CHAPTER 3
DRAINAGE BASIN OF THE ARAL SEA AND OTHER TRANSBOUNDARY WATERS IN CENTRAL ASIA

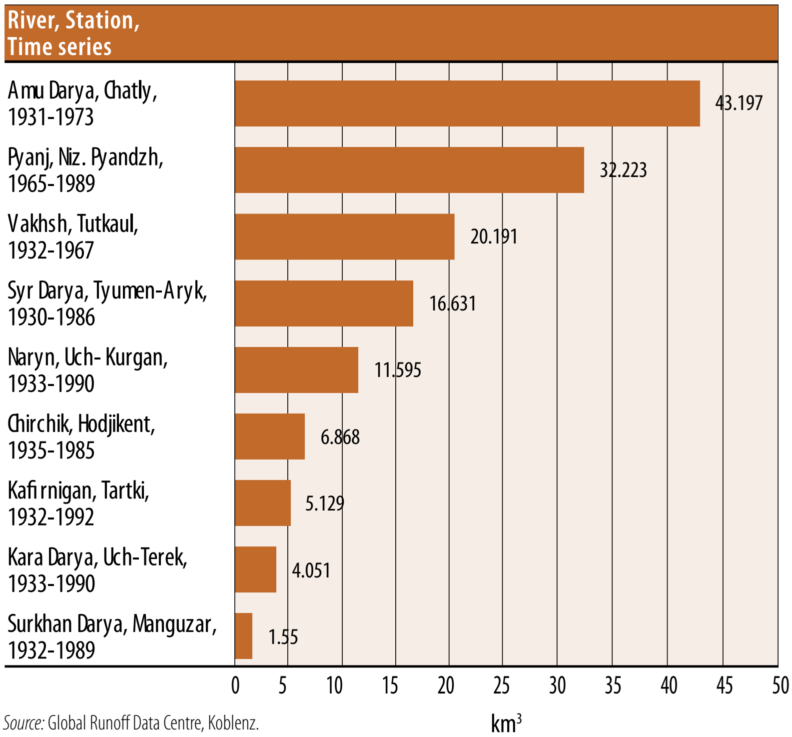
This chapter deals with the assessment of transboundary rivers, lakes and groundwaters, as well as selected Ramsar Sites and other wetlands of transboundary importance, which are located in Central Asia and discharge into the Aral Sea Basin, into another lake, or have a desert sink.

Assessed transboundary waters in Central Asia

Basin/sub-basin(s)	Recipient	Riparian countries	Lakes in the basin	Transboundary groundwaters within the basin	Ramsar Sites/wetlands of transboundary importance
Amu Darya	Aral Sea	AF, KG, TJ, TM, UZ	Aral Sea	Karatag/North-Surhandarya (TJ, UZ), Kofarnihon (TJ, UZ), *Sherabad (TM, UZ), Xorezm (TM, UZ), Amu-Darya (KZ, TM, UZ), Amudarya (AF, TJ, UZ)*	
- Surkhan Darya	Amu Darya	TJ, UZ			
- Kafirnigan	Amu Darya	TJ, UZ			
- Pyanj	Amu Darya	AF, TJ			
- Vakhsh	Amu Darya	KG, TJ		Vakhsh aquifer (TJ, KG)	
Zeravshan	Desert sink	TJ, UZ		Zeravshan aquifer (TJ, UZ)	
Syr Darya	Aral Sea	KZ, KG, TJ, UZ		Osh-Aravan, Almos-Vorzik, Maylusu, Sokh, Iskovat-Pishkaran (KG, UZ), Dalverzin, Zafarobod, Shorsu (TJ, UZ), Sulyukta-Batken-Nau-Isfara (KG, TJ, UZ), Syr Darya 1, Pretashkent (KZ, UZ), Naryn, Chust-Pap, Kasansay (KG, UZ), *Syr Darya 2–3 (TJ, UZ), Karaungur, Yarmazar, Chimion-Aval, Nanay (KG, UZ), Ahangaran (TJ, UZ), Kokaral (KZ, UZ), Havost (AF, TJ), Dustlik (TJ, UZ)*	Aydar-Arnasay Lakes System (KZ, UZ)
- Naryn	Syr Darya	KG, UZ			
- Kara Darya	Syr Darya	KG, UZ			
- Chirchik	Syr Darya	KZ, KG, UZ			
- - Chatkal	Chirchik	KG, UZ			
Chu	Desert sink	KZ, KG		Chu/Shu (KZ, KG)	
Talas	Desert sink	KZ, KG		North-Talas, South-Talas (KZ, KG)	
Assa	Desert sink	KZ, KG, UZ			
Ili	Lake Balkhash	CN, KZ	Lake Balkhash	Zharkent, Tekes (KZ, CH)	Ili Delta - Balkhash Lake (CN, KZ)
Murgab	Desert sink	AF, TM			
Tejen/Harirud	Desert sink	AF, IR, TM		Karat, Taybad, Torbat-e-jam (AF, IR), Janatabad (AF, IR, TM), Aghdarband, Sarakhas (IR, TM)	

Note: Transboundary groundwaters in italics are not assessed in the present publication.

