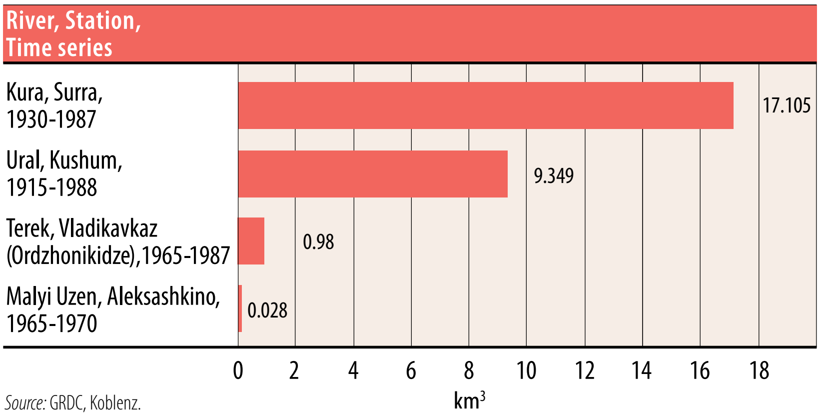
CHAPTER 4 DRAINAGE BASIN OF THE CASPIAN SEA

This chapter deals with the assessment of transboundary rivers, lakes and groundwaters, as well as selected Ramsar Sites and other wetlands of transboundary importance, which are located in the basin of the Caspian Sea.

Assessed transboundary waters in the drainage basin of the Caspian Sea

Basin/sub-basin(s)	Recipient	Riparian countries	Lakes in the basin	Transboundary groundwaters within the basin	Ramsar Sites/wetlands of transboundary importance
Ural/Zaiyk	Caspian Sea	KZ, RU		South-Pred-Ural, Pre-Caspian, Syrt (KZ, RU)	
Atrek/Atrak	Caspian Sea	IR, TM			Gomishan Lagoon (IR, TM)
Kura	Caspian Sea	AM, AZ, GE, IR, TR	Lake Jandari,Lake Kartsakhi/Aktaş Gölü	Kura (AZ, GE)	Wetlands of Javakheti Region
– Iori/Gabirri	Kura	AZ, GE		Iori/Gabirri (AZ, GE)	
– Alazani/Ganyh	Kura	AZ, GE		Alazan-Agrichay (AZ, GE)	
– Agstev/Agstafachai	Kura	AM, AZ		Agstev-Akstafa/Tavush-Tovuz (AM, AZ)	
– Potskhovi/Posof	Kura	GE, TR			
– Ktsia-Khrami	Kura	AM, AZ, GE		Ktsia-Khrami (AZ, GE)	
– –Debed/Debeda	Ktsia-Khrami	AM, GE		Debed (AM, GE)	
– Aras/Araks	Kura	AM, AZ, IR, TR	Araks Govsaghynyn Reservoir	Nakhichevan/Larijan and Djebrail (AZ, IR)	Flood-plain marshes and fishponds in the Araks/Aras River valley (AM, AZ, IR, TR)
– – Akhuryan/Arpaçay	Aras/Araks	AM, TR	Akhuryan/Arpaçay Reservoir	Leninak-Shiraks (AM, TR)	
– –Arpa	Aras/Araks	AM, AZ		Herher, Malishkin and Jermuk (AM, AZ)	
– –Vorotan/Bargushad	Aras/Araks	AM, AZ		Vorotan-Akora (AM, AZ)	
– –Voghji/Ohchu	Aras/Araks	AM, AZ			
– –Sarisu/Sari Su	Aras/Araks	TR, IR			
Astarachay	Caspian Sea	AZ, IR			
Samur	Caspian Sea	AZ, RU		Samur (AZ, RU)	
Sulak	Caspian Sea	GE, RU		Sulak Aquifer (GE, RU)	
– Andis-Koisu	Sulak	GE, RU			
Terek	Caspian Sea	GE, RU		Terek aquifer (GE, RU)	
Malyi Uzen/Saryozen	Kamysh-Samarsk Lakes	KZ, RU	Lakes of Kamysh-Samarsk	Pre-Caspian (KZ, RU)	
Bolshoy Uzen/Karaozen	Kamysh-Samarsk Lakes	KZ, RU		Pre-Caspian (KZ, RU)	

Long-term mean annual flow (km³) of rivers discharging to the Caspian Sea



Source: GRDC, Koblenz.

URAL RIVER BASIN[1]

The basin of the 2,428-km long Ural/Zaiyk[2] River is shared by Kazakhstan and the Russian Federation. Geographically, the basin is shaped by the Ural-Tau ridge (elevation commonly 700-900 m a.s.l.), the Zilairskoe plateau (elevation commonly 500-600 m a.s.l.) and the Obschiy Syrt (elevation mostly 200-300 m a.s.l.).

The Ilek, Or, Kigach, Khobda, Urta-Burtya, and the Chagan are transboundary tributaries.

Basin of the Ural River

Country	Area in the country (km²)	Country's share (%)
Russian Federation	83 200	36
Kazakhstan	147 800	64
Total	**231 000**	

Note: Other sources report a size of the basin ranging from 231,000 km² to 311,000 km².

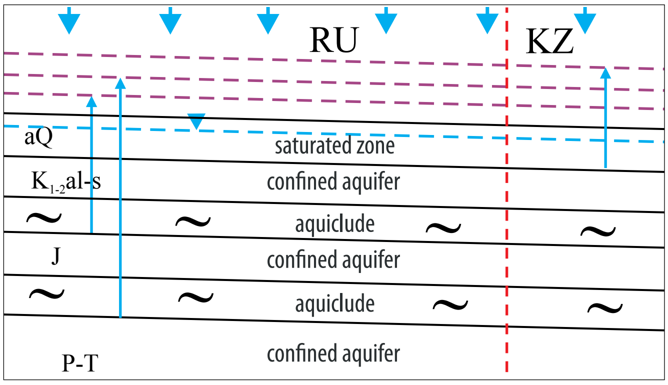
Hydrology and hydrogeology

The right bank tributaries, which originate in the more elevated Ural-Tau, the Malyi and Bolshoy Kizil and Sakmara, have an important role in feeding the flow of the Ural/Zaiyk. Towards the south, run-off significantly decreases, with increased aridity.

Surface water resources in the Russian part of the basin are estimated to amount to some 10.6 km³/year (based on observation during the period from 1958 to 2009).[3]

In Kazakhstan's part of the basin, surface water resources are estimated at 12.8 km³/year (with 4.1 km³/year estimated generated within the borders of Kazakhstan and 8.7 km³/year flowing from the Russian Federation). Groundwater resources are estimated at 1.03 km³/year. These add up to a total of 13.83 km³/year, which equals 6,612 m³/year/capita.

FIGURE1: Conceptual sketch of the South-Pred-Ural aquifer (No. 40) (provided by Kazakhstan)



SOUTH-PRED-URAL AQUIFER (NO. 40)

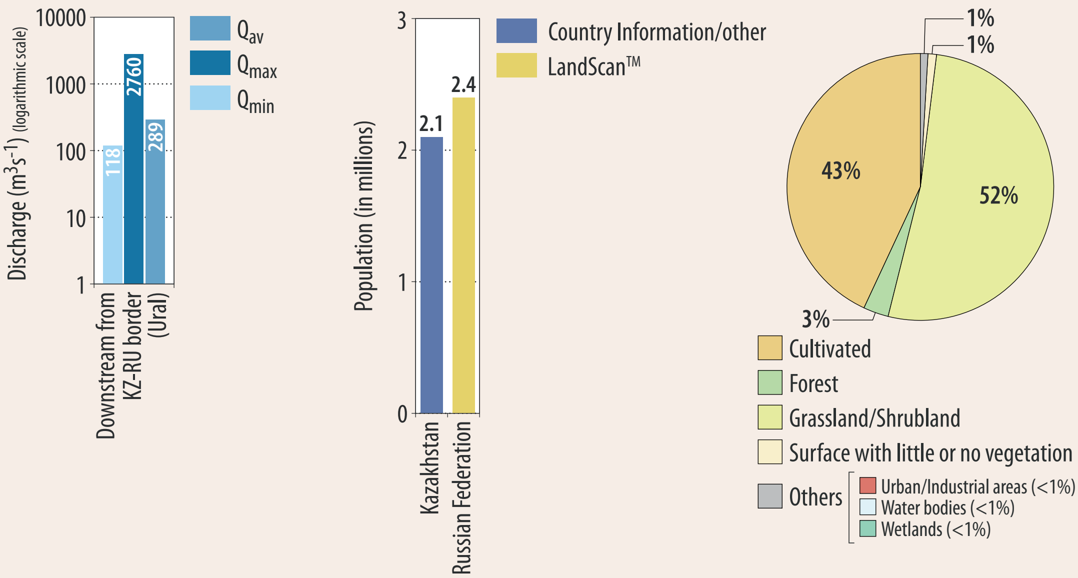
	Kazakhstan	Russian Federation
Sand and gravel; intergranular/multilayered, partly confined and partly unconfined; groundwater flow from the Russian Federation (north-east) to Kazakhstan (south-west); weak links with surface waters.		
Border length (km)	106	N/A
Area (km²)	9 512	N/A
Renewable groundwater resource (m³/d)	777 534	N/A
Thickness: mean, max (m)	75, 200	N/A
Groundwater uses and functions	80% for household water, 20% for technical purposes.	N/A
Pressure factors	Groundwater abstraction is significantly smaller than exploitable resources.	N/A
Groundwater management measures	Surveillance and early warning monitoring is needed.	N/A

PRE-CASPIAN AQUIFER (NO. 41)

	Kazakhstan	Russian Federation
Medium- to fine-grained sands; groundwater flow from the Russian Federation (north) to Kazakhstan (south) or along the border; medium links with surface waters. The aquifer extends to the Malyi Uzen/Saryozen and Bolshoy Uzen/Karaozen Basins.		
Border length (km)	1 680	N/A
Area (km²)	75 000	N/A
Thickness: mean, max (m)	21, 42	N/A
Groundwater management measures	Development of the groundwater requires agreement and sharing of resources between the countries.	N/A

[1] Based on information from Kazakhstan, the Russian Federation and the First Assessment.
[2] The river is known as Ural in the Russian Federation and as Zaiyk in Kazakhstan.
[3] *Source:* Committee on Water Resources of the Orenburg oblast, the Russian Federation.

DISCHARGES, POPULATION AND LAND COVER IN THE URAL RIVER BASIN



Sources: UNEP/DEWA/GRID-Europe 2011; Statistics Agency of Kazakhstan, 2006; Country data/First Assessment.

SYRT AQUIFER (NO. 42)

	Kazakhstan	Russian Federation
Quaternary gravel, pebbles, and sand, Cretaceous chalk; groundwater flow from the Russian Federation (north-east) to Kazakhstan (south-west); medium links with surface waters.		
Border length (km)	212	N/A
Area (km^2)	2 410	N/A
Renewable groundwater resource (m^3/d)	198 720	N/A
Thickness: mean, max (m)	50, 100	N/A
Pressure factors	Abstraction of groundwater is insignificant.	N/A
Groundwater management measures	Surveillance and early warning monitoring is needed.	N/A

FIGURE 2: Conceptual sketch of the Pre-Caspian aquifer (No. 41) (provided by Kazakhstan)

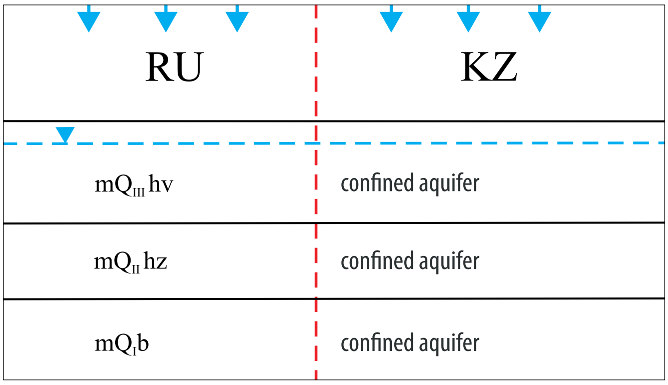
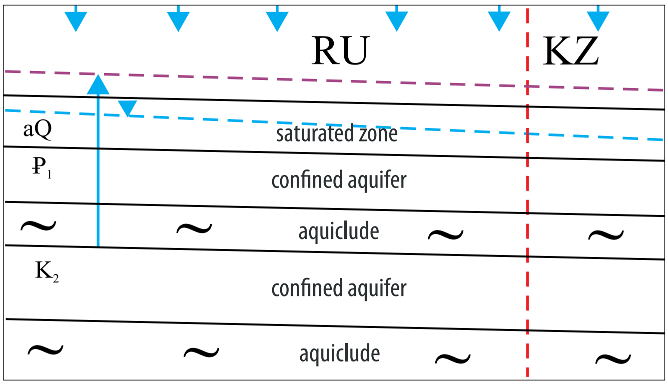


FIGURE 3: Conceptual sketch of the Syrt aquifer (No. 42) (provided by Kazakhstan)



Pressures

The main pressure factors in the basin are industry (especially in Magnitogorsk and the Orenburg oblast) and discharges of municipal wastewaters (the cities of Uralsk and Atyrau). Spring flooding and run-off in general mobilizes pollutants, among them oil products from oil extraction sites on the Caspian coast (Tengiz, Prorva, Martyshi, Kalamkas, Karazhmbas). In addition to oil products, phenols and heavy metals are principal pollutants in the Ural/Zaiyk Basin.

Status

The total concentration of dissolved solids of the Ural/Zaiyk River at the Yanvartsevo monitoring station was on average 848 mg/l in 2009. According to the water quality classification of Kazakhstan, water quality was classified as "moderately polluted" (class 3). At Uralsk, some 65 km downstream, the water pollution index was largely in the 1.18-1.68 (moderately polluted) range in the period from 1994 to 2004, even though water quality appeared to deteriorate (classified as "polluted", i.e. class 4) in the late 1990 and in the beginning of the 2000s.

Trends

Kazakhstan predicts water withdrawal from the Ural/Zaiyk to increase by almost 70% by 2020, compared with the level in 2006. Withdrawal for agriculture is expected to increase relatively, and the percentage share of withdrawals for other uses is expected to decrease.

Total water withdrawal and withdrawals by sector in the Ural/Zaiyk Basin

Country	Year	Total withdrawal $\times 10^6$ m^3/year	Agricultural %	Domestic %	Industry %	Energy %	Other %
Russian Federation	2009	1 650[a]	N/A	N/A	N/A	N/A	N/A
Kazakhstan	2006	1 429	49.9	14.9	33.8	-	1.4
	2020[b]	2 406	64.8	10.0	24.3	-	0.9

[a] For Orenburg oblast.
[b] Forecast.

Water quality classification in the Ural/Zaiyk Basin

Location of observation in the Ural Basin	Water pollution index[a] – water quality classification 2008	2009	Parameters exceeding MAC	Multiplier of MAC exceedence
Ural/Zaiyk River, station Yanvartsevo (on the Russian-Kazakhstan border)	1.25; "moderately polluted" (class 3)	1.67; "moderately polluted" (class 3)	total iron	3.16
			ammonium nitrogen	2.25
			Chromium (+6)	1.75
			phenols	1.19
Chagan tributary, station at the village of Kamennyi	1.35, "moderately polluted" (class 3)	1.26, "moderately polluted" (class 3)	BOD_5	2.25
			phenols	1.40
			sulphates	1.27
			total iron	1.10

[a] The water pollution index is defined on the basis of the ratios of measured values and the maximum allowable concentration of specific water-quality determinants.
Source: Kazhydromet, Ministry of Environmental Protection of Kazakhstan.

ATREK/ATRAK RIVER BASIN[4]

The basin of the 530-km long[5] Atrek/Atrak River[6] is shared by the Islamic Republic of Iran and Turkmenistan. It has its source in the Islamic Republic of Iran, forms for some length the border between the riparian countries, and discharges to the Caspian Sea.

The Sombar is a transboundary tributary (length about 35 km).

Basin of the Atrek/Atrak River

Country	Area in the country (km²)	Country's share (%)
Islamic Republic of Iran	26 500	79.1
Turkmenistan	7 000	20.9
Total	**33 500**	

Source: Ministry of Energy of the Islamic Republic of Iran.

Hydrology and hydrogeology

In the Iranian part of the river basin, all internally-generated water resources are estimated to amount 1,263 × 10^6 m^3/year. Of this amount, surface water resources make up an estimated 958 × 10^6 m^3/year, and groundwater resources 30^6 × 10^6 m^3/year (both values are averages for the years 1972–2007). Total water resources per capita in the basin are 1,368 m^3/year.

The long-term mean annual discharge of the river in Turkmenistan is approximately 100 × 10^6 m^3.

There are some aquifers in the Iranian (upstream) part of the basin — used mainly for agriculture — which are recharged by precipitation and return flows, and feed the Atrek/Atrak as baseflow. According to the Islamic Republic of Iran, there are no transboundary aquifers to speak of.

Pressures

In the Iranian part of the river basin, most of the water used (90%) is for agriculture, but only 25% of fertile land is irrigated, due to a shortage of water resources. Floods, high sediment load (especially in the Sombar tributary) and riverbank alterations are the other main pressures in the basin, which are assessed as widespread and severe by the Islamic Republic of Iran. Wastewaters are treated only in some big cities, and waste management — despite being controlled — is also insufficient; these factors are considered local and moderate in impact. Some illegal groundwater abstraction occurs. Return flows from the irrigated land affect the river's water quality, resulting in high concentrations of mineral salts.

Status, transboundary cooperation and responses

The most significant factors affecting the quantity and/or quality of surface water and groundwater resources are pollution from agriculture, flooding, and drought, as well as erosion and accumulation of sediments. Local problems include groundwater level decline, natural background pollution, municipal and industrial pollution, viruses and bacteria from inefficiently treated wastewater. Because of the poor water quality, especially downstream, water for drinking has to be supplied from another basin.

Efforts are on-going in the Islamic Republic of Iran to improve irrigation efficiency by developing the irrigation network and wastewater treatment, as well as to limit groundwater abstraction and control pollution.

Following a bilateral agreement with Turkmenistan dating from the time of the Soviet Union, the Atrek/Atrak River's water resources are equally shared between the Islamic Republic of Iran and Turkmenistan. There is a need for a new agreement to provide an institutional framework for transboundary cooperation in the current situation. Related to river training,[7] the Islamic Republic of Iran and Turkmenistan have held joint meetings and continue their projects. Some agreements have also been made about river management and dredging of the main Atrek/Atrak River. The riparian countries have a joint hydrometrical monitoring programme. Water quality and sediment monitoring are lacking.

Trends

Some decreasing trends in precipitation and discharge have been observed in the Islamic Republic of Iran, but a lack of data limits assessing whether it is due to climate change or related to periodic events.

