved in 1988 by the USSR Ministry of Health, and are being applied.

Kazakhstan adopted a new Law on subsoil and mineral exploitation on 27 January 1996 by Presidential Decree No. 2828. This Law retains the basic licensing and contracting regime for granting subsoil use rights from the old law. Thus, the Law provides for State ownership of the subsoil, including groundwaters. However, the rights for the exploration, development and extraction of minerals and groundwater may be licensed by the Government, and a contract concluded with a private enterprise.

Drinking-water quality is regulated by the GOST Drinking Water Hygiene Requirements and Quality Control, GOST 2874 –82 (introduced 01.01.85) and SNIP 2.1.4.559-96-Drinking Water and Water Supply for Localities, Hygiene Requirements for the Quality of Centralized Water Supply, Quality Control. The epidemic safety of drinking water is assessed for its conformity with microbiological standards (GOST 2874-82) listed in Tables 7.2 and 7.3.

Policies and priorities

The Strategic Plan up to 2030 for the environment and natural resources reflects water policy objectives. On this basis, the National Environmental Action Plan for Sustainable Development (NEAP/SD) includes the following priority measures for water policies and management:

- The rehabilitation of the water conservation zone of the Syr Darya river
- The development and implementation of inter-State measures to preserve transboundary watercourses ecosystems
- The study of methods and approval of action aimed at reducing the negative impact of highly toxic mercury pollution of ground sediments of the Nura river (in the Karaganda *oblast*) and groundwater (in the city of Pavlodar)
- The improvement of water resource management in the Balkhash-Alakol river basin (pilot project)
- Reducing drinking-water consumption and losses in the municipal sector (a pilot project for Almaty as a case study)
- The construction and rehabilitation of sewage treatment facilities in Kyzylorda and Shymkent (pilot projects)
- The prevention of pollution of water sources by mining and industrial waste in the northern in the East Kazakhstan *oblast*
- The prevention of leaching of oil products into groundwater
- The building and reconstruction of municipal waste-water treatment facilities
- Water resources conservation

For details, see Chapter 1. The Ministry of Agriculture has developed a strategy regarding water for irrigation, but it was not available during the EPR review mission.

Transboundary water issues

Following the independence of the Central Asian republics in 1991, the management of water resources became an international task to be undertaken jointly by the countries concerned. The management tasks include the sharing of water resources, the related water-quality management, and the management of water storage and control. Additionally, common tasks relate to the measurement of rainfall, river flows and water quality – all quite well developed in the Soviet period. Since independence, the respective monitoring systems have deteriorated, and modern methods for the electronic transmission and storage of data are not yet in place. Finally, remedial measures for the Aral Sea and wetlands ought to be agreed. The practical measures in these respects are strongly linked to the management of the Aral Sea problem and are reviewed in Chapter 8.

Institutional responsibilities

The Ministry of Natural Resources and Environmental Protection approves discharge limits, grants and revokes permits and licences for discharges of pollutants to water bodies, and grants and cancels permits for special-purpose water use. Among the ministerial bodies managing natural resources, or supervising specific aspects of water management, are the Committee for Water Resources and the Committee for Geology and Underground Resources Protection. In addition to the MNREP, the Ministry of Health, the State Committee on Emergency Situations, the Agency for Control of Strategic Resources and the Ministry of Agriculture also have water management tasks.

The Committee for Water Resources is responsible for maintaining and operating the existing inter-farm system for the delivery of irrigation and rural drinking water through regional and district water resources committees. It is responsible for inter-sectoral and inter-regional water allocation, and for defining national polices on water quality and the protection of water resources. It administers international river systems with respect to water sharing. It supervises the eight national River Basin Water Directorates (GoskomVodResurs), which are the Aral-Syr Darya, Balkhash-Alakol, Irtysh, Ishim, Nura-Sarysu, Tobol-Turgay, Ural-Caspian and Chu-Talas.