Long-term mean annual flow (km^3) of rivers in the Aral Sea Basin



Source: Global Runoff Data Centre, Koblenz.

AMU DARYA RIVER BASIN[1]

The Amu Darya, one of the main rivers of Central Asia, is taken to begin from the confluence of the Pyanj — biggest tributary in terms of flow volume — and the Vakhsh rivers. Afghanistan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan share the Amu Darya Basin.

In addition to the Pyanj and the Vakhsh, the major transboundary tributaries include the Surkhan Darya and the Kafirnigan. The former tributary Zeravshan no longer reaches the Amu Darya.

The upstream catchment area of the Amu Darya contributing water to the main river at Kerki gauging station, where the river leaves the mountains and flows into the desert lowlands, is 309,000 km^2. It includes a large part of Tajikistan, the southwest corner of Kyrgyzstan (the Alai Valley) and the northeast corner of Afghanistan. With the mid- and down-stream sections of the potential drainage area in Turkmenistan and Uzbekistan included, the total catchment area varies from 465 000 km^2 to 612 000 km^2, depending on the source of data.[2]

Hydrology and hydrogeology

The mean annual run-off in the Amu Darya Basin is about 78 km^3. Some 80% of the flow is estimated to be generated in Tajikistan.

Volume of run-off in the Amu Darya Basin by country

Country	Volume of run-off (km^3/year)
Afghanistan	6.18
Kyrgyzstan	1.9
Tajikistan	62.9
Turkmenistan	2.27
Uzbekistan	4.7
Total	**78.46**

Source: Executive Committee of the International Fund for Saving the Aral Sea.

Groundwater resources in the Amu Darya Basin that can be abstracted without significantly affecting surface water flow are estimated at 7.1 km^3/year.

More than 35 reservoirs with a capacity greater than 10×10^6 m^3 have been built in the Amu Darya Basin, and their total water storage exceeds 29.8 km^3. Some 17 km^3 of this amount is on the main Amu Darya River, among them the Tyuyamuyunsk Reservoir (7.27 km^3). There are four water reservoirs with a total storage capacity of 2.5 km^3 on the Karakum Canal in Turkmenistan, and a second phase of the Zeyid Reservoir is under construction, with a design storage capacity of 3.2 km^3.[3] The generally smaller reservoirs inside the complex systems of canals, such as the Talimardjansky and Tudakulsky reservoirs in Uzbekistan, play an important role in storing seasonal water.

The flow of the Vakhsh is regulated (the Nurek Reservoir, with a water storage volume of 10.5 km^3, being the main reservoir) but regulation of the Pyanj is limited, which leads to frequent occurrences of flooding between the confluence of these rivers and the Tyuyamuyunsk Reservoir.

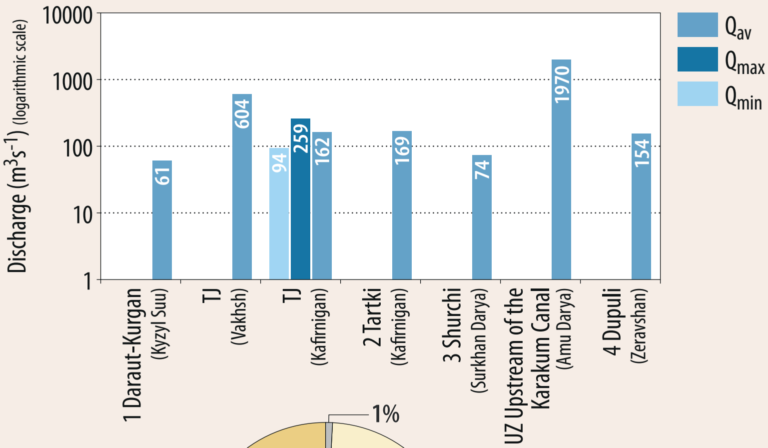
When flowing through the lowland part, the flow reduces through evaporation, infiltration, and withdrawal for irrigation.