The Islamic Republic of Iran reports that a comprehensive water management plan for the Atrek/Atrak River Basin is under preparation.

A number of needs are indicated by the Islamic Republic of Iran related to transboundary cooperation: joint bodies should be created between the two countries; hydroclimatological monitoring stations and data exchange should be set up; the Atrek/Atrak main river should be mapped at large scale; and, a joint study on river basin management and river engineering should be carried out, with implementation of erosion and sediment control in the upstream part of the basin.

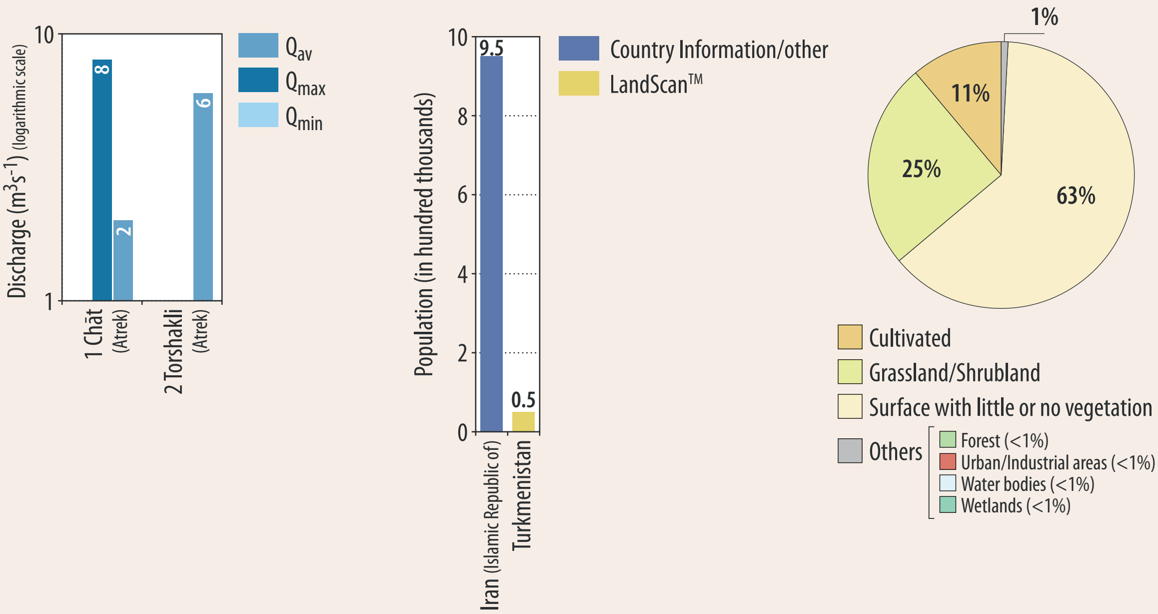
Total water withdrawal and withdrawals by sector in the Atrek/Atrak Basin

Country	Year	Total withdrawal ×10^6 m^3/year	Agricultural %	Domestic %	Industry %	Energy %	Other %
Islamic Republic of Iran	2009	1 264	90	5	5	N/A	N/A
	2020[a]	1 118	10	10	8	N/A	N/A
Turkmenistan	N/A	N/A	N/A	N/A	N/A	N/A	N/A

[a] Forecast figures.

[4] Based on information from the Islamic Republic of Iran and the First Assessment.
[5] With its tributaries, the river is 635 km long.
[6] The river is known as the Atrek in Turkmenistan, and as the Atrak in the Islamic Republic of Iran.
[7] River training refers to engineering river-works that are built in order to direct the flow.

DISCHARGES, POPULATION AND LAND COVER IN THE ATREK/ATRAK RIVER BASIN



Sources: UNEP/DEWA/GRID-Europe 2011; The Islamic Republic of Iran's National Institute of Demography, 2006.

GOMISHAN LAGOON[8]

General description of the wetland

The Gomishan Lagoon is a natural coastal lagoon located at the south-eastern coast of the Caspian Sea in the province of Golestan in the Islamic Republic of Iran, with an area of nearly 17,700 ha. It is part of two river basins, the Atrek/Atrak and the Gorgan. However, these rivers do not play a major role in the lagoon's water supply. The central part of the wetland is covered by saltmarsh vegetation as well as flats of glasswort species, interspersed with pickle-weed and sarsazan grasses which are flooded seasonally. To the east of the lagoon, the natural grasslands have mainly been converted into arable land, namely wheat and cotton production, while the west of the lagoon features coastal dunes. The northern part of the lagoon borders the Turkmen Steppe plains. The lagoon is a typical example of a "Coastal Permanent Brackish Lagoon" with an average depth of one meter. The average elevation of the wetland is the same as the Caspian Sea, nearly 27 m below sea level. It mainly consists of silty and sandy sediments. Average annual rainfall in the area is 431 mm.

Main wetland ecosystem services

The lagoon contributes to the stabilization of the shoreline, and plays a small role in terms of sediment trapping and coastal flood prevention. It supports fish and great water birds, as well as the local population (approximately 40,000 people), who use the lagoon for fishing and hunting, while the vast eastern flood plain of the wetland is mainly used for livestock grazing (mostly sheep and goats), as well as for wheat and cotton growing.

Cultural values of the wetland area

Due to the lack of fertile soil and sufficient fresh water in the region, people are dependent on fishing, as well as shooting waterfowl from the lagoon. The most important fish species is the Caspian Roach, which migrates into the lagoon from the Caspian Sea during winter and spring seasons.

Biodiversity values of the wetland area

The wetland supports 81 species of water birds, including threatened species such as the Dalmatian Pelican (Vulnerable) and the Sociable lapwing (Critically Endangered) (according

to IUCN's Red List of threatened species). It regularly supports more than 20,000 water birds, and also supports 1% of the global population of 20 species of water birds, and is an

important source of food for 15 fish species. The Common Roach fish sub-species depends on the wetland as an important part of its migratory path. A few mammal species are also supported, including the Caspian Seal, which is listed as being endangered according to IUCN's Red List. Reptile species include turtles, lizards and snakes. In terms of flora, the wetland supports 17 species of macrophytes.

Pressure factors and transboundary impacts

The most important factor, which has the potential to have a detrimental effect on the natural ecological character of the wetland, is the Caspian Sea's fluctuations in water level, causing the lagoon's shoreline to change. In 1978, when the Sea surface was at its lowest level, the large Gomishan Lagoon of today consisted only of a chain of narrow, small lagoons behind the Caspian Sea beach. Moreover, due to the Caspian Sea's connection to the lagoon — with only a narrow sandy barrier separating the two — all the exotic species introduced to the former may affect the site. The most important adverse human activities in the area are excessive disturbance through hunting of waterfowl and fishing. Overgrazing and agriculture are additional pressure factors.

Transboundary wetland management

Most of the northern half of the wetland is a "no-hunting and no-fishing zone". Up until recently, neither a management plan, nor any transboundary cooperation on the wetland existed. However, there has been some bilateral cooperation for determination of the border along the lagoon between the Islamic Republic of Iran and the Soviet Union, as well as between the Islamic Republic of Iran and Turkmenistan.

[8] Ramsar Information Sheet (http://www.wetlands.org/rsis/); BirdLife International. Important Bird Areas factsheet: Gomishan marshes and Turkoman steppes. 2010.

KURA RIVER BASIN[9]

The basin of the river Kura is shared by Armenia, Azerbaijan, Georgia, the Islamic Republic of Iran and Turkey.[10] The 1,515 km long river has its source in Turkey on the north slope of the Allahuekber Mountains Range at the height of 3,068 m a.s.l., and discharges to the Caspian Sea.

The basin has a pronounced mountainous and highland character in Turkey, with an elevation between 1,300–3,068 m a.s.l., and an average elevation of 2,184 m a.s.l.

Major transboundary tributaries include the following rivers: the Araks/Aras, Iori/Gabirri, Alazani/Ganyh, Debed/Debeda, Agstev/Agstafachai, Potskhovi/Posof and Ktsia-Khrami.

Basin of the Kura River

Country	Area in the country (km²)	Country's share (%)
Armenia	29 743	15.8
Azerbaijan	57 831	30.7
Georgia	29 741	15.8
Islamic Republic of Iran	43 209	23.0
Turkey	27 548[a]	14.6
Total	**188 072**	

[a] The figure refers to the total area within the whole Kura-Araks Basin which is Turkey's territory; the area within the Kura Basin only is 4,662 km².
Sources: UNECE Environmental Performance Review (EPR) programme; Ministry of Nature Protection of Armenia; Ministry of Ecology and Natural Resources of Azerbaijan; Ministry of Environment Protection and Natural Resources of Georgia; Iranian Ministry of Energy/Deputy of Water and Wastewater Affairs; and Turkey's General Directorate of State Hydraulic Works.

Spring floods cause damage in some parts of the basin. A number of reservoirs and dams on the Kura also help with flood regulation. The Mingechevir Reservoir has improved the situation regarding flood control in the lowlands of the river.

Pressures

The economy of the Turkish part of the Kura Basin relies on agriculture and animal husbandry. In Azerbaijan, extensive areas are under irrigated agriculture (some 745,000 ha, including

Most important water reservoirs in the Kura River Basin

River/tributary	Reservoir, country	Full volume ($10^6 \times m^3$)	Pay load volume ($10^6 \times m^3$)
Kura	Mingachevir (AZ)	15 730	4 665
Kura	Shamkir (AZ)	2 677	1 425
Aras	Aras (AZ)	1 350	1 150
Aragvi	Jhinvali (GE)	520	370
Iori	Sioni (GE)	325	315
Khrami	Khrami (GE)	313	293
	Samgori (Tbilisi) (GE)	308	155
Agstafa	Agstafa AZ)	120	111
Kura	Yenikend (AZ)	158	136
Algeti	Algeti (GE)	65	60
Kura	Barbarinsk (AZ)	62	10
	Jandari (GE)	54.28	25.03
Patara Liahvi	Zonkari (GE)	40.3	39
	Iakublo (GE)	11	10.8

Sources: Azerbaijan, Georgia and UNDP/Sida project Reducing Trans–boundary Degradation of the Kura-Aras river basin. 2005.

300,000 ha in the Azerbaijani part of the Araks/Aras sub-basin). In the part of the basin that is Turkey's territory, nearly one fifth of irrigable land is irrigated, but the area is increasing, due to land development projects. Upon completion of Turkey's Kura Master Plan, more than 38,000 ha of land will be irrigated. Where the groundwater table is high and there are problems with drainage, irrigation contributes to soil salinization. Water withdrawal from the Kura for irrigation occurs mainly downstream from Mingechevir.

Animal stocks have also gradually increased in parallel with irrigation, with manure and fertilizer pollution problems related to agricultural activities in the basin. There is some limited manufacturing activity in Turkey based on agriculture and animal husbandry.

Logging has reduced forested areas, and deforestation and overgrazing makes areas vulnerable to erosion, resulting in reduced stability of the ground, and loose sediment making the river water turbid. Climatic, topographic and geological conditions also

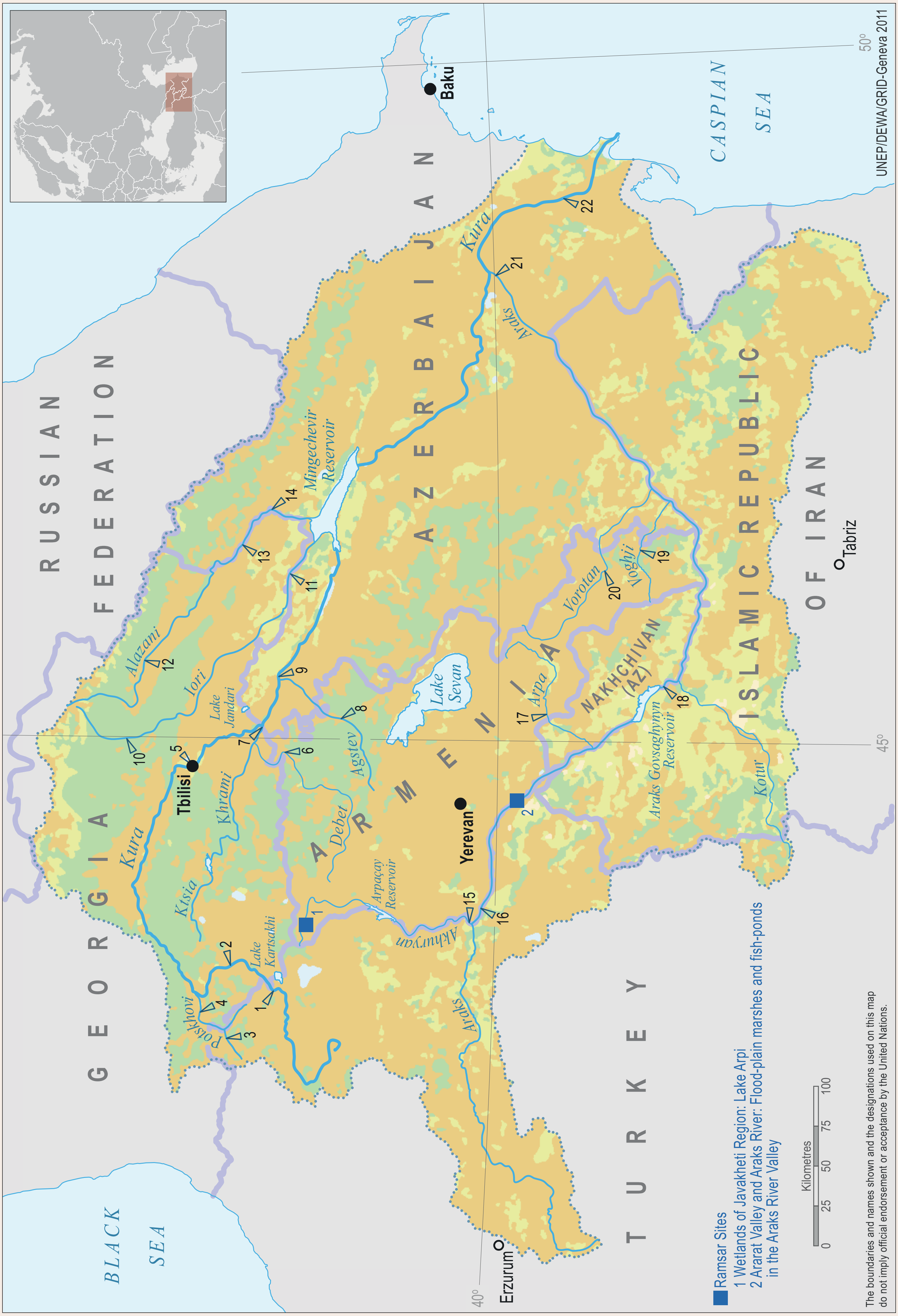
The largest protected areas located in the Kura River Basin[11]

Protected area	Country	Coverage (ha)
Sevan National Park including lake Sevan	Armenia	150 100
Marakan protected area	Islamic Republic of Iran	92 715
Agel National Park	Azerbaijan	17 924
Kiamaki protected area	Islamic Republic of Iran	84 400
Agri Mountain National Park	Turkey	87 380
Arasbaran Biosphere Reserve	Islamic Republic of Iran	72 460
Borjomi-Kharagauli National Park	Georgia	57 963
Shirvan National Park	Azerbaijan	54 373

Renewable water resources per capita in the Kura Basin per country

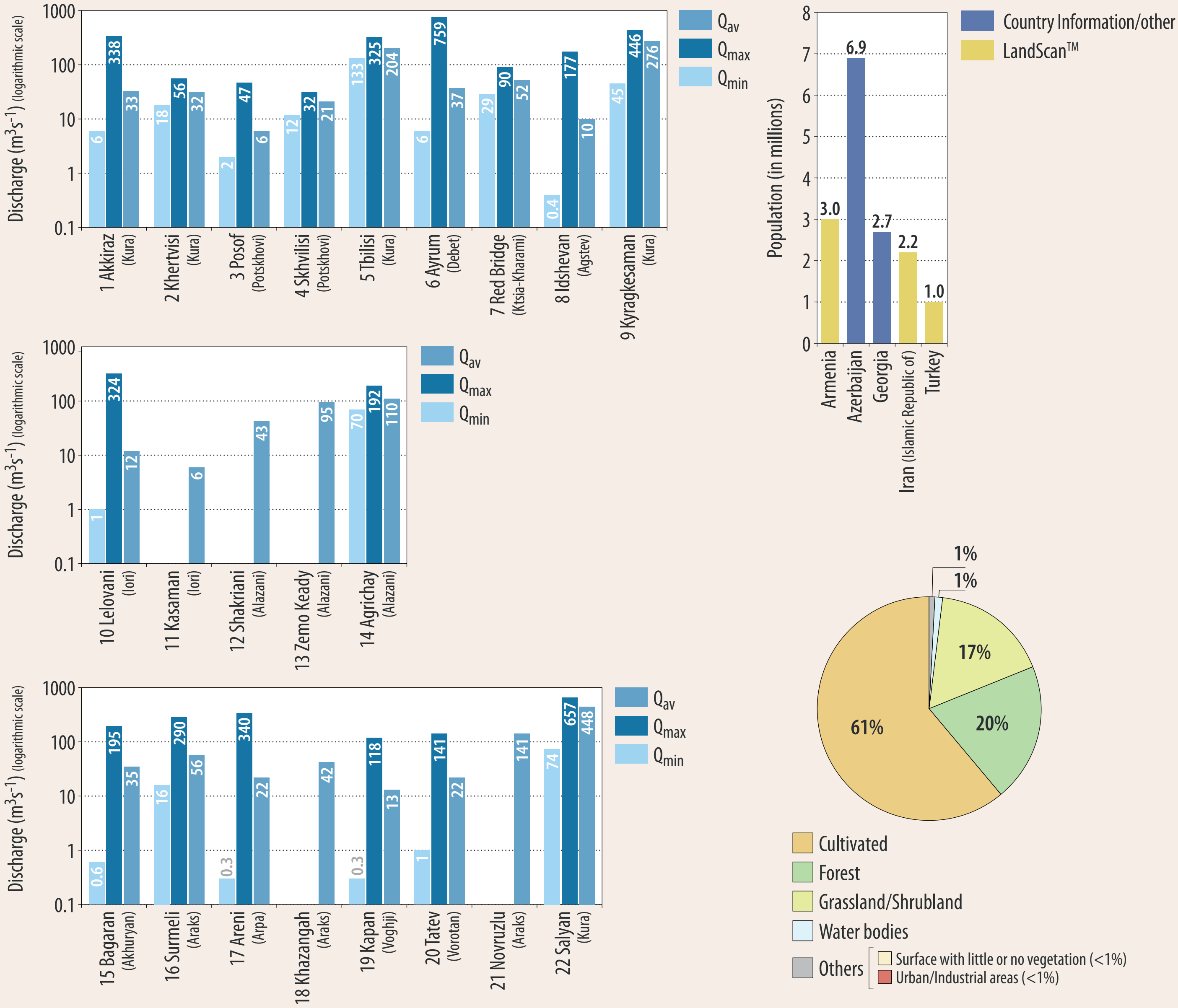
Country	Renewable surface water resources (km³/year)	Renewable groundwater resources (km³/year)	Total renewable water resources (km³/year)	Renewable water resources per capita (m³/capita/year)	Period of observations used for estimating water resources
Armenia	4.858	4.311	7.769	2.778	1977-2001
Azerbaijan	8.704	5.2	13.9	1 913	1953–2008
Georgia	6.438	1.923	8.362	3 144	1935–1990
Islamic Republic of Iran	N/A	N/A	N/A	N/A	N/A
Turkey	1.093	0.040	1.133	10 067	1969–1997

[9] Based on information from Armenia, Azerbaijan, Georgia, the Islamic Republic of Iran, Turkey and the First Assessment.
[10] The Russian Federation is usually not considered as a basin country, as its territory in the basin is far below 1% of the total basin area.
[11] *Source:* Kura-Aras River Basin Transboundary Diagnostic Analysis. Project Reducing Trans–boundary Degradation of the Kura-Aras River Basin. January 2007.