The Committee on Water Resources regulates the use of surface water resources, avoiding overuse and contamination. It implements the scientific and technical policies needed for the continuing use and protection of water, and protects the interests of the country in inter-State distribution of water resources. The Committee is in contact with other water management partners, including water users. The Committee on Geology and Underground Resources Protection has analogous responsibilities for groundwater.

The Ministry of Agriculture is in charge of agricultural research and extension, and on-farm agricultural and land reclamation development. It is also responsible for the monitoring of drainage, waterlogging and soil salinity conditions in the major irrigation projects in the five southern provinces. After the dissolution of the Ministry of Municipal Services in 1993, the Ministry of Municipal Affairs supervises domestic water supply and waste-water treatment, while the management of the main water supply network at provincial and inter-provincial levels falls under the authority of the Committee for Water Resources. In addition to water users, Kazhydromet is responsible for water monitoring.

Local bodies are involved in the implementation of the NEAP/SD. Permitting, monitoring and control of compliance with the conditions of nature use, as well as enforcement measures, are mainly applied at local level.

7.5 Drinking-water and waste-water treatment

Treatment of drinking water

From an institutional point of view, municipal companies ('vodokanal'), where they exist, are charged with drinking-water supply as well as sewerage and waste-water treatment. The conditions under which these companies operate vary considerably from city to city.

Almaty. The municipal company supplies about 1 million m^3 of drinking water daily to the 1.2 million people in the city and surrounding settlements. The present supply system in the municipal area extends over 300 km. The pipes are of steel and approximately 25 years old, except main pipes (about 30 years old). Loss within the pipe system varies between 34 per cent and 80 per cent. In the course of a pilot project, 200,000 water meters have been installed in 98 per cent of houses and in 30 per cent of flats. Since then, water use has gone down. It is now quoted as being at approximately 280 litres per inhabitant daily, but calculations based on the volume of waste-water treated would indicate considerably higher water use. The price per cubic metre of water is between 9 and 10 tenge. Unmetered water use is charged on the basis of flat size and number of occupants registered in the flat. Industry pays nearly all its water use bills, and up to two thirds of households pay theirs.

About 75 per cent of the water supply is abstracted from groundwater sources (well depth between 15 m and 500 m). Groundwater is chlorinated in 74 treatment stations before being fed into the distribution network. The remaining water comes from rivers and is processed in two waterworks, equipped for self-monitoring and sample analysis. The treatment of water includes coagulation, sedimentation, flocculation, filtration and chlorination.

Kokshetau. The majority of the population in the settlement area is centrally supplied, in some parts a piped supply outside the building is available (at a distance of 200 m in the town), and settlements of the town of Kokshetau are supplied by tanker. Some 140,000 people are supplied in these ways, at a rate of around 170 litres per person per day. Water losses due to burst pipes (an average number of 37 a month) officially stand at 30 per cent. Most supplied people pay flat rates, but enterprises and some houses are metered. The fee, including the supply price and waste-water treatment, amounts to 33 tenge/m^3.

Groundwater is the source of about 30 per cent of the supply. This part is used without treatment. The remaining water is drawn and produced from a reservoir by a water plant, in which treatment has similar characteristics to those described for abstracted surface water in Almaty. However, its laboratory equipment appears to be less developed.

Atyrau. The water supply is shared between the public petroleum company (KazTransOil) with distribution being in the hands of the local ‘vodokanal’ company. Water production amounts to around 60,000 m^3 daily, abstracted from rivers flowing down from the Ural mountains close by. Groundwater cannot be used, as it is too saline. The treatment of raw water for use in Atyrau includes coagulation, sedimentation, filtration and chlorination. Biological and some chemical parameters are being tested in the company’s laboratory. Water quality in the network is monitored by ‘vodokanal’. The distribution pipes in Atyrau are of high-grade steel, showing, however, signs of corrosion. KazTransOil not only supplies water to the city of Atyrau and the surrounding villages, but by pipeline and untreated, over a distance of about 1,000 km, it also supplies oil fields, as well as the city of Aqtau. The steel pipeline has serious leaks.