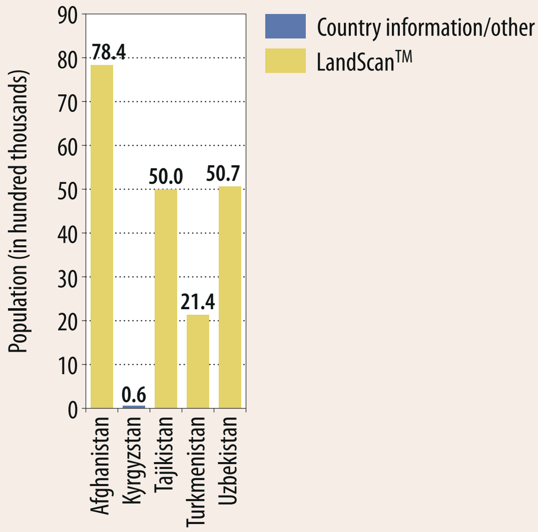
KARATAG/NORTH-SURHANDARYA AQUIFER (NO. 11)[4]

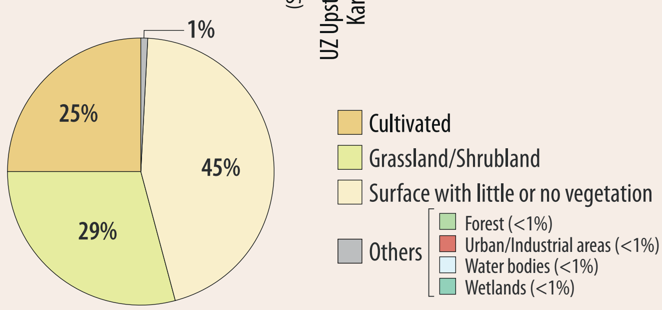
	Tajikistan	Uzbekistan
At least partly confined Quaternary aquifer; boulder, cobble sediments (Tajikistan) and pebble drifts with streaks of clay loam (Uzbekistan); groundwater flow direction towards Uzbekistan; medium links with surface waters.		
Border length (km)	46	50
Area (km^2)	3 428	3 550
Thickness: mean, max (m)	50–100, 100	70, 100
Groundwater uses and functions	Drinking water supply	Drinking water supply
Pressure factors	Water abstraction. Change of water resources on the edge of sustainability. Negligible local contamination by nitrate (agriculture).	Water abstraction. Change of water resources based on the water abstraction in Tajikistan. Negligible local contamination by nitrate (agriculture).
Groundwater management measures	Joint monitoring of the groundwater.	Joint monitoring of the groundwater.
Other information	Enhancement of the monitoring network of groundwater most needed.	Enhancement of the monitoring network of groundwater most needed.

[1] Based on information provide by Kyrgyzstan and Tajikistan, the Executive Committee of the International Fund for Saving the Aral Sea, CAWATERinfo and the First Assessment.
[2] *Source:* Environment and Security in the Amu Darya Basin. ENVSEC. 2011.
[3] *Source:* Dam Safety in Central Asia: Capacity-Building and Regional Cooperation. UNECE. Water Series No. 5. 2007.
[4] The Karatag aquifer was already assessed in the First Assessment, in which it was called Karotog. The names of some of the aquifers have been revised since. The updated inventory is mostly based on the inventory by UNESCO and IGRAC in 2009.

DISCHARGES, POPULATION AND LAND COVER IN THE AMU DARYA RIVER BASIN







Source: UNEP/DEWA/GRID-Europe 2011.

KOFARNIHON AQUIFER (NO. 12)

	Uzbekistan	Tajikistan
Confined Quaternary aquifer; pebble drifts with streaks of clay loam; groundwater flow direction towards Uzbekistan; medium links with surface waters.		
Border length (km)	50	N/A
Area (km^2)	343	N/A
Thickness: mean, max (m)	70, 100	N/A

Pressures

Irrigated agriculture makes up some 90% of the total water use. Cotton cultivation has decreased somewhat, and food crops are gaining more ground. Drainage waters from irrigation affect water quality negatively, with salinity and concentrations of major ions increasing gradually from upstream to the plains. Notably, the drainage waters contain sulphates, chlorides, sodium, and pesticides, as well as nitrogen and phosphorus compounds. Water losses are also associated with irrigation systems.

In the lowland part, large-scale irrigation schemes, such as the Qarshi steppe pumping cascade and the Amu-Bukhara canal, involve significant lifting by pumping, with capacities of 350 m^3/s and 200 m^3/s, respectively. The approximately 1,100-km long Karakum canal diverts some 18 km^3/year from the Amu Darya to the southern part of Turkmenistan, feeding gravitational irrigation systems. The area of irrigated agricultural land in the Kyrgyz part of the basin (in the Kyzyl Suu sub-basin) is 20,000 ha; in Afghanistan it amounts to 1,200,000 ha.