Sources: UNEP/DEWA/GRID-Europe 2011.

DISCHARGES, POPULATION AND LAND COVER IN THE KURA RIVER BASIN



Sources: Ministry of Nature Protection of Armenia; Ministry of Ecology and Natural Resources of Azerbaijan; Ministry of Environment Protection and Natural Resources of Georgia; Iranian Ministry of Energy/Deputy of Water and Wastewater Affairs; and Turkish Statistical Institute, 2008. The population figures refer to the Kura Basin only.

KURA AQUIFER (NO. 43)

	Georgia	Azerbaijan
Type 2; volcanic rocks of Tertiary and Quaternary age: tuff breccia, mergel, quartz porphury, albitophyre; moderate links with surface water.		
Area (km^2)	70	N/A
Thickness: mean, max (m)	100, 250	N/A
Groundwater uses and functions	Used for drinking water.	N/A
Other information	A common monitoring programme seems to be needed .	N/A

contribute to erosion. Land and soil degradation are a concern, such as in the upper part of the basin (Turkey). In addition to fertile soil wash-out, land degradation also involves salinization, especially in more arid zones. These are matters for concern in both Georgia and Azerbaijan. Some stone and aggregate quarries in Turkey have a degrading effect on the landscape, but at local scale. Aggregate quarries add to the erosion risk in the riverbed. Planned dam constructions are expected to influence the flow and hydromorphology.

Some 11 million people live in the catchment area of the Kura River.[12] Urban wastewater discharges pose a risk of surface and groundwater pollution. For example, in Georgia, municipal wastewater treatment plants are mostly not in functioning condition. In rural settlements, there is commonly no sewerage network. In the Turkish part, the influence of wastewater from settlements is considered local, but severe.

There are similar risks from controlled and uncontrolled dumpsites, which are assessed by Turkey as local but severe in influence, and in the Azerbaijani and Georgian territories are one of the main factors influencing waters. For example, the controlled dumpsite Ardahan in Turkey may cause pollution of nearby agricultural land.

Polluting activities also include mining (in Armenia, Georgia and the Islamic Republic of Iran), metallurgical and chemical industries. The major pollutants are heavy metals (copper (Cu), zinc (Zn), cadmium (Cd)) from mining and the leather industry, and ammonia and nitrates from the fertilizer industry. The waste rock dumps of Madneuli mine in the village of Kazreti, Georgia, are reported to have an impact through rainfall flushing metals and other contaminants from the heaps to the river Mashavera.

The Ceyhan-Tbilisi-Baku oil pipeline traversing the territory of Georgia in the basin is felt to pose a pollution risk.

The Kura River is the source of drinking water for almost 80% of the population of Azerbaijan.

The main water users in the Georgian part of the Kura River Basin are agriculture, industry, municipalities and the energy sector (hydro- and thermal energy generation). The efficiency of the irrigation network is quite low, with water losses estimated at 40–50%. The main industry sectors using water are chemicals, building materials, non-ferrous metallurgy, and food processing. Groundwater makes up 80% of the drinking water distributed through centralized networks.

In the Turkish part, water for domestic use is commonly taken from springs and wells; groundwater is also used locally for irrigation by farmers. Existing small factories generally use water from municipalities or from groundwater wells. Surface water is also withdrawn for irrigation locally in Turkey, but its influence is considered insignificant.

Status

According to Turkish Inland Water Quality Standards, water quality in the Turkish part of the Kura River is in Class I and Class II, that is, unpolluted and/or less polluted water bodies, respectively.

According to measurements by Armenia from 2006 to 2009 along the Araks/Aras River, heavy metals such as aluminium (Al), iron (Fe), manganese (Mn), chrome (Cr) and vanadium (V) occur in water in moderate amounts. Some of these are part of the typical geochemical background of the Araks/Aras. Cr occurs at amounts exceeding the MAC value almost every year, but it is also affected by the background concentrations. Nitrate level did not exceed MAC during the same observation period.

According to the Ministry of Environment of Georgia, in the Kura River in 2008 (Tbilisi, Vakhushti Bagrationi bridge) the BOD_5 fluctuated between 1.79 and 7.36 mg/l, and the concentrations of ammonium ion (NH_4^+) from 0.3 to 1.4 mg/l. In 2009, the maximum concentration of NH_4^+ was nine times higher than the corresponding MAC, ranging from 0.209 to 3.616 mg/l. Other measured components within the respective MAC. At present, the river is moderately polluted.

According to the Ministry of Ecology and Natural Resources of Azerbaijan, in 2009, the BOD_5 ranged from 2.45 to 5.02 mg/l, the concentration of NH_4^+-ion from 0.38 to 1.0 mg/l, and the concentration of copper and zinc ranged from 0.69 to 1.01 mg/l in the Kura River at monitoring station Kura Shikhli-2. Phenol concentrations ranged from 0.003 to 0.007 mg/l. Other measured components were below the respective MAC. To date, in Azerbaijan's view, the ecological and chemical status of the river is not satisfactory.

Total water withdrawal and withdrawals by sector in the Kura Basin

Country	Total withdrawal $\times10^6$ m^3/year	Agricultural %	Domestic %	Industry %	Energy %	Other %
Armenia	2.950	66	30	4	-	-
Azerbaijan	11 785	63.4	N/A	20.8	[a]	N/A
Georgia	12 158	1	3	2	94	N/A
Islamic Republic of Iran	N/A	N/A	N/A	N/A	N/A	N/A
Turkey	65	88	12	0	0	N/A

[a] Non-consumptive water use for energy purposes in Azerbaijan is 13.1 km^3/year.

[12] Environmental Performance Review of Azerbaijan, UNECE. 2004.

Trends

According to Turkish national predictions and long-term scenarios, both precipitation and river run-off are expected to decrease by 10 to 20%, the former by 2030 and the latter by 2070–2100. Seasonal variability in precipitation and flood/drought risk are predicted to increase. Based on expert knowledge, groundwater level is predicted to decrease and groundwater quality to be affected negatively. Both consumptive and non-consumptive water uses are foreseen to increase.

To assess the future impact of predicted climate changes on the hydrological regime of the Alazani/Ganyh and Iori/Gabirri Rivers in East Georgia, a hydrological model — the Water Evaluation and Planning System (WEAP) — was applied. The water resources of these rivers are used intensively for the irrigation of crops and pastures. A forecast of changes in climatic parameters (temperature, precipitation) has been made for the Georgian upstream part applying two regional models.[13] For the period 2070–2100, the annual mean temperature forecast is 8.9 °C (current average 3.3 °C) in the upper part of the Alazani/Ganyh and 11.9 °C (current average 6.4 °C) in the upper part of the Iori/Gabirri. The projected average for the annual sum of precipitation is 2,260 mm (current average 2,280 mm) for the Alazani/Ganyh and 1,351 mm (current average 1,325 mm) for the Iori/Gabirri. The predicted decreases in flow are about 8.5% in the Alazani/Ganyh and 11% in the Iori/Gabirri.

In the Turkish part of the Kura Basin, water use is expected to increase substantially, to 0.331 km^3/year (presently 0.065 km^3/year), upon the completion of the projects in the Kura Master Plan. In particular, water use for hydropower is foreseen to increase. Georgia predicts increases in withdrawals in some tributaries, including the Alazani, Iori and Ktsia-Khrami Rivers, from a few% up to 10% by 2015.

IORI/GABIRRI SUB-BASIN[14]

The basin of the 320-km long Iori/Gabirri River[15] is shared by Georgia and Azerbaijan. The river has its source in the Main Caucasian Range at 2,600 m and discharges into the Kura. The upper part of the sub-basin is mountainous (Kaveazskogo ridge), and the lower part is lowland steppe (Kakheti Kartlino plateau).

Sub-basin of the Iori/Gabirri River

Country	Area in the country (km^2)	Country's share (%)
Georgia	4 650	88.4
Azerbaijan	610	11.6
Total	**5 260**	

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

Hydrology and hydrogeology

Surface water resources in the Georgian part of the basin are estimated at 0.366 km^3/year (average for the years 1963–1992) and groundwater resources at 0.155 km^3/year (based on 2004), adding up to a total of 0.522 km^3/year (or 2,166 m^3/capita/year). The hydrological regime of the river is characterized by spring floods, summer/autumn high waters, and steady low water levels in winter.

In Georgia, there are three large irrigation reservoirs on the Iori/Gabirri River: the Sioni Reservoir, which is also used for hydropower generation and water supply; the Tbilisi Reservoir, used also for water supply; and the Dalimta Reservoir.

Pressures and status

Diffuse pollution from agriculture (about 94,000 ha are used for irrigated agriculture) and municipal wastewater are the main anthropogenic pollution sources in Georgia, which Georgia considers moderate and limited in extent. In Azerbaijan, 1,522 ha are used for irrigated agriculture. Some 30% of the basin area in Georgia and 10% in Azerbaijan is cropland, and in both countries some 50% is grassland.

One of the main factors influencing water quality negatively in the Georgian part is uncontrolled waste dumps on the river banks, with a severe but local influence.

In the Georgian part, wastewater treatment facilities in municipalities are not operational, and in rural settlements there is no wastewater collection system. Georgia ranks the influence of this pressure as severe and widespread.

According to Georgia, the withdrawal of surface water is a pressure factor, with withdrawal for agriculture having the most widespread and severe influence. Drinking water to a part of Tbilisi is supplied from the Tbilisi Reservoir (a part of the Sioni-Zhinvali Reservoir complex), receiving water from the Iori/Gabirri River. A few years ago there were concerns about capacity to meet the increasing drinking water demands of Tbilisi, together with agricultural water demands. Currently, the city of Tbilisi is improving its water supply — including by reducing water losses.

Only 1.4% of the total water demand is met from groundwater in Georgia's territory in the sub-basin. However, the Iori Valley is mainly supplied with groundwater from the flood-plain and river terraces above the flood-plain. Furthermore, drilled wells tap artesian groundwater for use by the population and industry.

Azerbaijan reported that there was little human impact on the river. The Ministry of Environment of Azerbaijan evaluates the ecological and chemical status of rivers as moderately polluted.

IORI/GABIRRI AQUIFER (NO. 44)

	Georgia	Azerbaijan
Sandstones, conglomerates, marls, limestone, alluvial-proluvial pebbles and sands; Tertiary and Quaternary in age; groundwater flow direction from Georgia to Azerbaijan; medium links with surface water.		
Area (km^2)	100	N/A
Thickness: mean, max (m)	100, 300	N/A
Groundwater uses and functions	Used for drinking.	N/A
Other information	A common monitoring programme is indicated to be needed.	N/A

[13] Regional climate models PRECIS and MAGICC/SCHENGEN.
[14] Based on information from Azerbaijan and Georgia, and the First Assessment.
[15] The river is known as Iori in Georgia and Gabirri in Azerbaijan.

Total water withdrawal and withdrawal by sector in the Iori/Gabirri sub-basin

Country	Year	Total withdrawal $\times 10^6$ m^3/year	Agricultural %	Domestic %	Industry %	Energy %	Other %
Azerbaijan	N/A	N/A	10	N/A	N/A	N/A	0.01
Georgia	2008	291	2.95	1.31	0.31	94.75	0.68

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

Trends

By 2015, Georgia predicts an increase of approximately 3% in water withdrawal from the Iori/Gabirri, to approximately 300 × 10^6 m^3/year. A slight relative decrease is expected in agricultural water withdrawal, but small increases are expected in withdrawals for households and industry.

ALAZANI/GANYH SUB-BASIN[16]

The basin of the river Alazani/Ganyh[17] is shared by Georgia and Azerbaijan. The 391-km long river has its source in the Main Caucasus Mountain Range (elevation 2,600–2,800 m a.s.l.). The Alazani/Ganyh flows for a substantial part of its length along the Georgia-Azerbaijan border, and discharges into the Mingachevir Reservoir in Azerbaijan.

In the basins of left bank tributaries of the Alazani/Ganyh, the baseflow component to the river flow (from groundwater) is estimated to be 40–50%. There is currently some concern about worsening conditions for generating baseflow.

In addition to spring flooding, flooding in the summer can also result in significant increases in water levels, especially in the lower reaches of the river.

Sub-basin of the Alazani/Ganyh River

Country	Area in the country (km^2)	Country's share (%)
Azerbaijan	4 755	41
Georgia	6 962	59
Total	**11 717**	

Transboundary protected areas within the Alazani/Ganyh sub-basin include Lagodekhi-Zagatala-West Dagestan (between Georgia, Azerbaijan and the Russian Federation, the total area of 498,706 ha), and Alazani Ganyh (between Georgia and Azerbaijan; 51,230 ha).

Pressures

Azerbaijan expresses concern about transboundary pollution from municipal wastewater (e.g. BOD, COD, nitrogen, phosphorus) and pollution from agriculture (e.g., nitrogen, phosphorus, pesticides). Municipal wastewaters are among the main anthropogenic pollution sources in Georgia.

Georgia ranks diffuse pollution from agriculture, viniculture

Renewable water resources in the parts of the Alazani/Ganyh sub-basin that are the territory of Azerbaijan and Georgia

Country	Renewable surface water resources (km^3/year)	Renewable groundwater resources (km^3/year)	Total renewable water resources (km^3/year)	Renewable water resources per capita (m^3/capita/year)	Period of observations used for estimating water resources
Azerbaijan	3.472	0.0007	3.473	6,150	195–2008
Georgia	1.360[a]	1.24	2.60	7,600	1946–1992

[a] Surface water resources in the Georgian part of the Alazani//Ganyh basin are estimated at 1.360 km^3/year at Shakriani gauging station and 3.001 km^3/year at Zemo-Kedi gauging station.

ALAZAN-AGRICHAY AQUIFER (NO. 45)

	Georgia	Azerbaijan
Type 3; slate and clay shale, siltstone, sandstone, limestone, marl, sea and continental Molasse, conglomerates, sands; Jurassic, Cretaceous, Tertiary and Quaternary in age; consists of an unconfined part (more vulnerable to pollution) at the top of an alluvial cone located at the foot of the mountains, underlain by confined aquifer where groundwater is artesian; groundwater flow direction from Greater Caucasus to the Alazani/Ganyh River, i.e., from Georgia to Azerbaijan; medium links with surface water.		
Border length (km)	140	N/A
Area (km^2)	980	3 050
Thickness: mean, max (m)	150, 320	N/A
Groundwater uses and functions	Used for drinking water (e.g. towns of Telavi and Gurjaani are supplied from groundwater in the alluvium); agriculture.	Irrigation (80–85%) Drinking water supply (10–15%) Industry (3–5%)
Groundwater management measures	Need to be improved: integrated management, abstraction management, efficiency of use, monitoring, agricultural practices, protection zones, mapping. Need to be applied: treatment of urban and industrial wastewater, transboundary institutions, data exchange.	Need to be improved: control of the use of groundwater resources. Need to be applied: treatment of urban and industrial wastewater, monitoring programmes both quantity and quality, data exchange.
Other information	A common monitoring programme seems to be needed. A substantial problem related to groundwater quantity or quality. Water demand was expected to increase. There is no information about transboundary impacts.	

[16] Based on information from Azerbaijan and the First Assessment.
[17] The river is known as Alazani in Georgia and as Ganyh in Azerbaijan.

Total water withdrawal and withdrawals by sector in the Alazani/Ganyh sub-basin

Country	Year	Total withdrawal $\times 10^6$ m³/year	Agricultural %	Domestic %	Industry %	Energy %	Other %
Azerbaijan		N/A	[a]	0.07	N/A	N/A	0.85
Georgia	2008	0.632	0.4	0.9	0.2	91.7	6.7

[a] Some 9 m³/h is pumped from the river for irrigation.

and animal husbandry as severe and widespread. As irrigation infrastructure involves a high share of open unlined channels, water efficiency is low. More than 40,000 ha is irrigated from the Upper Alazani irrigation system, and the Lower Alazani system is expected to be renovated (20,000 ha), resulting in a decrease of water losses. Some 45% of the sub-basin area in Azerbaijan, and 27% in Georgia, is cropland.

Flood-plain forests are still cultivated to some extent. Erosion of river banks is assessed by Georgia as severe, but local.

Status

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

According to the Ministry of Ecology and Natural Resources of Azerbaijan, in the Alazani/Ganyh in 2009 (Ganyhchay gauging station 1.7 km below confluence with the Agrichay) BOD_5 concentrations fluctuated between 1.95 and 3.02 mg/l, the concentration of NH_4^+-ion from 0.18 to 0.65 mg/l and the concentration of copper and zinc ranged from 0.03 to 0.08 mg/l. The concentration of phenols was measured at 0.002–0.004 mg/l. Other measured components were within the respective MAC. At present, the river is moderately polluted.

Trends

By 2015, Georgia predicts an increase of approximately 10% in water withdrawal from the Alazani/Ganyh, to approximately 700 × 10⁶ m³/year. The biggest relative increases are expected in agriculture and industry, followed by household water.

AGSTEV/AGSTAFACHAI SUB-BASIN[18]

The basin of the 121-km long river Agstev/Agstafachai[19] is shared by Armenia and Azerbaijan. The river has its source at about 3,000 m a.s.l., and discharges into the Kura River.

The sub-basin has a pronounced mountainous character with an average elevation of about 1,615 m a.s.l.