Atyrau has around 110,000 registered inhabitants, but estimates are that a further 85,000 unregistered people are also supplied with water. The drinking-water pipes in the city total some 200 km, and have large leaks, producing losses in distribution of up to 60 per cent. Present water consumption is calculated at 270 l/person/day, and the plan is to reduce it to 160 l/person/day. It is assumed that people in wooden houses without central supply require 40 l/person/day. There are few meters. Water costs roughly 14 tenge/m^3 and about 40 to 50 per cent of the consumers supplied actually pay for it. Investments in the water-supply system are being prepared.

Waste-water treatment

Waste waters from industry, agriculture and households represent about 9 km^3, of which 2 km^3 are discharged directly into rivers. The remaining quantity is discharged into specially prepared lakes, so that part of the abstracted water will not return to its source. The quantity of pollutants discharged into surface waters through waste waters is shown in Table 7.7.

Almaty. About 80 per cent of the 1.2 million inhabitants of Almaty and the surrounding settlements are connected to municipal sewerage. Separate collectors exist, but only waste water is collected in sewage collectors, while storm water is discharged to surface waters directly. A few industrial enterprises have their own waste-water treatment installations, however, they also discharge into public sewerage, as only the municipal company is entitled to discharge into surface waters. Steel collectors along all streets collect sewage from households, and commercial and industrial enterprises. The pipes lead to the waste-water treatment plant, located 45 km outside the city. The treated waste water is discharged to a lake, another 45 km away from the treatment plant. From the lake, a 52 km long canal leads to the Jri river. Discharge to the river is controlled in such a way that river water pollution does not exceed standards. As a rule, discharge is only possible during summer. In 1999, a discharge of 13 million m^3 of treated waste water was authorized. This corresponds to waste-water generation of about 30 days. The water in the above-mentioned lake is used for irrigation. The sludge from waste-water treatment is pumped to a large surface 10 km away from the treatment plant, where it is dried and then deposited.

Table 7.7: Discharges of pollutants into surface waters, 1995-96

	Units	1995	1996
Suspended solids	*10^3 tonnes*	159.83	205.00
Nitrogen ammonia	*10^3 tonnes*	3.46	1.64
Nitrate ions	*10^3 tonnes*	1.91	2.03
Organic compounds	*10^3 tonnes*	12.84	6.26
Oil products	*10^3 tonnes*	0.44	0.24
Phenols	*tonne*	0.57	0.58
Tensio-active subst.	*tonne*	84.01	46.27
Total phosphorus	*tonne*	51.39	35.77
Iron compounds	*tonne*	204.63	147.49
Copper	*tonne*	7.12	9.46
Zinc	*tonne*	24.89	18.65
Nickel	*tonne*	0.05	0.05
Mercury	*kg*	35.70	25.10

Source: Kazakhstan National Department of Hydrometeorology, “Report on the Pollution of Environment in Almaty City”, 1990.

The treatment plant was first built in 1974. It contains mechanical and biological treatment technology, which are separated by pipes over a distance of several hundred metres. The daily inflow of waste water totals 400,000 m^3 and contains 48 to 72 tonnes of BOD_5 (i.e. 120-180 l/day). The plant treatment efficiency is reported to be 88.5 per cent. The long distances over which collected sewage is transported between point of generation and treatment leads to chemical reactions inside the pipes, which create nuisances and complicate treatment. Furthermore, pumping is required prior to the treatment plant, inside the treatment plant and for the sewage sludge, making the system energy-intensive.

Kokshetau. The sewers in the city area of Kokshetau are similar to the installations in Almaty. Separate systems exist as in Almaty. They transport waste water to a treatment plant 7 km out of town, from which the treated waste waters are led to a first lake 17 km away, then to a second lake. The inflow is regulated through maximum allowable limits for selected parameters (BOD_5 of 20mg/l, oils and fats 0.05mg/l, phosphorus 15mg/l, nitrogen 20mg/l). The limits for phosphorus and nitrogen are often exceeded, leading to fines payable to the environmental protection fund. The charge for normal effluents is around 14,000 tenge per tonne of polluting substance. Information on how many users are connected to sewerage was not available during the EPR review mission.