Groundwater abstraction in the Amu Darya Basin is estimated at 4.8 km^3/year.

The lack of wastewater collection, degraded equipment and insufficient capacity of the sewage networks result in pollution by municipal wastewaters. Landfills for household waste also exert pressure.

The Amu Darya Basin is prone to natural hazards such as floods, mudflows and, in certain zones, earthquakes. Increased frequency of natural hazards, floods in particular, is a concern in Kyrgyzstan's part of the basin. Afghanistan — lacking regulation infrastructure — reports frequent damage by flooding. Landslides are assessed as widespread and severe in impact.

Processes such as bank erosion change strongly the channel of the river. Dried-up silt deposits from floods are the source of sand dunes forming in Afghanistan's part of the basin.

The lack of availability of a minimum ecological river flow is a source of concern. The Amu Darya delta suffers from reduced flow and poor water quality, which have a negative impact on ecosystems. Deforestation, which has substantially reduced the forest cover in the past few decades, is widespread and severe. Notably, the Tugai forests have been significantly reduced.

Pressures are described in further detail in the following assessments of the tributaries of the Amu Darya.

Status

The reduced flow due to withdrawals and diversions in the Amu Darya Basin has made the impacts on water quality more pronounced. The regulation of the river has altered the flow regime.

Because of reduced flow into the delta and the retreat of the Aral Sea's shoreline, about 50 water bodies (lakes) in the delta have dried up.

Transboundary cooperation and responses

The Amudarya Basin Water Organization (BWO) was established in 1992 as an executive body of the Inter-State Commission for Water Coordination (ICWC)[5], but it covers only the middle and lower part of Amu Darya. It operates some hydropower/irrigation dams in Uzbekistan's part of the basin. The BWO coordinates the withdrawals from the canals, as these need to be synchronized with water releases from the Nurek Reservoir on the Vakhsh tributary.

Turkmenistan and Uzbekistan cooperate in jointly operating the Tyuyamuyunsk dam.

In Afghanistan's part of the basin, there has been no investment into protection against flood or land degradation, due to decades of war. Vegetation that is resistant to water-logging is used by the population.

Efforts have been made in Uzbekistan to establish protected areas and improve the ecological conditions in the lower reaches of the Amu Darya.

The collection of drainage water into the Golden Century Lake in the Karakum desert by Turkmenistan aims to reduce discharges of

Total water withdrawal and withdrawals by sector in the Amu Darya Basin

Country	Year	Total withdrawal ×10^6 m^3/year	Agricultural %	Domestic %	Industry %	Energy %	Other %
Afghanistan	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Kyrgyzstan	N/A	54.0	97.4[a]	-	-	-	-
Tajikistan	1997	8 590	82.0	8.1	8.7	N/A	-
Tajikistan	2010	9 400	79.6	8.7	8.5	N/A	3.2
Uzbekistan	1997	28 986	95.0	4.3	0.7	N/A	-
Uzbekistan	2010	29 400	91.8	7.0	1.2	N/A	-
Turkmenistan	1997	22 773	97.7	1.8	0.6	N/A	-
Turkmenistan	2010	28 145	91.0	4.9	4.1	N/A	-

Notes: The 1997 figures are actual water uses, and the 2010 figures are prospective water requirements. The agricultural withdrawal figures for Tajikistan, Turkmenistan and Uzbekistan from CAWATERinfo include withdrawal for fisheries (minor).

[a] Kyrgyzstan predicts that withdrawal will increase by 10–15 × 10^6 m^3/year in the near future.

Sources: Amu Darya Basin Water Organization through CAWATERinfo (http://www.cawater-info.net/amudarya/index_e.htm), Kyrgyzstan.

[5] ICWC is a regional body for the Central Asian States mandated to jointly address the issues of management, rational use and protection of water resources of inter-State sources in the Aral Sea Basin, and to implement joint programmes.

drainage water into the Aral Sea. However, the consequences of the decreased water flow in the lower Amu Darya are to be assessed.

Trends

More hydropower development is planned or ongoing in the Amu Darya Basin, more specifically on the Vakhsh tributary (Sangtuda 1 and 2 dams).

At present, Afghanistan's withdrawal is at a relatively low level, but there is interest in rehabilitation and expansion of irrigation systems. The instability of the country and hesitation of donors have held back Afghanistan's development ambitions.