AGSTEV–AKSTAFA/TAVUSH–TOVUZ AQUIFER (NO. 47)[20]

	Armenia	Azerbaijan
Volcanic and carbonate rocks of Middle Jurassic and Middle Eocene age; consists of two main aquifers;[21] groundwater flow from Armenia to Azerbaijan; medium connections with surface water.		
Area (km²)	500	500
Thickness: mean, max (m)	N/A	N/A
Groundwater resource (m³/day)	279 000	N/A
Groundwater uses and functions	Drinking water up to 75%, irrigation up to 25%	Irrigation 80%, drinking water 15%, industry 5%
Pressure factors	1) industrial waste products (wine and woodworking factories of Ijevan, food processing of Dilijan), which leads to increased concentrations of organic matter (impact severe but local); 2) waste disposal.	Mining industry (heavy metal pollution, with moderate transboundary impacts).
Groundwater management measures	It is important to make controlled water abstraction Need to be improved: urban and industrial wastewater treatment, Need to be applied: transboundary institutions to be set up, monitoring programme to be enhanced and data exchange.	
Other information	-	Azerbaijan predicted increased water use as a consequence of economic growth.

[18] Based on information from Armenia and Azerbaijan, and the First Assessment.
[19] The river is known as Agstev in Armenia, and Agstafachai in Azerbaijan.
[20] In the First Assessment, the aquifer was called "Agstev–Tabuch".
[21] In the Margaovitsky groundwater system, there are two artesian aquifers: one with a depth of 46–57 m and a thickness of 11 m and another one with a depth of 98–150 m and a thickness of 52 m.

Major transboundary tributaries include the 58-km long Getik River (basin area 586 km^2) and the 58-km long Voskepar River (basin area 510 km^2). Lake Parz and Ijevan Reservoir are located within the sub-basin.

Pressures

In the Armenian part of the basin, the Ijevan and Dilidzhane landfills are close to the river and not protected from the effects of wind, which blows waste into the river. Also, drainage water from the landfills damages water quality, either directly, or possibly by seeping into groundwater. The groundwater resource is not significant, however, and this location is not a recharge area. Furthermore, in many rural areas located in the Armenian part of the aquifer Agstev–Tavush (No. 47), landfills are not controlled. Recreational visitors also leave behind refuse, which adds to the pollution of the river.

The high concentration of heavy metals (iron (Fe), copper (Cu), manganese (Mn) is mainly due to natural background pollution, according to Armenia.

Domestic and municipal wastewaters are one of the main sources of anthropogenic pollution of the river in the territory of Armenia, assessed as severe and widespread in impact.

Another main factor of anthropogenic pollution of surface water — ranked as severe and widespread by Armenia — is diffuse pollution from agriculture.

Status and transboundary impacts

According to Armenia, in the period 2006–2009, water quality in the Agstev/Agstafachai was evaluated mainly as "good". In the Armenian part of the sub-basin, the river is exposed to background contamination as a result of hydrochemical processes. The increased concentrations of heavy metals (vanadium — V, Mn, Cu, Fe) already exceed the MACs for the fish in the upper part of the sub–basin. The main factors that have a negative impact on surface water resources are untreated urban wastewater (indicated by elevated levels of BOD and COD downstream from Ijevan, nitrogen, phosphorus and sulfate), contamination of agricultural products (e.g., nitrogen, phosphorus) and contamination by industrial wastewater (mostly with organic substances). The concentrations of, for example, zinc (Zn), Fe and sulphate, decrease from upstream to the monitoring station just upstream from the border of Armenia and Azerbaijan, indicating reduced potential for transboundary impact. At three out of four reported monitoring stations[22] in the Armenian part of the sub-basin, the amount of suspended solids has increased from 2006 to 2009. In 2006–2009, the total dissolved solids at the border of Armenia and Azerbaijan was on average 330 mg/l. In the period 2004–2006, the average concentration of dissolved solids at the border was 559 mg/l and the maximum 600 mg/l.[23] According to monitoring carried out by Azerbaijani specialists during the period from 2006 to 2009, the average content of total dissolved solids on the border between Armenia and Azerbaijan is 570 mg/l.

Trends

By 2030, air temperature is forecast to rise by 1.1 °C, while rainfall will decrease by 3.1%. Under the influence of climate change, rainfall is predicted to decrease by 3–4% and run-off to decrease by 5–10%. Groundwater levels are expected to decrease, with minor changes in groundwater quality.

POTSKHOVI/POSOF SUB–BASIN[24]

The sub–basin of the river Potskhovi/Posof[25] is shared by Turkey and Georgia. The 64-km river has its source in Turkey from springs on Goze Mountain (Göze Dağı), and discharges into the Kura River.

The sub-basin has a pronounced hilly, rough, and mountainous character on the Turkish side, with an average elevation of about 2,100–2,200 m a.s.l., and is hilly on the Georgian side, with an average elevation of about 1,700 m a.s.l.

Sub-basin of the Potskhovi/Posof River

Country	Area in the country (km^2)	Country's share (%)
Turkey	601	31.1
Georgia	1 331[a]	68.9
Total	**1 932**	

[a] *Source:* Ministry of Environment Protection and Natural Resources of Georgia.

Hydrology and hydrogeology

Floods mostly occur in late March, and reach their height in April-May.

Surface water resources in the territory of Turkey are estimated to be approximately 0.217 km^3/year, which is 18,310 m^3/year/capita. In the part of the basin that is Georgia's territory, the surface water resources are estimated, based on observations from 1936 to 1990, to be approximately 0.672 km^3/year, about 14,400 m^3/year/capita.

Pressures

In the part of the basin that is Turkey's territory, human pressure on water resources is relatively low due to the small, rural population. In Georgia's part of the basin, water withdrawal is 9.156×10^6 m^3/year, with 78% withdrawn for energy, 13% for agricultural purposes, 4% for domestic uses and 5% for industry.

Problems related to landslides and erosion are local and moderate. Animal husbandry and agriculture are the main sources of income, and are increasing in the Turkish territory in the Kura basin (see assessment of the Kura). Almost half of the Turkish basin share is cropland, and some 30% is grassland. Georgia has much less cropland (7%), and almost 30% grassland.

At present, there are no installed treatment plants for municipal wastewater, which results in a risk of surface and groundwater being polluted by untreated wastewater. Turkey assesses this pressure as local and moderate.

In Georgia, pressure from diffuse pollution from fertilizers is assessed as local and moderate, and Georgia assesses as local but severe both discharge of non–treated wastewater from settlements, and illegal landfills on riverbanks.

Status

According to the information of the Ministry of Environment Protection and Natural Resources of Georgia, the concentration of ammonium has increased in the period from 2007 to 2009 to be a few times higher than MAC: 1.5 times higher in 2008 and three times higher in 2009. In general, Georgia estimates the ecological and chemical status of the river as satisfactory.

[22] Monitoring stations at Dilijan, Ijevan and a station just upstream from the border with Azerbaijan.
[23] The MAC for TDS for fisheries is 1,000 mg/l in Armenia.
[24] Based on information from Georgia, Turkey, and the First Assessment.
[25] The river is known as Potskhovi in Georgia and as Posof in Turkey.

Responses

In the Turkish part of the basin, households are generally connected to sewerage systems and a drinking water distribution network. However, a wastewater treatment plant for Posof Municipality has not yet been planned.

Afforestation campaigns and activities have been also carried out by Turkish Ministry of Environment and Forestry. Almost 20% of the basin share of the both riparian countries is forest.

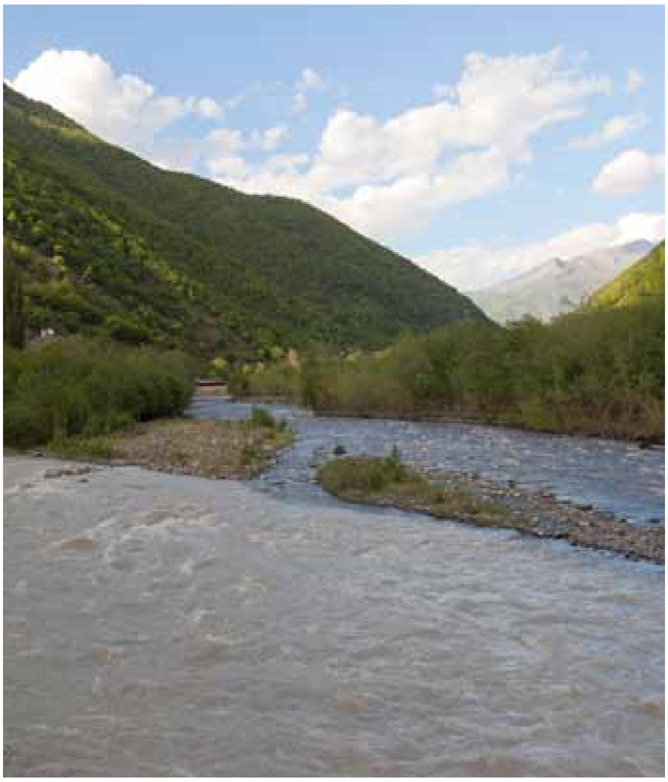
A project to construct new landfills is under development in Georgia.

The Potskhovi/Posof wildlife development and management plan, adopted by the Ministry of Environment and Forestry of Turkey, was prepared within a Turkish-Georgian collaborative project called "Enhancing Conservation in the West Lesser Caucasus through Transboundary Cooperation and Establishing a Training Program on Key Biodiversity Area Conservation".[26] The Project has supported establishment of cooperation between the two countries.

There is no transboundary monitoring at present on the Potskhovi/Posof, but the possibility of starting such work in the framework of international projects is being looked into.

Trends

Turkey predicts that pressure on the sub-basin's water resources and water uses (both consumptive and non–consumptive) will likely increase due to economic development, population increase, and climate change and variability. According to long-term national predictions of climate change, a decrease in precipitation by between 10% and 20% by 2070–2100 and increased variability in seasonal precipitation will likely result in decreased average run–off. To address these issues, preparation of a river basin management plan is seen as essential for sustainable management of the Potskhovi/Posof sub-basin water resources.



KTSIA-KHRAMI SUB-BASIN[27]

The sub-basin of the Ktsia-Khrami River is shared by Armenia, Azerbaijan and Georgia. The 201-km long Ktsia-Khrami River has its source in a spring on the southern slope of the Trialeti range at the height of 2,422 m, and discharges into the Kura. The Debed/Debeda is a major transboundary tributary.

The basin of the Ktsia-Khrami has a pronounced mountainous character with rugged terrain, with an average elevation of about 1,535 m a.s.l. The Ktsia-Khrami River is characterized by one significant spring flood. In other periods of the year the water level is mostly low, occasionally disrupted by summer-autumn high waters.

Basin of the Ktsia-Khrami River, including sub-basin of the Debed/Debeda River

Country	Area in the country (km^2)	Country's share (%)
Armenia	3 790	45.4
Georgia	310	
Subtotal Debed/ Debeda sub–basin[a]	4 100	
Georgia	4 160	53.5
Azerbaijan	80	1.1
Total	**8 340**	

[a] Armenia and Georgia share the Debed/Debeda sub-basin, with respectively 92.4% and 7.6% of the basin.
Sources: Ministry of Environment Protection and Natural Resources of Georgia and L.A. Chilingarjan et al. "Hydrography of rivers and lakes in Armenia", Institute of hydro-technology and water problems, Armenia.

Hydrology and hydrogeology

In the part of the Ktsia-Khrami sub-basin that is Georgia's territory, surface water resources are estimated at 1.631 km^3/year (based on data from 1928 to 1990) and groundwater resources at 0.0815 km^3/year, making up a total of 1.713 km^3/year, equalling 9,465 m^3/year/capita.

Pressures

More than 50% of the land is used for agriculture, some 20% is forest and about 30% grassland.

The total withdrawal in the Georgian part of the Ktsia-Khrami Basin is 853×10^6 m^3/year, with 94% for energy, 3% for domestic purposes, 2% for industry, and 1% for agriculture.[28]

Municipal wastewater treatment plants in a number of cities in Georgia are not operational, and in rural areas there is no sewage collection. The impact is considered serious, but remaining local according to Georgia. Pollution from illegal waste dumps is one of the main sources of pollution in the Georgian part of the sub-basin, and its impact is described as widespread and severe.

The copper-mining industry is reported to have a negative impact on the river in Georgia: acid mine drainage — leaching of metals from waste rock dumps when exposed to rainfall at JSC Madneuli in Kazreti village — causes pollution of the Mashavera River (a tributary of Ktsia-Khrami).

The Ceyhan-Tbilisi-Baku oil pipeline traversing the basin is considered a risk of accidental pollution in Georgia.

Status and responses

Georgia reports that during the period from 2007 to 2009, only the concentration of ammonium ions in the Ktsia-Khrami exceeded the MAC, three times in January 2008 and nine times in July 2009.

[26] Critical Ecosystem Partnership Fund Final Project Completion Report: "Enhancing Conservation in the West Lesser Caucasus through Transboundary Cooperation and Establishing a Training Program on Key Biodiversity Area Conservation", 2009.
[27] Based on information from Armenia and Georgia, and the First Assessment.
[28] *Source:* Yearbook of Water Use in Georgia 2008.

KTSIA-KHRAMI AQUIFER (NO. 48)

	Georgia	Azerbaijan
Type 3; Tertiary and Quaternary age gravel and conglomerates, tuffaceous sandstone, calcareous basalt, dolerites, quartz sandstone, marl, sand etc.; strong links with surface water.		
Area (km^2)	340	N/A
Thickness: mean, max (m)	120, 250	N/A
Groundwater uses and functions	Used for drinking water.	N/A
Other information	Joint monitoring programme is felt to be needed.	N/A

On agricultural water use, drip irrigation techniques have been introduced through several projects in Georgia.

The JSC Madneuli mining company has developed a plan of water conservation measures, which is reportedly implemented consistently. Georgia reports some measures to have been realized to protect riverbanks.

For Georgia, pollution from municipal non-treated or inefficiently treated wastewaters is a priority issue to address.

In the framework of the EU Project: "Trans-Boundary River Management Phase II for the Kura River Basin — Armenia, Georgia, Azerbaijan", joint monitoring was being carried out between Georgia, Azerbaijan and Armenia four times a year from 2009 to 2010.

Trends

Georgia predicts water use for agriculture, domestic needs and for industry to increase relative to water use for energy by 2015. The total water withdrawal in 2015 is predicted to be 875 $\times 10^6$ m^3/year, which is more than in 2008.

According to the draft strategic directions of the Ministry of Environment and Natural Resources of Georgia (2009), a River Basin Management Plan will be developed for the Ktsia-Khrami River in 2012.

DEBED/DEBEDA SUB-BASIN[29]

The basin of the river Debed/Debeda[30] is shared by Armenia and Georgia. The 154-km long river rises at about 2,100 m a.s.l. and flows through a deep valley, joins with the Ktsia-Khrami, and discharges into the Kura. The sub-basin has a pronounced mountain territory character with an average elevation of about 1,770 m a.s.l.

Hydrology and hydrogeology

Flow of the river is not regulated. There is one reservoir on the Dzoraget tributary in the Armenian part of the catchment area of the Debed/Debeda River-Metsavan, with a volume of 5.40 × 10^6 m^3. This facility for energy generation impacts moderately on natural flow.

Spring floods affect the lower part of the sub-basin, also causing damage.

Surface water resources in the sub-basin as flow generated in Armenia are estimated at 1.197 km^3/year (based on data from 1955 and 1961 to 2008) and groundwater resources at 0.180 km^3/year (average for the years from 1991 to 2008), making up a total of 1.377 km^3/year. This equals 188,000 m^3/year/capita.

Pressures

In Georgia, river water is mainly used for irrigation (13% of the cropland area irrigated). Due to the poor technical condition of irrigation systems, water loss occurs. In addition, there is pollution of surface water from diffuse sources as a result of the use of fertilizers and pesticides.

In the Armenian part of the basin, surface water withdrawal for irrigation (102 × 10^6 m^3), impacts locally on natural water flow. Almost 12% of Armenia's share of the sub-basin is cropland (27% of it irrigated), 33% grassland.

In the Armenian part of the sub–basin, heavy metal (V, Mn, Cu, Fe) concentrations are naturally elevated (due to ore deposits). Improvements in ore processing facilities in recent years have decreased water pollution by wastewaters from the ore enrichment and processing industry, but leakages from a tailings dam of the Achtalinsk ore processing factory are still a concern. Discharges of municipal wastewater are also a pressure factor.

Diffuse pollution from agriculture is among the main pollution sources.

Shortcomings in solid waste handling can influence water quality negatively, but this is local and remains moderate.

Status and transboundary impacts

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

The most significant factors concerning impacts on surface water are untreated municipal wastewater (increased BOD, COD, and content of nitrogen and phosphorus), pollution from agriculture (e.g., nitrogen, phosphorus, pesticides) and pollution from industrial wastewater (heavy metals). Erosion and accumulation of sediments also affect the status of the water system. In Armenia, the intensity of the before-mentioned factors is observed to be reduced already at the border between Armenia and Georgia. In the period 2006–2009, the average content of dissolved solids at the border between Armenia and Georgia was 270 mg/l, according to monitoring by Armenia.

Total water withdrawal and withdrawals by sector in the Debed/Debeda sub-basin

Country	Total withdrawal $\times 10^6$ m^3/year %	Agricultural %	Domestic %	Industry %	Energy %	Other %
Armenia	1358.8	7.5	0.8	0.3	90.6	0.7
Georgia	8.9	99	-	1	-	-

29 Based on information from Armenia and Georgia, and the First Assessment.
30 The river is known as Debed in Armenia and Debeda in Georgia.

DEBED AQUIFER (NO. 46)[31]

	Georgia	Armenia
Type 3; Consists of two main aquifers[a] — Alluvial–proluvial formation of modern Quaternary age in the upper part of the basin; volcanic–sedimentary rocks, limestone, tuffbreccia; medium links with surface water.		
Area (km²)	N/A	20
Thickness: mean, max (m)	N/A	20–30, 50
Groundwater resource (m³/day)	N/A	39 000
Groundwater uses and functions	Drinking water supply 100%; increased water use predicted as a consequence of economic growth.	Drinking water up to 90%, irrigation and mining industry.
Pressure factors	Lack of data.	Mining industry (assessed as severe in influence but local), agriculture and drainage water from dumps (widespread but moderate).
Groundwater management measures	Effective: controlled water abstraction. Need to be improved: urban and industrial wastewater treatment. Need to be applied: transboundary institutions to be set up, monitoring programme to be enhanced.	It is important to make controlled water abstraction. Need to be improved: urban and industrial wastewater treatment. Need to be applied: transboundary institutions to be set up, monitoring programme to be enhanced and data exchange.
Other information	1) There is a lack of data about problems related to groundwater quantity and quality; 2) Joint monitoring programme is felt to be needed.	