The treatment plant was built for a capacity of 32,000 m^3/day, and it handles currently 23,000 m^3/day. The inflow carries around 150 mg/l of BOD_5 and has a COD concentration of around 300 mg/l. The efficiency of the station's mechanical and biological treatment reaches 83 per cent. The sludge obtained in waste-water treatment is stabilized in a digester tank before its use in agriculture. It is not clear whether the gas generated in the tank is used or can be used for reducing the plant's high energy requirements.

Atyrau. Sewerage is limited to municipal and industrial waste water. The Ural divides the city. The waste water from one side is transported to a mechanical treatment plant, from where it flows to a lake 4.5 km away. The waste water collected in the other part of the city (including several industrial sites) remains untreated and is transported to another lake.

The treatment plant was built for a capacity of 31,000 m^3 per day, but currently treats only 13,000 m^3/day. Its treatment efficiency varies between 30 and 60 per cent, depending on the characteristics of the effluents. The plant is in bad overall condition and requires refurbishing and extension. The sludge generated in the process remains in the grounds of the treatment plant. Special problems have occurred because of the rising water table during recent decades (Atyrau is located on the Caspian Sea, see Chapter 8) and the substantial leakage from pipes.

7.6 Conclusions and recommendations

Kazakhstan has strengthened its water management efforts in recent years and is continuing to do so. The Government outlined its priorities for water management in the strategic action plan. Much attention is given to the reformulation and extension of the legislative and regulatory framework, e.g. charges for water use and the coordination of State monitoring. Furthermore, problem-oriented programmes and projects for their implementation are being developed (e.g. plans for the improvement of the drinking-water supply). However, despite all the regulations and programmes, few measures have been taken so far to reach the water management objectives.

As for the further development of an adequate legal framework for water management, the Water Code no longer corresponds to the real social and economic situation in the country. In particular, it does not include the necessary legal basis for ensuring that water is protected from pollution, littering, and depletion, and that water for economic and other needs is used rationally. Water wastage by households and industry is high, also because there are no incentives to save water. The Water Code developed economic instruments and governmental management mechanisms insufficiently, and standards allowing water use for business activities are not covered. Furthermore, legal acts dealing with sea pollution need to be revised. There is an urgent need for the regulation of oil pollution of water. The corresponding legal instruments will have to comply with the international conventions that Kazakhstan has signed.

Recommendation 7.1:
The Water Code should be revised as soon as possible. The revised law should focus on the efficiency of water use and the reduction of water pollution. It should cover ambient water quality as well as waste-water discharge and effluent standards and should identify necessary regulatory and economic instruments which are likely to reach the objectives specified in the law. *See Recommendations 1.1 and 14.1.*

The development of an adequate legal and political framework for water management has to be complemented by sufficient organizational measures. Improving the management of water resources requires further implementation of the river basin approach. National action plans have already been developed for some rivers. Further institutional changes might be required to design an effective integration of land-use planning with water management and conservation for the country as a whole. Such integration should coordinate activities at all levels and include the development and management of contingency plans for accidental spills and the response to natural disasters.

The authority of the local bodies and basin authorities and their responsibilities in the organization and implementation of environmental measures should be expanded, possibly with the help of legal instruments that promote the participation of all relevant stakeholders. The newly established associations of agricultural water users are still too weak to manage the system and prevent overuse of water resources. The joint solution of environmental problems at all levels between national and local authorities would improve links and cooperation between national and local administrations. In Kazakhstan, the majority of nature protection expenditures by the public sector are made by local sources. Yet, the decentralization of responsibilities is rarely matched by sufficient resources. The result is an excessive fragmentation of capacities, resources and responsibilities.

Recommendation 7.2:
Institutional frameworks should be envisaged that bring together water utilities, non-governmental organizations, the private sector, and community groups to exchange views, contribute skills and prepare decisions on water-supply and sanitation projects. The responsibility for standard-setting should be streamlined in order to avoid differences in water management as undertaken by the various participating institutions.. Institutional changes should favour the preparation of basin action plans, particularly for high-risk basins, including their rivers, lakes and groundwaters.