Uzbekistan assesses the Amu Darya and small rivers of the region to be most vulnerable to climate change, but the predictions depend on the chosen scenario. On the basis of scenario A2[6], Uzbekistan predicts no significant changes in the water resources of the Amu Darya by 2030. By 2050, a reduction of water resources by 10 to 15% in the basin of the Amu Darya is considered possible. During the years of acute water scarcity (extremely warm and dry years), water resources might decrease by 25-50% in the basin.[7] Kyrgyzstan predicts an increase in river flow by 2025, due to the melting of mountain glaciers, and a subsequent decline. The predicted increased aridity and evapotranspiration in the region are expected to be reflected as increased irrigation requirements, which would have severe implications in the Amu Darya.

SURKHAN DARYA SUB-BASIN[8]

The Surkhan Darya is a transboundary tributary to the Amu Darya, originating in Tajikistan. The basin has a total area of 13,500 km², the major part of which is located in Uzbekistan.

The flow of the Surkhan Darya is heavily influenced by water management activities.

Drinking water for Dushanbe, the capital of Tajikistan, is taken from the Varzob River, a tributary of the Surkhan Darya. Expanding settlements negatively affect water quality and contribute to the erosion of mountain slopes. The wastewater treatment plant of Dushanbe is operational, but the treatment is entirely mechanical, and its functioning is hampered by a substantial dilution of wastewater and large amount of trash.[9]

KAFIRNIGAN SUB-BASIN[10]

The Kafirnigan River,[11] which is a glacier-fed tributary of the Amu Darya, originates and mainly flows in Tajikistan, forming the border with Uzbekistan for some 30 km. The Tartki is a transboundary tributary.

The basin has a mountainous character, with an average elevation of 4,806 m a.s.l.

Sub-basin of the Kafirnigan River

Country	Area in the country (km²)	Country's share (%)
Tajikistan	9 780	84.4
Uzbekistan	1 810	15.6
Total	**11 590**	

Hydrology and hydrogeology

The long-term average discharge of the Kafirnigan at Tartki in Tajikistan is approximately 5.33 km³/year. Groundwater resources in Tajikistan's part of the basin are estimated at 6.86×10^6 m³/year.

No transboundary aquifers have been identified in this sub-basin. In Tajikistan's part, groundwater occurs mainly in Quaternary deposits consisting of boulders, gravel and sands, which extend over more than 1,200 km². The thickness is on average about 35 m, and reaches some 110 m at most. Links with surface waters are medium.

Pressures

Pressure factors in Tajikistan include discharges of untreated or insufficiently treated wastewaters, agriculture, industry and dumping of waste. Groundwater pollution is also a concern.

Total water withdrawal and withdrawals by sector in the Kafirnigan Basin

Country	Year	Total withdrawal ×10⁶ m³/year	Agricultural %	Domestic %	Industry %	Energy %	Other %
Tajikistan	N/A	90	N/A	N/A	N/A	N/A	N/A
Uzbekistan	2009	29	95.9	-	-	-	4.1

Note: Groundwater is used for household water and for industry.

PYANJ SUB-BASIN[12]

Afghanistan and Tajikistan share the sub-basin of the Pyanj River,[13] a tributary of the Amu Darya, which, together with the Pamir River, forms the border between Afghanistan and Tajikistan. The total length of the Vakhan Darya/Pyanj[14] is 1,137 km. Most of the catchment area is mountainous.

The Bartang and the Pamir are transboundary tributaries of the Pyanj.

Sub-basin of the Pyanj River

Country	Area in the country (km²)	Country's share (%)
Afghanistan	47 670	42
Tajikistan	65 830	58
Total	**113 500**	

[6] This refers to the scenarios described in the Intergovernmental Panel on Climate Change (IPCC) Special Report on Emissions Scenarios (SRES, 2000). The SRES scenarios are grouped into four scenario families (A1, A2, B1 and B2) that explore alternative development pathways, covering a wide range of demographic, economic and technological driving forces and resulting greenhouse gas emissions. Scenario A2 describes a very heterogeneous world with high population growth, slow economic development and slow technological change.
[7] *Source:* Second National Communication of the Republic of Uzbekistan under the United Nations Framework Convention on Climate Change.
[8] Based on information provided by Tajikistan and the First Assessment.
[9] 2nd Environmental Performance Review of Tajikistan, UNECE, 2011.
[10] Based on information provide by Tajikistan and the First Assessment.
[11] In Tajikistan, the river is called Obisahid in the upstream part and, in the downstream part, from the confluence with the Obi Barzangi, it is known as the Kafirnigan.
[12] Based on information provide by Afghanistan and Tajikistan, and the First Assessment.
[13] The river is also known as the Panj.
[14] Commonly the confluence of the rivers Vakhan Darya (Afghanistan) and Pamir is considered as the beginning of the Pyanj, but hydrologists consider the Vakhan Darya as the prolongation of the Pyanj.