[a] There are two main aquifers: one at a depth of 71–120 m, with a thickness of stratum 48 m, and a second one at a depth of 98–150 m, with a thickness of stratum of 25 m.

Responses

Supported by the Municipal Development Fund of Georgia, projects for rehabilitation of irrigation systems are implemented. Bank protection activities are carried out at selected sites.

So far, no particular measures have been taken in Armenia to address pollution by municipal wastewaters.

In the framework of the EU Project: "Trans–Boundary River Management Phase II for the Kura River Basin — Armenia, Georgia, Azerbaijan", joint monitoring was being carried out between Georgia, Azerbaijan and Armenia four times a year, at 16 monitoring stations, from 2009 to 2010.

Trends

Armenia predicts that by 2030 that the air temperature will rise by 1.1 °C and that precipitation will decline by 3.1%. River discharge is predicted to decline by 3–5% and groundwater level to drop under the influence of climate change. Some moderate deterioration of groundwater quality is expected. Even though indirect or secondary impacts are expected to be appreciable in Armenia, water use will not be greatly influenced.

[31] Based on information provided by Armenia and the First Assessment, in which the aquifer was called "Pambak–Debet".

LAKE JANDARI[32]

Lake Jandari (surface area 12.5 km^2), which, through construction of the Gardaban Canal, was turned into a reservoir, is shared by Georgia and Azerbaijan. The volume of water is 51.15 × 10^6 m^3, with a maximum depth of 7.2 m and average depth of 4.8 m. Water comes mainly through the Gardaban Canal (maximum capacity 15 m^3/s) from the Kura River, and another canal starting from the Tbilisi (Samgori) water reservoir. The lake is quite rich in fish (carp and catfish).

Basin of Lake Jandari

Country	Area in the country (km^2)	Country's share (%)
Georgia	68	67
Azerbaijan	34	33
Total	**102**	

Pressures and status

Wastes from industry, residential areas and agriculture pollute water coming into the reservoir from the Kura River.

A channel was dug from the south-eastern bank of the lake for irrigating land in the territory of Azerbaijan.

In Georgia, lake waters are not used for industrial purposes, and there are no industrial enterprises in the surroundings. There are no direct wastewater discharges to the lake in Georgia. The lake is an important area for commercial fisheries.

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

Transboundary cooperation

According to the agreement concluded in 1993 between the State Committee of Irrigation and Water Economy of the Azerbaijan Republic and the Department of Management of Melioration Systems of Georgia, 70 × 10^6 m^3 of water is delivered annually to Jandari water reservoir from Georgia. This includes 50 × 10^6 m^3 for irrigation of 8,500 ha of land of the Akstaphi region of Azerbaijan, and 20 × 10^6 m^3 for maintaining the ecological balance of the water reservoirs.

According to the Agreement on Collaboration in Environmental Protection between the Governments of Georgia and Azerbaijan (1997), the Parties of the Agreement shall consolidate their efforts and take all appropriate measures to ensure that the Kura River and Lake Jandari waters are used with the aim of ecologically sound and rational water management, conservation of water resources, and environmental protection.

KARTSAKHI LAKE/AKTAŞ GÖLÜ[33]

The area of the lake surface is 27 km^2, (about 13 km^2 in Turkey and 14 km^2 in Georgia) and the basin is 158 km^2.[34] The average and maximum depths are respectively 1.5 and 3.5 m.

The basin is characterized by a very weakly developed hydrographical network, consisting mainly of seasonal streams. On the South-Western side (Turkish territory), there are some springs.

Pressures and status

The lake is not designated as protected area but, being located in a military zone on the Turkish side, human activities are highly restricted. Therefore the quantity and quality of the lake water is preserved as in natural conditions. Only three villages are located near the lake in Turkish territory (population some 700). In the Georgian part, the population is some 5,900 within a radius of 7 km from the lake. There is no extraction of water from the lake in Turkey, nor does Georgia use the lake water for industrial or household needs.

The lake water has naturally elevated salinity of 880 mg/l, affected by volcanic rocks occurring in the area.

Lake Kartsakhi/Aktaş Gölü belongs to the Javakheti Wetlands, of which Lake Arpi is included in the List of Wetlands of International Importance under the Ramsar Convention. The lake is a breeding site for White Pelican and the Dalmatian Pelican, as well as for a variety of other bird species.

[32] Based on information from Georgia and the First Assessment.
[33] Based on information from Georgia, Turkey and the First Assessment.
[34] *Source:* Turkish Statistical Institute, 2008; Resource of Surface Water, Georgia, 1974.

WETLANDS OF JAVAKHETI REGION[35]

General description of the wetland area

The distinctive characteristic of the Javakheti region, which distinguishes it from the whole Caucasus, is the presence of numerous lakes. Most are connected by rivers, although groundwater interchange is also notable, and all together they represent an ecological entity. Several lakes are of great importance for maintaining the biodiversity of this region. These are, specifically, Lake Arpi in Armenia, which became a reservoir (2,120 ha) after construction of a dam in 1946–1950; Georgian high mountain shallow freshwater lakes Madatapa (870 ha), Khanchali (590 ha) and Bugdasheni (30 ha); and Lake Kartsakhi/Aktaş/Gölü (2,660 ha), shared by Georgia and Turkey. Adjacent marshes and wet meadows as well as flood-plains also represent important wetland ecosystems.

Main wetland ecosystem services

Lake Arpi is considered to play a significant role in sediment trapping. The lakes in this area are valuable sources of freshwater. Lake Arpi also provides water for irrigation, while cattle watering and fishing are also of major importance for the local economy. Lake Khanchali and springs fed by the lake are important sources of drinking and irrigation water for local villages; in Georgia some lakes are also used by the local population for fishing. Around the lakes, adjacent meadows are traditionally used for mowing and cattle and sheep grazing. Javakheti landscapes are of high aesthetic value, and the region has good potential for recreation and nature tourism development.

Biodiversity values of the wetland area

Javakheti wetland ecosystems support species-rich natural communities that include endemic species (e.g., reptiles, plants and Armenian Gulls), as well as other threatened elements of biological diversity.

One of the main bird migration routes in the Caucasus crosses the Javakheti Plateau, with lakes Arpi, Madatapa, Bugdashen and Khanchali being the most important for migratory birds in this region. In Georgia alone, the lakes receive about 30,000–40,000 migratory birds each year. The lakes provide important feeding, resting and breeding habitats for grebes, pelicans, herons, geese, ducks, waders, gulls, terns and other waterfowl, as well as for birds of prey, including globally threatened species mentioned in the IUCN Red List: Dalmatian Pelican, Imperial Eagle and Greater Spotted Eagle. Many species are also covered by the African-Eurasian Waterbird Agreement and national Red Lists.

Pressure factors and transboundary impacts

After construction of the dam, the surface of the lake/reservoir Arpi increased around five times, the volume around 20 times, and seasonal water-level fluctuation started exceeding 3 m (natural fluctuations less than 0.5 m). The average turnover period became one year (while the natural one is one month). This caused loss of submerged, floating and emergent vegetation, and degradation of habitats for waterfowl and fish. In addition, droughts downstream cause serious deterioration of spawning and nesting conditions for fish and birds. Organic pollution from agriculture (mainly livestock) in the form of nitrogen and phosphorus represents another threat.

On the Georgian side, large-scale draining of wetlands for agricultural purposes or transforming them into fish farms began in the 1960s. Lake Khanchali was affected the most: due to drainage it lost two thirds of its surface area, and later was completely drained several times. The draining of Bugdasheni Lake began in 1998 due to draw-off for drinking water supply for the town Ninotsminda. The southern part of Lake Madatapa is dammed for fishing and agricultural needs; this prevents water exchange and facilitates eutrophication. Draining of lakes leads to the loss of habitats important for waterbirds; another effect is decreasing humidity leading to changes in plant communities that may also affect agricultural production. Additional water loss occurs due to damaged irrigation systems. Disturbing factors for waterbirds include illegal hunting in spring, as well as mowing on lakes' shores and egg-collecting by locals.

In Georgia, introduction of non–native fish species negatively affected local fish communities. In addition, Crucian Carp, which has minor economic value, has been accidentally introduced and has out-competed all native fish species. One positive consequence is that these fish provide a food source for birds on those lakes where there was no fish before.

Transboundary wetland management

The "Eco-regional Nature Protection Programme for the South Caucasus Region", part of the Caucasus Initiative launched by the German Federal Ministry for Economic Cooperation and Development (BMZ), aims to promote cooperation on development of a coherent strategy to ensure biodiversity conservation in the region. A number of wetlands will be given the status of protected areas on both sides of Armenian-Georgian border. In Armenia, the Programme component "Establishment of Protected Areas in the Armenian Javakheti Region" is aimed at establishing a National Park and integrating it into the local context, as well as promoting related transboundary cooperation. The National Park was established in 2009, and includes Lake Arpi and its basin, as well as flood-plains of the upper stream of the Akhuryan/Arpaçay River. At present Ramsar Site Lake Arpi covers 3,149 ha, and includes the whole reservoir and surrounding marshes.

A project aimed at establishment of Javakheti National Park and Kanchali, Madatapa and Bugdasheni Managed Reserves is implemented by the Agency of Protected Areas of Georgia and the WWF Caucasus Programme Office with financial support of the BMZ and German Credit Bank of Reconstruction (KFW).

[35] *Sources:* Information Sheet on Ramsar Wetlands (RIS), available at the Ramsar Sites Information Service; Lake Arpi Ramsar site; Armenia (RIS updated in 1997); Jenderedjian, K., and others. About Wetlands, and around Wetlands in Armenia. Zangak, Yerevan. 2004; Jenderedjian, K. Transboundary management of Kura Basin wetlands as an important step towards waterbird conservation in the South Caucasus region; Boere, G.C., Galbraith, C.A., Stroud, D.A. (eds). Waterbirds around the world. The Stationery Office, Edinburgh, UK. 2006; Matcharashvili I. and others. Javakheti Wetlands: biodiversity and conservation, NACRES, Tbilisi. 2004.

ARAKS/ARAS SUB-BASIN[36]

The sub-basin of the 1,072-km river Araks/Aras[37] is shared by Armenia, Azerbaijan, the Islamic Republic of Iran and Turkey. The river has its source at 2,732 m a.s.l. and discharges into the Kura. The character of the basin ranges from mountain terrain, with an elevation from 2,200 to 2,700 m a.s.l., to lowland.

Major transboundary tributaries to the Araks/Aras River include the rivers Akhuryan/Arpaçay, Arpa, Sarisu/Sari Su, Kotur/Qotur, Voghji/Ohchu and Vorotan/Bargushad.

The reservoirs in the Iranian part of the sub-basin include Aras storage dam, Mill-Moghan diversion dam, Khoda-Afarin storage dam, and the Ghiz-Gale diversion dam.

The following wetlands/peatlands are located in the Iranian part of the basin: Arasbaran protected area; Marakan protected area; Kiamaki wildlife preserve; Yakarat no-hunting zone; Aghaghol wetland and no-hunting zone; and Yarim Ghijel wetland. Also the protected areas of Ghare Boulagh wetland, Sari Su wetland, Eshgh Abad wetland and Siah Baz wetland are located in the Iranian part.

Sub-basin of the Araks/Aras River

Country	Area in the country (km^2)	Country's share (%)
Armenia	22 560[a]	22
Azerbaijan	18 140	17
Islamic Republic of Iran	41 800	40
Turkey	22 285[b]	21
Total	**104 785**	

[a] Chilingaryan, L.A. and others, "Hydrography of rivers and lakes in Armenia", Institute of hydro-technology and water problems, Armenia. 2002.
[b] Total catchment area of the Kura-Aras basin in Turkey is 27,548 km^2.

In the part of the Araks/Aras sub-basin that is Turkey's territory, surface water resources are estimated at 2.190 km^3/year and groundwater resources at 0.144 km^3/year, making up a total of 2.334 km^3/year, representing 3,058 m^3/year/capita.

In the Iranian part of the basin, surface water resources are estimated at 1.327 km^3/year and groundwater resources at 0.730 km^3/year, making up a total of 2.057 km^3/year, almost 854 m^3/year/capita.

Pressures

There are pressures on water quality from mining, industrial and municipal wastewater, as well as natural geochemical processes. Agricultural pollution from return flows consisting of agrochemical waste, pesticides, nutrients and salts is a particular concern along the whole Araks/Aras River.

Agriculture and animal husbandry are the main economic activities in the Turkish part of the basin, where there is need for development of irrigation (including efficient techniques). Some 28% of Turkey's territory in the basin is cropland (20% of it irrigated). The shares of cropland of the basin area in Armenia and in the Islamic Republic of Iran are somewhat smaller, about 13% and 15% (37% irrigated), respectively. The Turkish part of the basin is not industrialized, with manufacturing industry limited to small- and medium-size factories; the tourist sector is growing.

Urban areas are connected to a sewerage network, but in general no wastewater treatment plants have been set up yet. Concerning solid waste disposal, in the Turkish part, only Erzurum province has a sanitary landfill. Municipalities' controlled dump sites cause a pollution risk to surface water and groundwater. The pressures from wastewater and solid waste are both assessed by Turkey as widespread but moderate. Wastewater discharges from small and medium industries are reported to cause pollution in Turkey, but it is considered local and moderate, whereas in the Islamic Republic of Iran discharges from industries are viewed to have a widespread and severe influence.

Flooding of the plain areas in Iğdır province in Turkey is a longstanding issue, despite protection works over decades. The lower part of the Araks/Aras River in Turkey is at a risk of flooding during high flows in winter and spring.

NAKHICHEVAN/LARIJAN AND DJEBRAIL AQUIFER (NO. 49)[38]

	Azerbaijan	Islamic Republic of Iran
Type 3; gravel-pebble, sand, boulder. Strong and shallow links with surface water.		
Area (km^2)	1 480	N/A
Thickness: mean, max (m)	60, 150	N/A
Groundwater uses and functions	Irrigation (55–60%) drinking water (40–45%)	N/A
Groundwater management measures	Need to be improved: abstraction management, quantity and quality monitoring, protection zones, good agricultural practices, mapping. Need to be applied: transboundary institutions, data exchange, integrated river basin management, treatment of urban and industrial wastewater.	N/A
Other information	1) Joint monitoring programme is felt to be needed; 2) Increased water use is expected in Azerbaijan; 3) no water quality or quantity problems are reported.	N/A

[36] Based on information from Armenia, the Islamic Republic of Iran, Turkey and the First Assessment.
[37] The river is known as Aras in Azerbaijan, the Islamic Republic of Iran and Turkey.
[38] In the First Assessment, the aquifer was called "Middle and Lower Araks".

Total water withdrawal and withdrawals per sector in the Araks/Aras sub-basin

Country	Total withdrawal $\times 10^6$ m^3/year	Agricultural %	Domestic %	Industry %	Energy %	Other %
Armenia	N/A	N/A	N/A	N/A	N/A	N/A
Azerbaijan	N/A	N/A	N/A	N/A	N/A	N/A
Islamic Republic of Iran	3 000	93	5.5	0.76	0	0.5
Turkey[a]	507	89	11	N/A	N/A	N/A

[a] Agriculture and domestic are the main water-user sectors (no information available on the others).

Hydraulic action, particularly in the plain regions, has resulted in intense bank erosion. In Turkey, erosion is severe in steep valleys and slopes, from where sediments are transported from tributaries into the main river course. Morphological changes and erosion in the riverbed and riverbanks have occurred also due to aggregate mining, which is assessed as severe in influence, ranging from local to widespread. Medium- and small-scale quarrying in the Turkish part of the sub-basin result in morphological changes in landscape.

According to the Islamic Republic of Iran, heavy metals (Cu, Mn, Fe etc.) from mining waste in left-side tributaries from Armenia rank among the main sources of transboundary pollution in the Araks/Aras River. However, investments in improving the facilities in recent years, including by international companies, have improved the situation. According to Armenia, 1) the wastewater flow from mining on the Armenian side is small and their preliminary treatment should limit adding to heavy metals content in the river; 2) heavy metals content in the river at the Armenian-Iranian border, according to the Armenian-Iranian monitoring data 2006-2009, is typical geochemical background.

Transfer of experience within the region could be beneficial, for example in controlling pollution from copper mines, in which area the Islamic Republic of Iran has gained experience by developing closed water circulation in the processes. There is awareness that tailings dams are vulnerable to earthquakes.

In Turkey, water supply for villages and municipalities is mainly provided from groundwater sources, and groundwater is also used by farmers for local irrigation. Surface water is withdrawn for irrigation. There are hydropower projects under development, which may influence water availability for other sectors.

The Islamic Republic of Iran expects its water use to increase from 3,000 × 10^6 m^3/year to 4,800 × 10^6 m^3/year.

Status

The ecological and chemical status of the river is reported as satisfactory for aquatic life, municipal and industrial uses, and other uses.

According to measurements by Armenia from 2006 to 2009 along the Araks/Aras, heavy metals such as Al, Fe, Mn, Cr and V occur in the water in moderate amounts. Some of these are part of the typical geochemical background of the Araks/Aras. The Islamic Republic of Iran rates the issue of naturally elevated metal concentrations as serious but local; Armenia, as widespread but moderate (considering the levels of the following elements: Al, Fe, Mn, V, Cr, cobalt (Co), nickel (Ni), Cu and Zn). Chrome (Cr) occurs at amounts exceeding MAC almost every year. The nitrate level did not exceed MAC during the same observation period. Metal concentrations are influenced by elevated background levels in the area.

Water quality monitoring results from the period 2006–2009 in Armenia indicate a gradual increasing trend of BOD_5 (MAC: 3 mg/l), especially during 2009. The concentration of total phosphorus was lower than MAC (MAC: 1–0.4 mg/l). The nitrite ion exceeded MAC (MAC: 0.024 mg N/l) during the 2006–2009 period, and the greatest influence of municipal wastewater on water quality in the river has been observed before and after mixing with waters of the tributary Razdan.

The previously important industrial activities in Armenia (mineral fertilizers, synthetics for instruments and watches, fiberglass) have considerably decreased in the past two-three decades; the chemical industry essentially shut down for a long period after the break-up of the Soviet Union. While the Islamic Republic of Iran assesses that there are still problems of heavy metal pollution, in particular downstream the Agarak copper-molybdenum mine (on the Karchevan tributary), Armenia assesses mining impacts limited, taking into account the geochemical background concentrations and that the treatment of wastewater from mining has improved.

In the section of the river downstream in Azerbaijan, the highest concentrations in river water are observed for phenols (13 MAC), metals (9 MAC), sulphate (6 MAC) and petroleum (4 MAC),[39] and the quantity of mineralization/total dissolved solids (1,130 mg/l) exceeds the sanitary norm by 25-35%.