The most important water management tasks in Kazakhstan are to ensure a safe water supply, suitable water quality in rivers and groundwater, and waste-water treatment facilities throughout the country. Immediate action is required to solve acute problems that endanger the safety of the drinking-water supply. It seems that supply systems are not functioning properly because of a lack of maintenance. This results in water losses during distribution, and direct exposure to pollution. It is therefore necessary to evaluate the situation in each region, identifying major accidents and problems that occur or have occurred in both public and "unorganized" water-supply systems. The criteria that need to be used in this analysis are the quality of the water, the sensitivity to environmental pollution and water losses in the networks.

As groundwater is growing in importance as source of drinking-water supply, the gradual decrease in its quality is likely to become a serious concern if adequate measures are postponed for too long. Priorities and action plans should begin to concentrate on preserving groundwater resources for drinking water. Due to the increasing degradation of the currently exploited aquifers, it is important that deeper aquifers are sought, and protected and managed appropriately. The implementation of mapping programmes for the identification of aquifer recharge areas, the establishment of national inventories of known groundwater resources and the characterization of aquifers and the determination of their response to groundwater development activities could respond to the requirements. Such aquifer information would allow water managers to identify recharge and abstractions areas as well as interactions between surface waters and aquifers, and to establish adequate control of the types of activities taking place in these areas.

Recommendation 7.3:
Measures are required for improving the long-term security of the drinking-water supply to both the urban and the rural population. They should involve the identification of suitable groundwater reserves and their protection, as well as the development and application of rapid assessment procedures for the identification, inventory and quantification of pollution sources endangering groundwater quality in abstraction areas *See Recommendation 14.1.*

To establish a long-term programme and a national strategy for water it is important to identify goals, priorities and financial resources. One way of preparing a coherent overall strategy would be to specify (a) a national water planning programme, (b) a national master plan for water resources and sewage treatment, (c) general plans for groundwater resources, and (d) general plans for runoff basins. Planning future water resources needs a strategic programme and policy guidance, in order to direct and set up action plans. Improving waste-water treatment performance should be a priority among the protection measures, in order to reduce the pollution burden on freshwater. The envisaged measures should be integrated into the revision of NEAP/SD (see Recommendation 1.2), but must not be delayed by that process.

There have been no significant investments in the domestic water or waste-water infrastructure since the dissolution of the Ministry of Municipal Services in 1993. Other factors have contributed to the problems of the water economy. The urbanization process in Kazakhstan was such that many settlements developed around industries. This implied that many of the water-supply and sewerage networks were built as temporary schemes, which were never optimized. This is the case of Karaganda, Zhezkazgan, Satpaev, Temirtau and some others. Also, most of the industries had their own water systems, now in the hands of the municipal water companies, but completely depreciated, with no maps or technical specifications of the infrastructure available.

Monitoring is of great importance to water management and is another area requiring development in Kazakhstan. So far, monitoring-including the provisions for effluent self-monitoring by polluters-has mostly been used to show and record point sources of pollution. It should be extended to both individual and public supply systems, to help detect leaks and prevent quality problems. The monitoring data should be used more systematically in analysis and for action plans. The required environmental information strategy should, *inter alia*, ensure that the planning, construction and management of engineering works are based on the best scientific information. See Recommendation 1.3.

<u>*Recommendation 7.4:*</u>
A comprehensive water strategy and a complementary programme for implementation should be developed. In addition to drinking-water supply issues, it should focus on waste-water treatment efficiency. The following measures could be envisaged:
- *The identification of a priority list for investments in sewerage and waste-water treatment, covering the construction of new and the repair of old installations, their scheduling, and their funding arrangements.*
- *The introduction of water metering for all users.*
- *The specification of a long-term water pricing strategy to cover the full cost of investment, maintenance and operation of all water-production and waste-water treatment infrastructure. The resulting social hardship should in the long term be avoided through solutions other than water pricing, in order not to complicate water supply and treatment unduly.*
- *The training of waste-water treatment staff in plant operation, process control and instrument operation.*