Hydrology and hydrogeology

In the part of the sub-basin that is Tajikistan's territory, groundwater resources are estimated to amount to 12.01 × 10^6 m^3/year. In Tajikistan, groundwaters occur in Quaternary deposits consisting of boulders, gravels, and sands, with an average thickness of 30 m (maximum 160 m), with medium links with surface waters.

There is a reservoir on the Gunt tributary, but because of the limited regulation of the Pyanj, flooding is severe. In Tajikistan there are no measurements of discharge; water levels only are measured at some stations. Limited access to hydrometeorological data is also a constraint, according to Afghanistan.

Pressures

Some 30 years of war have prevented investment in flood protection in Afghanistan, leaving the country's embankment vulnerable to flooding, which contributes to land degradation by washing out fertile soil and depositing fine sediment. A number of multi-purpose reservoir construction projects were planned before the war in Afghanistan but then suspended, including the Upper and Lower Kokcha Reservoirs (the Kokcha is a tributary of the Pyanj). With the infrastructure lacking, Afghanistan has little means to limit damage from flooding.

Waste disposal is a pressure factor affecting water resources in Tajikistan's part of the basin.

The limited water use for irrigated agriculture in Tajikistan concentrates in the Kyzylsu sub-basin. Tajikistan's total withdrawal from the Pyanj amounts to about 300,000 m^3/year. Groundwater is abstracted for drinking water and for industrial use.

In this earthquake-prone area, the possibility that the earth "dam" blocking Sarez Lake (volume 16.1 km^3) on the Bartang tributary may fail is a potential threat for the downstream population.

Trends

According to the 1946 agreement between the Soviet Union and Afghanistan, Afghanistan is entitled to use up to 9 km^3 of water a year from the Pyanj. At present, Afghanistan is estimated to use about 2 km^3 yearly. Should water use in Afghanistan increase, the flow situation of the Amu Darya downstream would change.

VAKHSH SUB-BASIN[15]

The sub-basin of the Vakhsh,[16] one of the main headwater tributaries of the Amu Darya, is shared by Kyrgyzstan and Tajikistan. Only the headwaters are in Kyrgyzstan's territory. Typically of the area, glaciers — in this case the Abramov and the Fedchenko — contribute to the run-off.

Sub-basin of the Vakhsh River

Country	Area in the country (km^2)	Country's share (%)
Kyrgyzstan	7 900	20.2
Tajikistan	31 200	79.8
Total	**39 100**	

Hydrology and hydrogeology

The mean annual discharge of the Vakhsh is 19.05 km^3/year; the river contributes about a fourth to the total discharge of the Amu Darya. Groundwater resources in Tajikistan's part of the sub-basin are estimated at 13.48 km^3/year.

The Vakhsh is regulated and important for hydropower generation, with the Nurek Reservoir being the main one (water storage volume 10.5 km^3). The Nurek Dam, which is the largest dam in Tajikistan and in Central Asia, serves for both irrigation and hydropower generation. The other dams on the Vakhsh in Tajikistan include the Baipazin, Golovnaya, the Prepadnaya and the Central.[17]

Pressures

Pressures in the Tajikistan's part include discharge of insufficiently treated municipal wastewaters, uncontrolled landfills, and a large dump of hazardous chemicals, notably pesticides, close to Sarband. Industrial wastewaters are discharged from a nitrogen-fertilizer plant (causing nitrate pollution), and from Yavan electro-chemical plant in Tajikistan. There is also mining and aluminium processing in Tursunzade, and the expansion of these activities might have a transboundary impact.

In addition to hydropower, surface water is used for irrigation; groundwater is mainly used for household water and for industry.

Sangtuda 1 hydroelectric power plant was commissioned in 2009 on the Vakhsh, and Sangtuda 2 is being built in 2011. The Government of Tajikistan resumed the construction of the large Rogun Reservoir[18] (storage capacity 13.8 km^3) upstream of the Nurek for hydropower generation, mainly for energy-intensive aluminium-processing. A technical pre-feasibility study and socio-environmental impact assessment, with funding from the World Bank, are being carried out from 2010 to 2011. The Shurob Dam and hydropower plant are also planned in Tajikistan; Uzbekistan and Turkmenistan are concerned about the implications related to water availability downstream.

ZERAVSHAN RIVER BASIN[19]

The basin of the Zeravshan River is shared by Tajikistan and Uzbekistan. The Zeravshan is a former tributary of the Amu Darya, but no longer reaches it due to abstraction for irrigation systems in the lowland part of the catchment.[20] Estimates of the catchment area vary. Tajikistan reports 17,700 km^2 of the basin to be in Tajikistan territory.