Heavy metal concentrations from monitoring locations on the Araks/Aras in Armenia before (IMS-1, 500 m upstream) and after (IMS-3; 2.5 km downstream) the confluence with the Karchevan tributary where wastewaters from the Agarak mine are discharged

Sites	Copper (mg/l)	Manganese (mg/l)	Iron (mg/l)	Chrome (mg/l)
IMS-1	0.0039	0.0130	0.1729	0.0045
IMS-3	0.0022	0.0106	0.2016	0.0040

Source: Armenian – Iranian joint monitoring.

According to Turkish Inland Water Quality Standards, water quality in the Turkish part of the Araks/Aras River is in Class I and Class II, that is, unpolluted and/or less polluted water bodies, respectively.

Responses

In the Araks/Aras River Basin, the monitoring network in Turkish territory includes some 55 monitoring stations (regular monitoring of water quantity and quality goes back to the 1960s), and the network in Armenian territory 80 stations (regular monitoring of quality since 1977).

The development of Water Resources Management Plan for the Araks/Aras River sub-basin is a part of Turkey's medium- to long-term national environmental strategies. Water and land development projects carried out in the Turkish part of the Araks/Aras River sub-basin are mainly oriented towards developing hydropower, irrigation and domestic water supply. There is at present

[39] The MAC for phenols and petroleum is 0.05 mg/l in Armenia. In Armenia the detected concentrations have been reported to be a few times lower.

time no river basin organization or council in the Turkish part of the Araks/Aras River sub-basin. In Turkey, conjunctive management of surface and groundwaters is considered in determining water availability and allocation. A comprehensive IWRM plan for the Araks/Aras Basin is under preparation, according to the Islamic Republic of Iran.

Wastewater treatment plants for municipalities will be installed in Turkey as a part of medium- and long-term national environment strategies (3–10 years). A wastewater treatment plant is required from new industrial facilities, and the existing small-medium industrial facilities are required to complete their wastewater treatment plants. Any direct discharges into groundwater bodies are not allowed.

Measures implemented in Turkey to tackle pollution from agriculture include the introduction of efficient drainage systems for irrigated land, as well as limiting and controlling use of pesticides and fertilizers in agriculture. Extension of efficient irrigation methods are one of the priorities of the Turkish Government in agricultural policy; the application of drip and sprinkle irrigation techniques has started in the Araks/Aras River sub-basin. Organic agricultural practices have been adopted, for example, in grain production and fruit growing by some local producers and farmers. The Organic Agriculture Law was adopted in 2004. In most modern Iranian irrigation and drainage schemes — e.g., Moghan, Khodaafarin — wastewater reuse or managed aquifer recharge are applied. Demand management should be developed more.

Afforestation of land has been carried out by Turkey's Ministry of Environment and Forestry, for example on the drainage area of existing reservoirs. Erosion control measurements are done in Turkish territory, and sediments are dredged in certain parts of the river.

Transboundary cooperation

Bilateral transboundary collaborative projects on water quality monitoring are ongoing between the Islamic Republic of Iran and Armenia, as well as between Iran and Azerbaijan. A related database has also been established in cooperation.

The Islamic Republic of Iran has some river training and flood control projects on the Araks/Aras River with both Armenia and Azerbaijan: river training plans are prepared and shared with the other riparian countries for possible modifications regarding border protocols or needed changes in the river regime.

The following are felt to be lacking in the current institutional frameworks in the Araks/Aras sub-basin:

- a regional strategy for integrated management and planning (for preventing and reducing pollution in particular);
- a multilateral agreement between the riparian countries; and,
- a transboundary basin council.

Strengthening cooperation in water quality control is called for, as well as in risk and crisis management in cases of man-made or natural disasters.

Trends

In the sub-basin of the Araks/Aras, in the Iranian part, average annual temperature is predicted to increase by 1.5 to 2°C by 2050. A reduction of 3% in precipitation is expected. More frequent floods and droughts are predicted. The impacts on land use and cropping patterns, as well as agricultural water requirements, are expected to be considerable. Groundwater quality is expected to deteriorate.

Turkey reports that, in the region in general, precipitation is predicted to decrease from 10% to 20% by 2070–2100, and its seasonal variability is predicted to increase. By 2030 a decrease of 10% to 20% in run-off is predicted, with increased variability. Based on expert knowledge, groundwater levels are predicted to decrease, and groundwater quality to be affected negatively. Flood/drought risk is expected to increase. Both consumptive and non-consumptive water uses are foreseen to increase.

According to adaptation strategies identified in National Climate Change Strategy[40] of Turkey, the possible negative impacts of climate change on vulnerable ecosystems, urban biotopes and biological diversity will be identified, and a vulnerability assessment will be carried out. Development and implementation of preventive and preparedness measures in Turkey will be done using scenarios and risk maps to be prepared.

In Turkey, the water resources of the sub-basin have been used mainly for irrigation, domestic supply and hydropower purposes. In recent years, particularly, hydropower projects have been owned by private enterprises according to Turkish Electricity market law, increasing involvement and investment of the private sector in water projects in the sub-basin.

AKHURYAN/ARPAÇAY SUB-BASIN[41]

The sub-basin of the 186-km long river Akhuryan/Arpaçay[42] is shared by Armenia and Turkey. The river has its source in Armenia and discharges to the Araks/Aras. The Karkachun/Karahan, which is 55-km long and has a catchment area of 1,020 km², is the biggest tributary.

The basin has a pronounced mountainous and highland character, with an average elevation of about 2,010 m a.s.l. in the Armenian part, and 1,500–1,600 m a.s.l. in the Turkish part.

LENINAK-SHIRAKS AQUIFER (NO. 50)

	Armenia	Turkey
None of the described aquifer[a] types; lavas, basalts and andesitic basalts of Upper Miocene, Quaternary and Upper Pliocene age; two aquifer layers; groundwater flow from Akhuryan/Arpaçay sub-basin to Ararat valley; medium links with surface water.		
Area (km²)	925	N/A
Renewable groundwater resource (m³/d)	612	N/A
Thickness: mean, max (m)	18, 85	N/A
Groundwater uses and functions	Community water supply, (industrial) production, irrigation and fisheries.	N/A
Other information	Population 168 900 (density 182 inhabitants/km²).	

[a] Based on information provided by Armenia. Turkey reports that it has not carried out any study on transboundary aquifers in this region.

[40] National Climate Change Strategy. Ministry of Environment and Forestry of Turkey, Ankara. December 2009.
[41] Based on information from Armenia, Turkey and the First Assessment.
[42] The river is known as Arpaçay in Turkey and as Akhuryan in Armenia.

Sub-basin of the Akhuryan/Arpaçay River

Country	Area in the country (km²)[a]	Country's share (%)
Turkey	6 798	71
Armenia	2 784	29
Total	**9 582**	

[a] *Source:* Chilingaryan, L.A. and others. Hydrography of rivers and lakes in Armenia, Institute of hydro-technology and water problems, Armenia. 2002.

In the part of the basin that is Turkey's territory, surface water resources are estimated at 0.781 km³/year and groundwater resources at 0.020 km³/year, making up a total of 0.801 km³/year, representing 3,055 m³/capita/year. In the part of the sub-basin that is Armenia's territory, surface water resources are estimated at 1.093 km³/year (based on data from 1983 to 2008) and groundwater resources at 0.369 km³/year (based on data from 1983 to 2008), a total of 1.462 km³/year, with an approximate total of 5,200 m³/capita/year.

The river flow of the Akhuryan/Arpaçay is heavily regulated by reservoirs: Akhuryan/Arpaçay Reservoir (volume 525 × 10^6 m³) and Arpilits Reservoir (105 × 10^6 m³).

Pressures

Surface water is mainly used for irrigation purposes in the Turkish part of the sub-basin. Water supply for municipalities is generally provided from groundwater sources, and this is also used for local irrigation by farmers.

Some 913 × 10^6 m³ of water was withdrawn in 2009 in the Turkish part of the basin, including withdrawal from storage water of Arpacay Reservoir. Some 97% of the withdrawal was for agricultural and 3% for domestic purposes. Some 35% of Turkey's territory in the basin is cropland (about 10% irrigated), and almost 40% is grassland; for Armenia, the figures are 27% and 43%, respectively. Water use for industry may be considered insignificant in the Turkish share of the basin; the existing small factories are supplied generally with water from municipalities or with groundwater from wells.

The main pressure factors in the Akhuryan/Arpaçay basin include agriculture and animal husbandry, as well as discharge of untreated or insufficiently treated urban/municipal wastewater. Municipalities in urban areas are generally connected to a sewerage network, but they mostly do not have wastewater treatment plants in place for the time being. Controlled municipal dump sites also cause a pollution risk for surface and groundwater resources. Morphological changes and erosion in the riverbed are also a concern. Geochemical processes are another factor that affects water quality. River water quality is assessed as moderate.

Trends

According to predictions reported by Armenia, air temperature is expected to increase by 1.1°C, and precipitation to decrease by 3.1%, by 2030. Later, the amount of precipitation is predicted to decrease by 7 to 10%. As a result of climate change, groundwater level is expected to decrease. River discharges are predicted to decrease by 10–15%. The impact on water use is also expected to be significant.

Turkey reports that there is no existing study or research involving climate change modelling for the sub-basin of the Akhuryan/Arpaçay River based on observations. However, according to national predictions and long-term scenarios, both precipitation and river run-off are expected to decrease by 10 to 20% — the former by 2070–2100 and the latter by 2030 — with increased seasonal variability in precipitation and flood/drought risk. Water use is foreseen to increase.

AKHURYAN/ARPAÇAY RESERVOIR[43]

The Akhuryan/Arpaçay dam[44] (active storage capacity of 525 × 10^6 m³/year) was jointly constructed by Turkey and the Soviet Union, mainly for irrigation and flood protection, between the period from 1979 to 1983, along the Akhuryan/Arpaçay boundary river, in accordance with the Cooperation Agreement of 1975 between the two countries. Up until the 1990s the dam was jointly operated by Turkey and the Soviet Union and, since then, by Turkey and Armenia.

Pressures

In Turkey, the water of Akhuryan/Arpaçay Reservoir and the flow of the Araks/Aras River is used for irrigation of Iğdır Plain (70,530 ha). The Serdarabat Regulator for diverting irrigation water was constructed in 1937 downstream of the dam, on the main course of the Araks/Aras River, in accordance with a 1927 agreement between Turkey and the Soviet Union.

Since 2004, there is an Interstate Commission of Armenia and Turkey on the Use of Akhuryan Water Reservoir.

ARPA SUB-BASIN[45]

The sub-basin of the 92-km river Arpa is shared by Armenia and Azerbaijan. The river has its source at an elevation of 3,200 m a.s.l. and discharges into the Araks/Aras River.

The sub-basin has a pronounced mountainous character, with an average elevation of about 2,090 m a.s.l.

Sub-basin of the Arpa River

Country	Area in the country (km²)	Country's share (%)
Armenia	2 080	79
Azerbaijan	550	21
Total	**2 630**	

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

Hydrology and hydrogeology

Reservoirs on the Arpa include Gerger (volume 26.0 × 10^6 m³)

HERHER, MALISHKIN AND JERMUK AQUIFERS (NO. 51)[43]

	Armenia	Azerbaijan
Does not correspond with described aquifer types; volcanic rocks of Upper and Middle Eocene age; weak links with surface water.		
Groundwater uses and functions	Domestic water supply and irrigation.	N/A
Pressure factors	Agriculture.	N/A
Other information	In the Armenian part of the aquifer, groundwater storage is estimated to be about 40 × 10^6 m³.	N/A

[43] Based on information from Armenia, Turkey and the First Assessment.
[44] The dam is called "Arpaçay Baraji" and the reservoir "Arpaçay Baraj Gölü" in Turkey.

and Kechoot (volume 25.0 × 10^6 m^3). Flow is strongly regulated by the reservoirs, and there are several hydroelectric power plants on the river.

Surface water resources in the Armenian part of the Arpa sub-basin, as run-off generated from precipitation within the area, are estimated at 0.751 km^3/year (based on data from 1931 to 2008), and groundwater resources at 0.084 km^3/year (average for the years from 1991 to 2008), making up a total of 0.835 km^3/year, equals to about 15,460 m^3/year/capita.

Pressures

Untreated urban wastewaters containing pollutants are discharged into the Arpa River from drainage systems, with what Armenia ranks as both severe and widespread influence on water resources. Inappropriate waste disposal at recreation areas impacts moderately on water quality.

Pressures related to agriculture, demonstrated as increased levels of nutrients, are reported to be significant and widespread in the Armenian part, but moderate in impact. Some 7% of the land area in the Armenian part of the basin is cropland, and 37% grassland.

According to monitoring by Armenia, V, Cr and Cu concentrations along the river remain almost constant, indicating naturally elevated background levels. With regard to heavy metal concentrations, only V and Cu exceeded the MAC (for fish life) level.

Status and transboundary impacts

The river has been assessed as very clean. There is almost no human impact, and the ecological and chemical status has been viewed as "normal and close to natural conditions". In the period from 2004 to 2006, the average concentration of dissolved solids on the border is 315 mg/l, with a maximum of 439 mg/l.

Increased anthropogenic impact can be observed in monitoring results from 2009 as nitrogen compound concentrations — nitrate (NO_3^-), nitrite (NO_2^-), ammonium (NH_4^+) — increased up to three times in the Armenian part of the basin from above the Jermuk tributary down to the Areni monitoring station (upstream from the border with Azerbaijan). This is reported to be due the influence of agriculture. The levels nevertheless remain lower than the MAC norms for fish life.

Trends

Armenia predicts that, under the influence of climate change, precipitation will decrease 5–10% within the next 20 years. Surface flow is predicted to decrease by 7–10%. Groundwater levels are also predicted to decrease and groundwater quality to deteriorate. Impact on water use is projected to be noticeable, and indirect impacts are projected to be evident in connection with reducing precipitation and increasing air temperature.

VOROTAN/BARGUSHAD SUB-BASIN[46]

The sub-basin of the 111-km river Vorotan/Bargushad[47] is shared by Armenia and Azerbaijan. The river has its source at a height of 3,080 m a.s.l., and discharges into the Araks/Aras. The sub-basin has a pronounced mountainous character, with an average elevation of about 2,210 m a.s.l.

Sub-basin of the Vorotan/Bargushad River

Country	Area in the country (km^2)	Country's share (%)
Armenia	2 575	41.6
Azerbaijan	3 620	58.4
Total	**6 195**	

Surface water resources in the Armenian part of the Vorotan/Bargushad sub-basin are estimated at 0.748 km^3/year (based on the periods from 1988–1991 and 1999–2008). Groundwater resources are estimated at 0.218 km^3/year. Total water resources in the Armenian part of the Vorotan sub-basin are estimated at 0.966 km^3/year, about 13,270 m^3/year/capita.

The flow in the river is heavily regulated, and there are several hydroelectric power stations on the river.

Pressures

Agriculture is one of the main pressure factors, assessed by Armenia as widespread but moderate in influence. Cropland makes up almost 6% of Armenia's territory in the basin, and grassland 45%. Pollution from discharging untreated urban and rural wastewaters into the river is another severe pressure factor, but more local in the extent of influence.

The influence of hydropower generation and related infrastructure on the river are considered as local and moderate.

Natural hydro-geochemical processes cause elevated V concentrations.

VOROTAN-AKORA AQUIFER (NO. 52)[50]

	Armenia	Azerbaijan
Area (km^2)	1 100	N/A
Renewable groundwater resource (m^3/d)	637 000	N/A
Groundwater uses and functions	Used for water supply, irrigation, power engineering and fisheries.	N/A

[45] Based on information from Armenia and the First Assessment.
[46] Based on information from Armenia and the First Assessment.
[47] The river is known as Vorotan in Armenia and Bargushad in Azerbaijan.

Status

The ecological and chemical status has been assessed as “normal and close to natural conditions”. The average content of dissolved solids was found at the border to be 199 mg/l, with a maximum of 260 mg/l during the period from 2004 to 2006.[48]

The anthropogenic impact is manifested by the fact that the concentrations of NO_3^-, NO_2^-, NH_4^+, phosphate (PO_4^{3-}) ions and COD_{Cr} in river water increased 1.5–2.5 times from source to mouth, but remain lower than the MAC norms for fish life.[49] The increases in concentrations may be due to diffuse pollution from agriculture and/or pollution from municipal wastewater. Monitoring results in Armenia in 2009 show the concentrations of both nitrogen compounds and phosphate to have peaked below the confluence of the Sisian tributary. BOD and dissolved oxygen remained approximately unchanged along the length of the river in the Armenian part.

Heavy metal concentrations, except V and Cu, were within the MAC (for fish life) level in the Armenian part of the basin. The consistency of Cd, Cu, Fe and Cr concentrations may be influenced by the natural geochemical background. In 2009, V and arsenic (As) concentrations were clearly more elevated on the Sisian tributary and below its confluence. Mn, molybdenum (Mo) and lead (Pb) were highest on the main course of the river, below the confluence of the Sisian, and Cu reached its highest concentration at the Tatev hydroelectric station monitoring station, just upstream from the border with Azerbaijan.

Transboundary cooperation

An agreement between Armenia and Azerbaijan on the joint utilization of the waters of the river Vorotan/Bargushad was signed in 1974.

Trends

According to Armenian predictions, precipitation should decrease in the area by 5–10% within the next 20 years, due to climate change. Surface flow is predicted to decrease by 8–10%. Groundwater level is also expected to decrease, and groundwater quality to deteriorate somewhat. Some indirect or secondary impacts, such as on land use and agriculture, are also expected.

VOGHJI/OHCHU SUB-BASIN[50]

The sub-basin of the 82-km river Voghji/Ohchu[51] is shared by Armenia and Azerbaijan. The river discharges into the Araks/Aras. The Geghi is the most important tributary. The sub-basin has a pronounced mountainous character, with an average elevation of 2,337 m a.s.l. Lakes Gazana and Kaputan are located in the sub-basin.

At present, the river flow is not regulated. The Geghi Reservoir in the Armenian part is unfinished.

Sub-basin of the Voghji/Ohchu River

Country	Area in the country (km^2)	Country's share (%)
Armenia	880	70
Azerbaijan	377	30
Total	**1 257**	

Surface water resources in the Armenian part of the Voghji/Ohchu sub-basin — estimated as run-off generated from precipitation — are approximately 0.472 km^3/year (based on the periods from 1965-1991 and 2000-2008). Groundwater resources are estimated at 0.036 km^3/year (average for years from 1991–2008). Total water resources in the Armenian part of the sub-basin are estimated at 0.508 km^3/year, about 10,100 m^3/year/capita.

Pressures

In Armenian territory, arable lands are mainly on slopes, especially in Kapan region, limiting effective land cultivation. These areas commonly serve as pastures, limiting the impact of agriculture.