VAKHSH AQUIFER (NO. 13)

	Tajikistan	Kyrgyzstan
Type 3; Quaternary; boulders, gravels, sands; groundwater flow direction from Kyrgyzstan to Tajikistan; medium links with surface waters.		
Area (km^2)	2 233	N/A
Thickness: mean, max (m)	35, 166	N/A

[15] Based on information provide by Tajikistan and the First Assessment.
[16] The river is also known as Kyzyl Suu in Kyrgyzstan and as Surkhob in Tajikistan.
[17] *Source:* Dam Safety in Central Asia: Capacity-Building and Regional Cooperation. UNECE. Water Series No. 5. 2007.
[18] *Source:* Dam Safety in Central Asia: Capacity-Building and Regional Cooperation. UNECE. Water Series No. 5. 2007.
[19] Based on information provided by Tajikistan and the First Assessment.
[20] The most upstream weir of the irrigation system for the Karakul Oasis is considered the "mouth" of the Zeravshan River.

ZERAVSHAN AQUIFER (NO. 14)

	Tajikstan	Uzbekistan
Type 4, Quaternary; boulder-pebble, pebble; groundwater flow direction from Tajikistan to Uzbekistan; medium links with surface waters.		
Area (km^2)	383	N/A
Thickness: mean, max (m)	36, 110	N/A

The average discharge at Dupuli, Tajikistan, is 4.86 km^3/year. Groundwater resources in the Tajik part of the basin are estimated at 3.289 × 10^6 m^3/year. From the point of view of use, they are not considered important by Tajikistan.

Pressures

The flow is regulated at the Karaultepinsky, Kattakurgansky and Kuyumazarsky dams, which serve irrigation in Uzbekistan.[21] It has been estimated that some 96% of the water resources are used for irrigation, mainly in Uzbekistan.

The Ayni hydropower plant is planned upstream, in Tajikistan.

Tailings and wastewaters of mines (Dzhipsiprutsky Mining and Panjakent gold mining — about 17 km upstream from the border) and uncontrolled dumps of household waste are reported by Tajikistan to be pressure factors.

The quality of waters is also affected by natural background pollution, municipal and industrial wastewaters, pollution from agriculture (nutrients, pesticides) as well as suspended sediment and debris flows.

The main uses of groundwater are for household and industry.

SYR DARYA RIVER BASIN[22]

Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan share the basin of the Syr Darya. The Naryn, Kara Darya and Chirchik transboundary sub-basins of the Syr Darya are assessed separately.

Some literature sources quote a basin area of up to 782,600 km^2; some quote 142,200 km^2 as the basin area upstream of the point where the river leaves the Fergana Valley.

Hydrology and hydrogeology

The river is strongly regulated, major reservoirs include the Kayrakkum Reservoir (design capacity 3.4 km^3) and the Chardara Reservoir in Kazakhstan (design capacity 5.2 km^3). The infrastructure for flow regulation was built mainly from the 1960s to 1980s, but some developments date from the 2000s. The most recently constructed dam is the Koksarai in Kazakhstan (volume about 3 km^3), the filling of which began in January 2011, to supply irrigation water to the provinces of Kyzyl-Orda and Southern Kazakhstan.

In Kyrgyzstan, the surface water flow amounts to 27.6 km^3/year including the tributaries Naryn and Kara Darya. In Kazakhstan, surface water resources are estimated at 19.66 km^3/year (14.96 km^3 of it originating from outside the country), and groundwater resources at 2.838 km^3/year.

TRANSBOUNDARY AQUIFERS IN THE SYR DARYA RIVER BASIN[23]

Name	Country to which the information refers (country also sharing the aquifer)	Area (km^2)	Shared boundary length (km)	Confined/ unconfined, aquifer type	Lithologies and stratigraphy	Mean thickness (m)	Max thickness (m)	Dominant flow direction	Link with surface water
Osh-Aravan (No. 15)*	Kyrgyzstan	718.3		mostly unconfined	boulder-pebble, pebble	200-250	400	towards Uzbekistan	medium
	Uzbekistan	1 266	90	confined	boulder-pebble drifts	90-150	300	towards Uzbekistan	medium
Almos-Vorzik (No. 16)*	Uzbekistan (Kyrgyzstan)	485	20	unconfined	pebbles with streaks of clay loam	100	300	towards Uzbekistan	medium
Maylusu (No. 17)*	Uzbekistan (Kyrgyzstan)	387	25	confined	pebble with streaks of clay and loam	150	300	towards Uzbekistan	medium
Sokh (No. 18)*	Uzbekistan (Kyrgyzstan)	1 810	55	confined	boulder-pebble drifts with streaks of clay loam,	200	350	towards Uzbekistan	medium
Dalverzin (No. 19)*	Tajikistan (Uzbekistan)	1 029	100		boulder, cobble sediments	20-120	120	towards Uzbekistan	
Zafarobod (No. 20)*	Tajikistan, (Uzbekistan)	3 833	229		boulder, cobble sediments	60-70	70	towards Uzbekistan	
Sulyukta-Batken-Nau-Isfara (No. 21)*	Tajikistan (Kyrgyzstan, Uzbekistan)	3 339	323		boulder, cobble sediments	50-120	120	towards Tajikistan, Uzbekistan	

* The aquifers indicated with an asterisk were already assessed in the First Assessment and some complementary information can be found there. Please note that the names of some of the aquifers have been revised since.