Groundwater discharging from springs is used for domestic water supply and for irrigation. Groundwater occurs in intrusive rocks and metamorphic slates of Upper Jurassic and Middle Devonian age. Links with surface water systems are medium.

Discharges of untreated or insufficiently treated municipal wastewater into the river, in addition to industrial activities, are among the main pressure factors. Their influence is assessed as widespread and severe.

Water seeping from Artsvanik tailings dam in Kapan affects the river water quality, mainly by increasing heavy metal concentrations (V, Mn, Zn, Mo, Cd).

The influence of hydropower generation and related infrastructure on the river are considered as local and moderate in Armenia.

Status

At the time of the First Assessment (2007), the ecological and chemical status of the Voghji/Ohchu River system was reported to be “not satisfactory for aquatic life”, but appropriate for other uses. The average mineral content was at the time reported to be 296 mg/l, with a maximum of 456 mg/l during the period from 2004 to 2006.

The annual average concentrations of NO_3^-, NO_2^- and NH_4^+ measured in Armenia increased by 2.7–7.8 times from the source of the Voghji/Ohchu River to the downstream monitoring site located close to the border. This demonstrates anthropogenic impact, mainly from pollution by municipal wastewater and/or agriculture. At the monitoring site located close to the border, only NH_4^+ concentrations exceed the MAC norms (for fish life), by 1.3 times, in particular at the monitoring station located at the mouth of the Norashenik tributary. NO_2^- ion concentrations were clearly higher compared with the rest, as were to some degree those of NO_3^-.

Natural hydro-geochemical processes in the areas of ore deposits cause elevated metal concentrations in water (Pb, Fe and Cr), but this influence is rated as local and moderate by Armenia. However, as an increase in concentrations of heavy metals such as Zn, Cd, Mn and Cu has been observed from upstream to downstream in 2009, increasing markedly below Kapan and staying at elevated levels down to the last monitoring station upstream from the border, some influence of sewage and industrial effluents is inferred in Armenian territory.

Trends

Precipitation is predicted by Armenia to decrease in the area by 3–5% within the next 20 years, due to climate change. Surface water flow is predicted to decrease (by 2–3%), and groundwater level also. A marked impact from climate change on water use is expected, as well as impacts on land use and agriculture.

[48] *Source:* The First Assessment.
[49] In Armenia, water classification is based on MAC values for maintenance of aquatic life, which are more stringent than the MAC values for other uses.
[50] Based on information from Armenia and the First Assessment.
[51] The river is known as Voghji in Armenia and Ohchu in Azerbaijan.

FLOOD-PLAIN MARSHES AND FISHPONDS IN THE ARAKS/ARAS RIVER VALLEY[52]

General description of the wetland area

The Araks/Aras River Valley harbours a large number of natural and man-made wetlands, including extensive permanent freshwater marshlands and brackish, seasonally wet marshlands, lakes and fishponds. On the Armenian side, particularly noteworthy are Khor Virap Marsh, occupying the ancient Araks/Aras riverbed, and the Armash fishponds to the south, as well as the Metsamor wetland system, including Lake Aighr and the Sevjur River (one of the tributaries of the Araks/Aras), together with surrounding marshlands and fishponds. Other parts of this vast river valley ecosystem are located in Azerbaijan, the Islamic Republic of Iran and Turkey.

Main wetland ecosystem services

Over the past decades, fish farming in Armenia has become an important part of the economy. The Armash fishponds used to be the biggest fish farming enterprise in the South Caucasus, with a total capacity of several thousand tons of fish per year. This complex contains 25 big ponds (covering 1,700 ha) and a number of smaller ponds surrounded by extensive reed stands and muddy areas. Other large enterprises are Aygherlich, Yeghegnut and Masis, with a total surface area of 1,000 ha. The fish species being farmed in wide and shallow "lacustrine" fishponds with emergent vegetation and soft bottom are Carp, Silver Carp and Grass Carp. In the narrow "riverine" fishponds with concrete walls and bottoms, the main commercial species are Rainbow Trout, Brown Trout, Sevan Trout and Siberian Sturgeon.

The marshes of the Metsamor wetland system are used for cattle grazing, amateur hunting and fishing.

Cultural values of the wetland area

The Old Testament records that it was on Mount Ararat that Noah's Ark came to rest after the Great Flood. The complex of Khor Virap Monastery (built in the ninth to twelfth centuries) is one of the most popular tourism destinations in Armenia. The early Iron Age archaeological excavations and the museum of Metsamor are of considerable significance for historians.

Biodiversity values of the wetland area

Khor Virap Marsh and the Armash fishponds are among the Caucasus's richest ornithological hotspots. Both sites provide

important nesting areas for numerous cormorants, geese, ducks, ibises, waders and other waterbirds, including globally threatened species such as the Marbled Teal and the White-headed Duck. Other man-made "lacustrine" fishponds and the Metsamor wetland system also play an important role for nesting waterfowl that lost their breeding habitats when the water level dropped in lakes Sevan and Gilli. The same wetlands provide stopover sites for migrating birds. Bird life is especially rich during the autumn migration, when more than 100 species can be recorded.

Pressure factors and transboundary impacts

Due to increasing demand for trout, many enterprises have replaced existing earth ponds with concrete pools that are more effective for intensive trout breeding. This leads to loss of habitats for nesting and migrating waterfowl.

In the 1950s, Khor Virap Marsh was drained and reclaimed as agricultural land. However, as early as the 1980s, the unmaintained drainage system ceased to work properly, and marsh habitats recovered. At the Armash fishponds, the main threat to waterfowl is intensive poaching, while in the Metsamor wetland system, grazing represents a disturbance for birds.

Transboundary wetland management

There are several ongoing programmes initiated by the European Commission and the UNDP to improve water management in the Kura Basin through the harmonization of legislation, monitoring and regional planning. The "Eco-regional Nature Protection Programme for the South Caucasus Region", part of the Caucasus Initiative launched by the German Federal Ministry of Economic Cooperation and Development (BMZ), aims to promote cooperation in the development of a coherent strategy to ensure biodiversity conservation in the region.

The Critical Ecosystem Partnership Fund (CEPF) is developing a strategy based on the results of stakeholder workshops and background reports coordinated by the WWF Caucasus Programme Office. CEPF gives special attention to wetlands and international cooperation.

In 2007, the Government of Armenia designated part of Khor Virap Marsh (~50 ha) as a sanctuary to be managed by the Khosrov Forest Reserve authorities and as a Wetland of International Importance (Ramsar Site). Documentation is under preparation for formal submission to the Secretariat of the Ramsar Convention on Wetlands.

[52] *Sources:* Jenderedjian, K. and others, About Wetlands, and around Wetlands in Armenia. Zangak, Yerevan. 2004; Jenderedjian, K. Transboundary management of Kura Basin wetlands as an important step towards waterbird conservation in the South Caucasus region; Boere, G.C., Galbraith, C.A., Stroud, D.A. (eds). Waterbirds around the world. The Stationery Office, Edinburgh, UK. 2006.

SARISU/SARI SU SUB-BASIN[53]

The basin of the river Sarısu/Sari Su[54] is shared by Turkey and the Islamic Republic of Iran. The river has its source in the Tandurek mountains in Turkey, and discharges into the Araks/Aras River in the Islamic Republic of Iran.

The sub-basin has a pronounced volcanic mountainous and high plain land character, with an average elevation of about 1,900–2,000 m a.s.l.

Sub-basin of the Sarisu/Sari Su River

Country	Area in the country (km²)	Country's share (%)
Islamic Republic of Iran	241	10
Turkey	2 230	90
Total	**2 471**	

Hydrology and hydrogeology

Water bodies cover 1% of the Turkish part of the sub-basin. In the part of the Sarisu/Sari Su sub-basin that is Turkey's territory, surface water resources are estimated at 0.054 km³/year (based on data from 1988–1996), and groundwater resources at 0.028 km³/year, making up a total of 0.082 km³/year, equals to 725 m³/year/capita.

Pressures and responses

Some 7.8% of Turkey's part of the sub-basin is cropland (with 23% of it being irrigated), and 73% grassland.

The riparian countries have signed a protocol entitled "The Protocol on the Joint Utilization of the Waters of the Sari Su and Kara Su River" in 1955. This protocol includes, for example, the basic principles of water use in the border region, minimum water flow, and water allocation.

ASTARACHAY BASIN[55]

The basin of the 36-km long Astarachay River is shared by Azerbaijan and the Islamic Republic of Iran. For some 30 km the river forms the border between the riparian countries. It discharges into the Caspian Sea in Azerbaijan.

Basin of the Astarachay River

Country	Area in the country (km²)	Country's share (%)
Azerbaijan	124	54
Islamic Republic of Iran	118	46
Total[a]	**242**	

[a] According to the Islamic Republic of Iran, the total basin area is approximately 280 km².

The average discharge of the river is approximately 6.9 m³/s (218 × 10⁶ m³/year), of which some 3.5 m³/s (109 × 10⁶ m³/year).

It is estimated that Iranian water use in the basin is about 54 × 10⁶ m³/year, and in Azerbaijan about 32 × 10⁶ m³/year. There are more farmers in Iranian territory, mostly cultivating rice. There is no agreement on the Astarachay River between the riparian countries.

SAMUR RIVER BASIN[56]

The basin of the river Samur is shared by Azerbaijan and the Russian Federation. The river has its source in Dagestan, Russian Federation, and discharges into the Caspian Sea. The average elevation of the basin is 1,970 m a.s.l.

A transboundary aquifer called Samur (No. 53) is linked to the surface waters in the basin.

Basin of the Samur River

Country	Area in the country (km²)	Country's share (%)
Azerbaijan	340	4.6
Russian Federation	6 990	95.4
Total[a]	**7 330**	

[a] Including the tributary Giolgerykhay.

Hydrology and hydrogeology

Before flowing into the Caspian Sea, the river divides into several branches, located both in Azerbaijan and the Russian Federation. Some 96% of the river flow originates on Russian territory.

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

The estimated renewable groundwater resources in the foothill plains of the Samur-Hussar amount to about 1.27 × 10⁶ m³/year.

Use of the water for irrigation (currently some 90,000 ha in Azerbaijan and 62,000 ha in the Russian Federation)[57] and to supply drinking water to the cities of Baku and Sumgait in Azerbaijan (up to 400 × 10⁶ m³/year) and settlements in Dagestan (Russian Federation) has led to pressure on water resources.

Status and transboundary impacts

The river has been classified as "moderately polluted". Natural background concentrations of some heavy metals and trace elements are elevated, but the influence is assessed by the Russian Federation as local. In three areas in the Russian part of the basin, groundwater pollution has been identified. Groundwater monitoring is carried out at nine points of observation in the Russian part of the basin three times per month.

The total water demand of both countries considerably exceeds the available resources, indicated by the considerable decrease of water flow from source to mouth, and the drop in the groundwater table, which has adverse ecological effects in the river valley and the delta. For about six months of the year, there is a more severe shortage, with almost no water flow downstream from the

[53] Based on information from Turkey, the Islamic Republic of Iran.
[54] The river is known as Sarisu in Turkey and Sari Su in the Islamic Republic of Iran.
[55] Based on information provided by Azerbaijan and the Islamic Republic of Iran.
[56] Based on information from Azerbaijan, the Russian Federation and the First Assessment.
[57] The countries' irrigation inventory indicates 210,000 ha for Azerbaijan and 155,700 ha for the Russian Federation.

SAMUR AQUIFER (NO. 53)[58]

	Azerbaijan	Russian Federation
Type 3; The upper, alluvial aquifer consists of gravel-pebble, sand and boulders of Neogene-Quaternary age (N-Q); the lower aquifer consists of fractured sandstones and siltstones of Jurassic and Cretaceous age (J-K). In the alluvial aquifer groundwater flow is from Azerbaijan and the Russian Federation to the Samur River. In the lower aquifer the flow direction is from Azerbaijan to the Russian Federation. Both aquifers have strong links with surface water.		
Area (km²)	2 900	699
Thickness: mean, max (m)	50, 100	N-Q: 50, 100 J-K: 40, 90
		N/A
Groundwater uses and functions	Drinking water (90–92%) irrigation (5–8%) industry (2–3%)	Drinking water (90%) irrigation (7%) industry (3%)
Pressures		No pressure factors, no problems related to groundwater quantity and no substantial problems related to groundwater quality.
Groundwater management measures	Need to be improved: abstraction management, quantity and quality monitoring, protection zones, good agricultural practices, mapping. Need to be applied: transboundary institutions, data exchange, integrated river basin management, treatment of urban and industrial wastewater.	Improvement of water management system, coordination of groundwater monitoring (observed parameters, monitoring network, procedures for information exchange).
Other information	Joint monitoring programme felt to be needed. Azerbaijan predicts increased water use as a consequence of economic growth.	

hydrotechnical installation at Samursk. Otherwise, the impact of groundwater level decrease is assessed by the Russian Federation as widespread but moderate in influence.

Transboundary cooperation

An intergovernmental agreement on joint use and protection of the transboundary Samur River was signed between Azerbaijan and the Russian Federation on 3 September 2010 (and entered into force on 21 December 2010).

At the present time there is no exchange of monitoring information, although the agreement provides for it.

SULAK RIVER BASIN AND ANDIS-KOISU SUB-BASIN[59]

The basin of the river Sulak is shared by Georgia and the Russian Federation. The river has its source in the confluence of the Avarsk-Koisu (Russian Federation) and the Andis-Koisu, and discharges into the Caspian Sea. The Sulak River itself flows entirely in the Russian Federation. Andis-Koisu is a major transboundary tributary, shared by Georgia and the Russian Federation (basin area 4,810 km²), originating in Georgian territory at the confluence of the Pirikita Alazani and Tushetskaya Alazani rivers.

The Georgian part of the basin is traversed by deep gorges and ravines. The lower part of the basin has a meandering lowland character. The average elevation of the basin is about 1,800 m a.s.l.

Basin of the Sulak River and sub-basin of the Andis-Koisu

Country	Area in the country (km²)	Country's share (%)
Georgia	869	18
Russian Federation	3 941	82
Andis-Koisu subtotal	4 810	
Total	**15 200**	

Hydrology and hydrogeology

In the part of the Andis-Koisu sub-basin that is Georgia's territory, total water resources are estimated at 0.802 km³/year (based on data from 1951–1977), equals to 400,827 m³/year/capita. The surface water resources in the Russian part of the basin are estimated at some 2.26 × 10^6 m³/year (based on data from 1929–1980), and groundwater resources at 0.26 km³/year.

Pressures and status

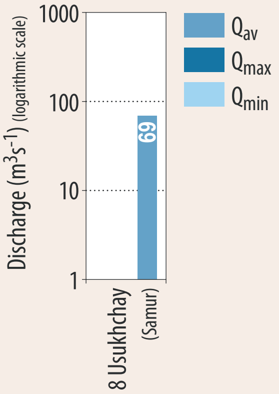
Irrigation and human settlements constitute the main pressure factors in the sub-basin of the Andis-Koisu River. The trans-

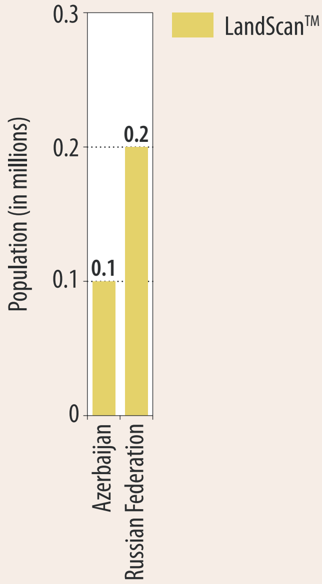
SULAK AQUIFER (NO. 54)[60]

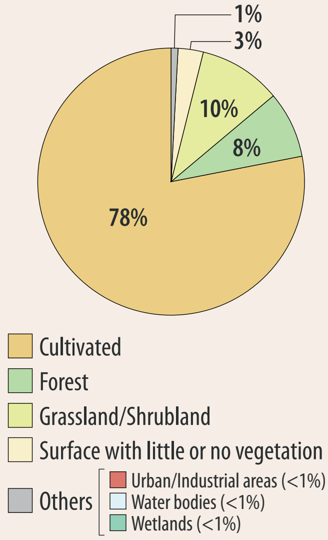
	Georgia	Russian Federation
Type 2; The upper aquifer consists of sand and gravel of Quaternary age (Q); the lower aquifer consists of sandstone, siltstone and limestone of Jurassic and Cretaceous age (J-K). In the upper aquifer, groundwater flow is from Georgia and the Russian Federation to the Sulak River. In the lower aquifer, the flow direction is from Georgia to the Russian Federation. Both aquifers have medium links with surface water.		
Thickness: mean, max (m)	N/A	Q: 30, 50 J-K: 25, 50
Groundwater uses and functions	N/A	Some 20 × 10^6 m³/year of groundwater is abstracted for drinking water and for irrigation.
Pressure factors	N/A	Six areas of groundwater contamination have been identified.

[58] Based on information from Azerbaijan, the Russian Federation and the First Assessment.
[59] Based on information from Georgia, the Russian Federation and the First Assessment.
[60] Based on information provided by the Russian Federation.

DISCHARGES, POPULATION AND LAND COVER IN THE SAMUR RIVER BASIN

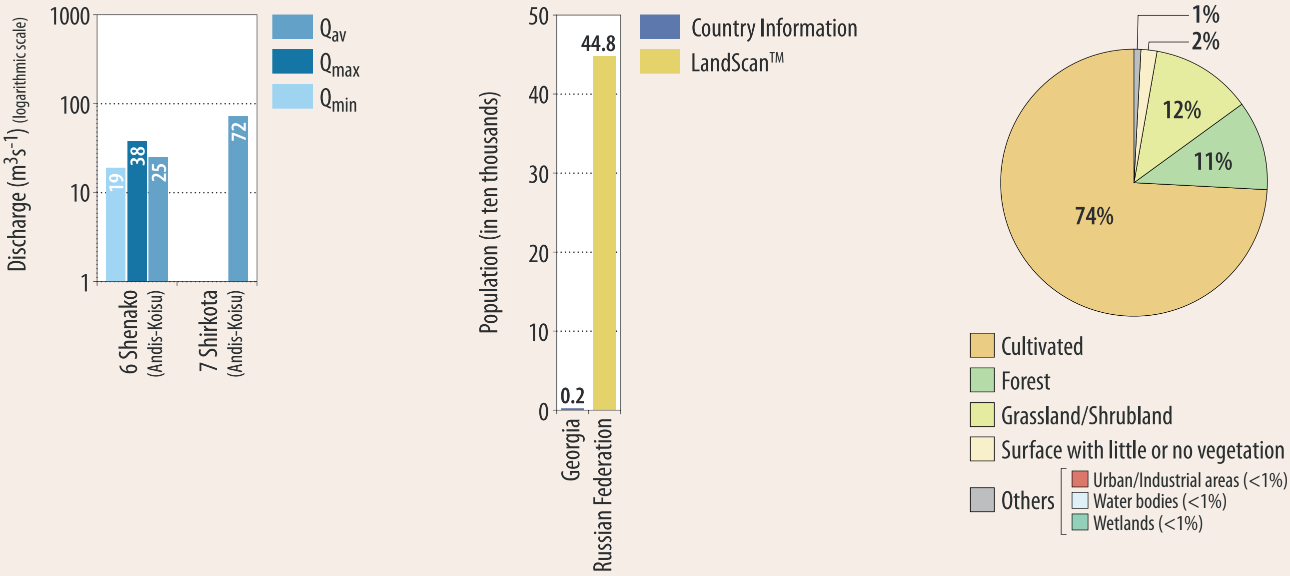




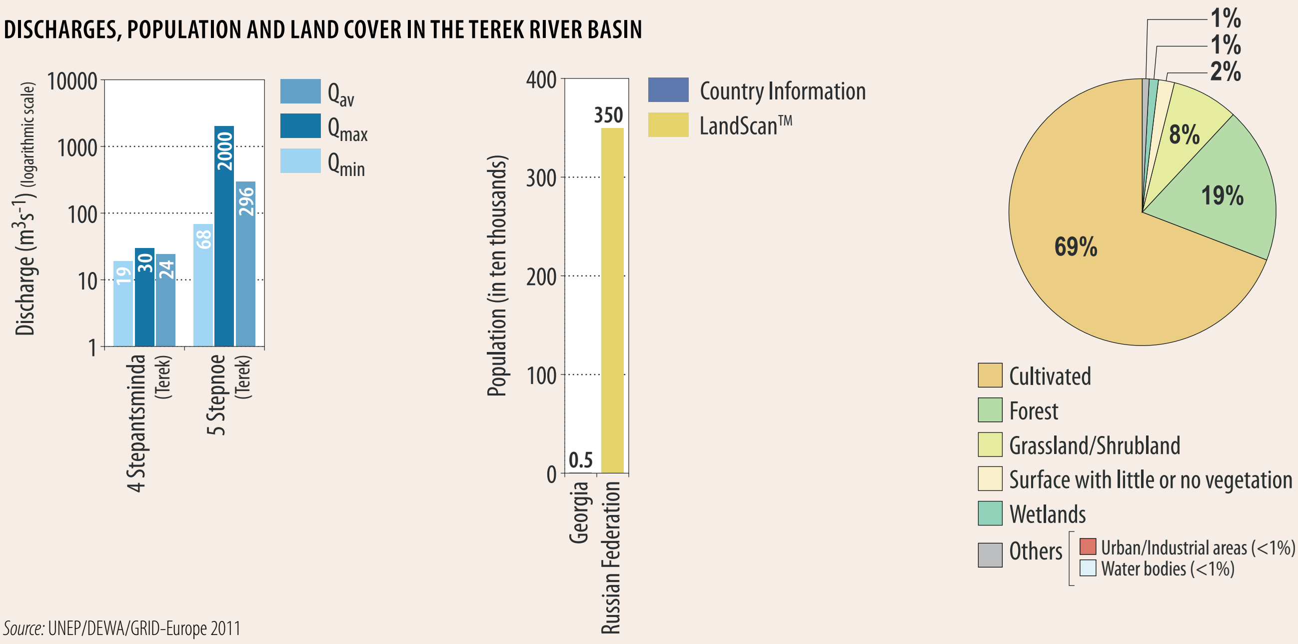


Source: UNEP/DEWA/GRID-Europe 2011.

DISCHARGES, POPULATION AND LAND COVER IN THE SULAK RIVER BASIN



DISCHARGES, POPULATION AND LAND COVER IN THE TEREK RIVER BASIN



Source: UNEP/DEWA/GRID-Europe 2011

boundary impact is assessed to be insignificant. The Andis-Koisu River has a good ecological and chemical status.

Increased pumping lifts and costs for groundwater abstraction are an issue in the Russian Federation, but this concerns a limited area. The State groundwater monitoring network in the Russian part of the basin consists of six monitoring points, with 3–10 observations per month.

There have been plans to construct a number of hydropower stations in the Russian part of the Andis-Koisu sub-basin.

Trends

Based on research studies and expert knowledge, a decrease in precipitation is expected in Georgia in the next 50 years: by 7% in eastern part of the country (where the Sulak Basin is also located) during fall, winter and spring, and by 30% in the summer. Increase in drought frequency is expected in the eastern part of Georgia, but no data is available.[61]

[61] *Sources:* Second National Communication of Georgia to the UNFCCC; Adaptation to Climate Change in Eastern Europe, Caucasus and Central Asia and South–Eastern Europe. UNECE, WHO. 2008.

TEREK RIVER BASIN[62]

The basin of the river Terek is shared by Georgia and the Russian Federation. The 623-km long river has its source in the slopes of Mount Kazbek in Georgia and discharges into the Caspian Sea. The river flows through North Ossetia/Alania, Kabardino-Balkaria, the Stavropol Kraj, Chechnya and Dagestan (Russian Federation). In the Georgian part, the basin is characterized by mountainous, glacial topography.

The Assa (total basin area 2,060 km^2) and the Argun (total basin area 3,390 km^2) are transboundary tributaries to the Terek.

Basin of the Terek River

Country	Area in the country (km^2)	Country's share (%)
Georgia	1 559	3.6
Russian Federation	41 641	96.4
Total	**43 200**	

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

Hydrology and hydrogeology

The period of high water levels in spring-summer is very long (end of March to September). Spring floods cause damage, especially in the Russian part of the basin.

In the part of the Terek Basin that is Georgia's territory, surface water resources are estimated at 0.761 km^3/year (based on data from 1928–1990), equals to some 155,220 m^3/year/capita. In the Russian Federation, water resources amount to 11.0 km^3/year in an average year (based on data from 1912–1980). Groundwater resources are estimated at 5.04 km^3/year in the Russian part of the basin.

Pressures and status

Human settlements are the main pressure factors in the Georgian part of the basin. More than half of the Georgian territory in the basin is grassland (53.6%), and only about 1% is cropland. In the Russian part of the basin, pressure arises from irrigation (>700,000 ha), industry, aquaculture/fisheries and human settlements.

According to data provided by the Russian Federation, the Terek has been in the "polluted" category of the Russian water quality classification from 2005 to 2008, without significant variation.

MALYI UZEN/SARYOZEN BASIN[63]

The 638-km long Malyi Uzen/Saryozen[64] originates in the Syrt chain of hills in the Russian Federation (Saratov oblast) and discharges into Lake Sorajdyn, which is one of the Kamysh-Samarsk lakes in Kazakhstan.

Basin of the Malyi Uzen/Saryozen River

Country	Area in the country (km^2)	Country's share (%)
Russian Federation	5 980	51.6
Kazakhstan	5 620	48.4
Total	11 600	

Hydrology and hydrogeology

Surface water resources in the Russian part of the basin are estimated at 88 × 10^6 m^3/year (based on observations from 1948 to 1987).[66]

According to the Russian Federation, the river practically does not have baseflow from groundwater, due to the clay riverbed. The Pre-Caspian aquifer (No. 41) extends to the Malyi Uzen/Saryozen Basin (see the assessment of the Ural).

As in the basin of the Bolshoy Uzen/Karaozen, the lack of rain and short duration of rainfall events, dryness of the air and soil, as well as high levels of evaporation, is typical of the area.

On the Russian side, the biggest reservoirs are the Upper Perekopnovsk (volume 65.4 × 10^6 m^3), Molouzensk (18.0 × 10^6 m^3) and Varfolomejevsk (26.5 × 10^6 m^3) reservoirs and several artificial lakes (87.33 × 10^6 m^3). Reservoirs in Kazakhstan include: the Kaztalovsk-I (7.20 × 10^6 m^3), the Kaztalovsk-II (3.55 × 10^6 m^3) and the Mamajevsk (3.50 × 10^6 m^3) reservoirs and several artificial lakes (4.83 × 10^6 m^3).

Pressures and status

Water scarcity is severe in the basin. Irrigated agriculture is the main pressure factor.

Wastewater discharges and surface run-off, as well as sediments and riverbank erosion, degrade water quality. Non-respect of water protection zones and unauthorized reconstruction works have affected water quality.

The status of the watercourses is assessed as "stable".

Responses and transboundary cooperation

Monitoring the water resources of the Malyi Uzen/Saryozen and Bolshoy Uzen/Karaozen in the Russian Federation is carried out by the Regional Centre for Hydrometeorology and Environmental Monitoring of Saratov, and of reservoirs also by "Saratovmeliovodhoz". Surface water quality is monitored on the Malyi Uzen/Saryozen (at monitoring station Malyi Uzen), with sampling during the main hydrological seasons and, monthly, on the Bolshoy Uzen/Karaozen (at the town of Novouzensk). A

TEREK AQUIFER (NO. 55)[65]

	Georgia	Russian Federation
Type 2/3; The aquifer consists of sand and gravel of Quaternary age (Q). Groundwater flow is from Georgia and the Russian Federation to the Terek. Strong links with surface water.		
Thickness: mean, max (in m)	N/A	20, 50
Groundwater uses and functions	N/A	Some 409 × 10^6 m^3/year of groundwater is abstracted for drinking water and for irrigation.
Pressure factors	N/A	75 areas of groundwater contamination have been identified.
Other information	N/A	The length of the aquifer is 12 km.

[62] Based on information from Georgia, the Russian Federation and the First Assessment.
[63] Based on the information provided by Russian Federation and the First Assessment.
[64] In the Russian Federation the river is known as Malyi Uzen and in Kazakhstan as Saryozen.
[65] Based on information provided by the Russian Federation.
[66] *Source:* Water management balance of the Malyi and Bolshoy Uzen River basins, TOO Uralvodproject 1998.

Total water withdrawal and withdrawals by sector in the Malyi Uzen/Saryozen Basin

Country	Year	Total withdrawal $\times 10^6$ m³/year	Agricultural %	Domestic %	Industry %	Energy %	Other %
Russian Federation	2009	56.85	95.9	4.1	0.1	-	-
Kazakhstan	N/A	N/A	N/A	N/A	N/A	N/A	N/A

schedule for joint water sampling by specialized laboratories is approved annually.

During the regional program "Providing the population of Saratov region with drinking water, 2004-2010", wastewater treatment plants were constructed in Krasnokutskaya, Fedorovskoye, Piterskaya and Algayskom rayons (districts) of Saratov oblast.

Water transfer, including from the Volga Basin, which is used to address scarcity in the Malyi Uzen/Saryozen and Bolshoy Uzen/Karaozen basins, is subject to annual agreements between the riparian countries. The basis of the cooperation is the 1992 Agreement between the Russian Federation and Kazakhstan on the joint use and protection of transboundary waters.

The minimum flow across the border between the Russian Federation and Kazakhstan that should be ensured is 17.1 × 10⁶ m³, but this amount was increased at the request of Kazakhstan in 2006 (to 19.2 × 10⁶ m³), due to a very dry period of half a year and a low level of water in the river. Issues of transboundary significance are discussed in the Kazakh-Russian joint commission, and monitoring data is shared in the intergovernmental working group on allocation of flow of the Bolshoy Uzen/Karaozen and Malyi Uzen/Saryozen.

A scheme of complex use and protection of the rivers Bolshoy Uzen/Karaozen and Malyi Uzen/Saryozen is under development in the Russian Federation.

Trends

The main form of land use downstream from the border between the Russian Federation and Kazakhstan is irrigated agriculture. The land area requiring irrigation largely depends on the actual availability of river water (depending on the hydro-meteorological conditions), and ranges from some 1,960 ha in wet years to 45,980 ha in dry years.

Withdrawals for agricultural purposes are expected to increase by about two per cent.

BOLSHOY UZEN/ KARAOZEN RIVER BASIN[67]

The 650-km long Bolshoy Uzen/Karaozen[68] River originates in the Syrt hills in the Russian Federation (Saratov oblast) and discharges into Lake Ajden/Ajdyn,[69] which is a part of the Kamysh-Samarsk lakes in Kazakhstan, which lakes spread over a large area where the river flows on to the Caspian lowland.

Area in the Bolshoy Uzen/Karaozen Basin

Country	Area in the country (km²)	Country's share (%)
Russian Federation	9 660	61.9
Kazakhstan	6 135	38.1
Total	**15 795**	

Source: Water management balance of the Malyi and Bolshoy Uzen River basins, TOO Uralvodproject.

Water resources in the Russian part of the basin are estimated at approximately 215.4 × 10⁶ m³/year (based on observations from 1948 to 2002).[70]

Groundwater practically does not contribute at all to the flow, because of the clay river bottom. The transboundary Pre-Caspian aquifer (No. 41) extends to the Bolshoy Uzen/Karaozen Basin (see the assessment of the Ural).

On the Russian side, the biggest reservoirs are the Nepokojevsk (48.75 × 10⁶ m³) and Orlovogajsk (5.4 × 10⁶ m³), and several artificial lakes (183.67 × 10⁶ m³). Three reservoirs in Kazakhstan are the Sarshyganak (46.85 × 10⁶ m³), the Ajdarchansk (52.3 × 10⁶ m³) and the Rybnyj Sakryl (97 × 10⁶ m³) reservoirs.

Pressures

Irrigated agriculture is the main pressure on water resources, especially downstream from the border between the Russian Federation and Kazakhstan. Depending on the hydrometeorological conditions, the area requiring irrigation ranges from 1,200 ha to 27,000 ha.

The Russian Federation ranks as widespread and severe the problem of water scarcity.

Water quality is negatively affected by wastewater discharges, surface run-off, suspended sediments and riverbank erosion.

Status, responses and transboundary cooperation

The condition of the river is assessed as "stable".

During the regional program "Providing of the population of Saratov region with drinking water, 2004-2010", wastewater treatment plants were constructed in Krasnopartizansk and Ershovsky, Dergachevsky rayons (districts) of Saratov oblast.

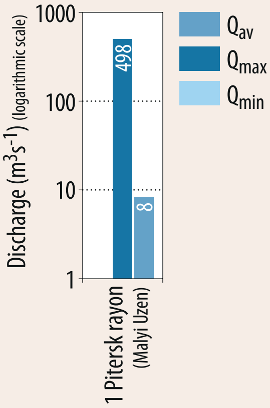
Other response measures concerning also the Bolshoy Uzen/Karaozen are described in the assessment of the Malyi Uzen/Saryozen.

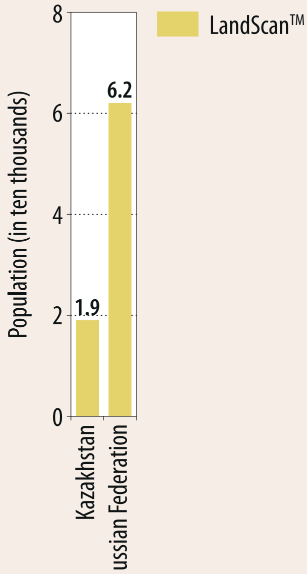
Total water withdrawal and withdrawals by sector in the Bolshoy Uzen/Karaozen Basin

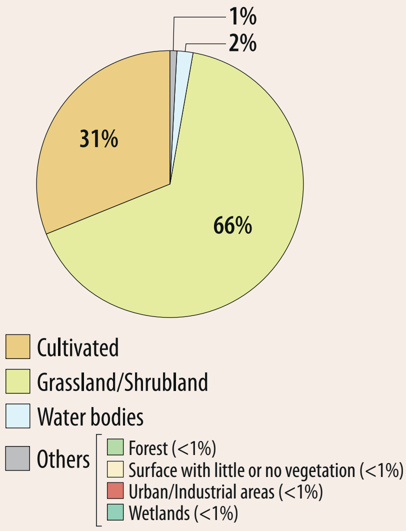
Country	Year	Total withdrawal $\times 10^6$ m³/year	Agricultural %	Domestic %	Industry %	Energy %	Other %
Russian Federation	2009	70.22	94.1	5.4	-	-	0.5
Kazakhstan	2009	33.86	100	-	-	-	-

[67] Based on the information provided by Russian Federation and Kazakhstan, and the First Assessment.
[68] The river is known as Bolshoy Uzen in the Russian Federation and as Karaozen in Kazakhstan.
[69] The lake is known as Ajden in the Russian Federation and as Ajdyn in Kazakhstan.
[70] *Source:* Water management balance of the Malyi and Bolshoy Uzen River basins, TOO Uralvodproject 2003.

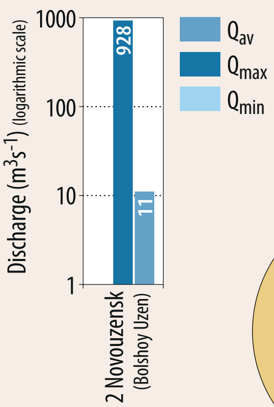
DISCHARGES, POPULATION AND LAND COVER IN THE MALYI UZEN/SARYOZEN BASIN

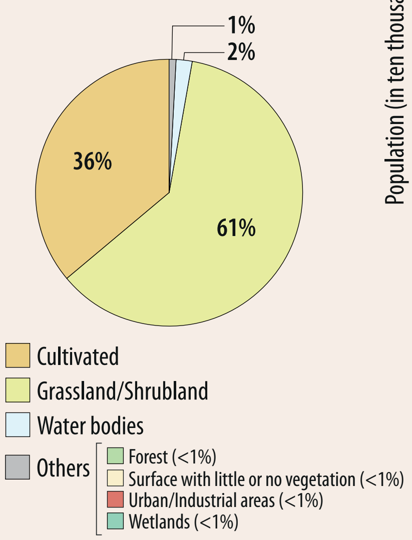


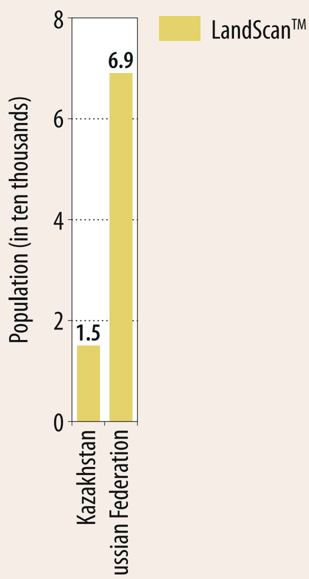




DISCHARGES, POPULATION AND LAND COVER IN THE BOLSHOY UZEN/KARAOZEN RIVER BASIN







Sources: UNEP/DEWA/GRID-Europe 2011; Annual data on the regime and resources of surface waters. Volume 1, Part 1, State Water Cadastre, Samara. 2008.