[21] *Source:* Dam Safety in Central Asia: Capacity-Building and Regional Cooperation. UNECE. Water Series No. 5. 2007.
[22] Based on information provided by Kazakhstan, Kyrgyzstan and Tajikistan, as well as the First Assessment.
[23] The updated inventory is for the most part based on the inventory by UNESCO and IGRAC in 2009.

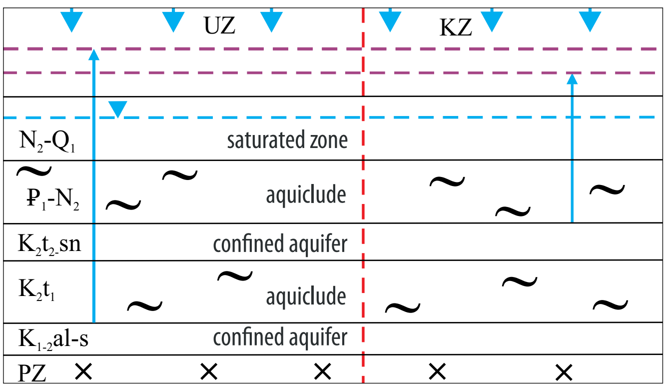
Name	Country to which the information refers (country also sharing the aquifer)	Area (km²)	Shared boundary length (km)	Confined/ unconfined, aquifer type	Lithologies and stratigraphy	Mean thickness (m)	Max thickness (m)	Dominant flow direction	Link with surface water
Syr-Darya 1 (No. 22)	Kazakhstan (Uzbekistan)	189 000	960	confined, intergranular/ multilayered	sand, gravel, pebbles	0.5-40	500-3000	Along the border towards north-west	weak
Naryn (No. 23)	Uzbekistan (Kyrgyzstan)	1 424	36	confined	boulder-pebble drifts	200	350	towards Uzbekistan	medium
Chust-Pap (No. 24)	Uzbekistan (Kyrgyzstan)	456	55	confined	pebble, boulder, gravel	100	200	towards Uzbekistan	medium
Kasansay (No. 25)	Uzbekistan (Kyrgyzstan)	164	30	confined	pebble with streaks of clay loam	80	200	towards Uzbekistan	medium
Shorsu (No. 26)	Uzbekistan, Tajikistan	658	35	confined	boulder, pebble with streaks of clay loam	175	350	towards Uzbekistan	medium
Pretashkent (No. 27)*	Kazakhstan	17 020	394	confined, intergranular/ multilayered	sand, clay	200	400	towards Uzbekistan/ N-S	weak
	Uzbekistan	1 079	85	confined/ artesian	boulder and pebble sediment with streaks of clay loam	300	550	towards Uzbekistan	medium
Iskovat-Pishkaran (No. 28)	Uzbekistan (Kyrgyzstan)	444	32	confined	pebble with boulders	100	350	towards Uzbekistan	medium

* The aquifers indicated with an asterisk were already assessed in the First Assessment and some complementary information can be found there. Please note that the names of some of the aquifers have been revised since.

SYR DARYA 1 AQUIFER (NO. 22)

	Kazakhstan	Uzbekistan
Does not correspond with any of the described model aquifer types (see Figure 1); intergranular/multilayered aquifer (confined); sand, gravel and pebbles; groundwater flow direction along the border towards north-west; weak links with surface waters.		
Border length (km)	960	N/A
Area (km²)	189 000	N/A
Renewable groundwater resource (m³/d)	7.776×10^6	N/A
Thickness: mean, max (m)	0.5–40, 500–3 000	N/A
Groundwater uses and functions	Some 67.73×10^6 m³/year was abstracted in 2009, mainly for household water (88 %) and some for agriculture (8%) and industry (4%).	N/A
Pressure factors	No problems reported at present time. Groundwater resources are used little.	N/A
Groundwater management measures	Surveillance and early warning monitoring is indicated to be needed.	N/A

FIGURE 1: Sketch of the Syr Darya 1 aquifer (No. 22) (provided by Kazakhstan)



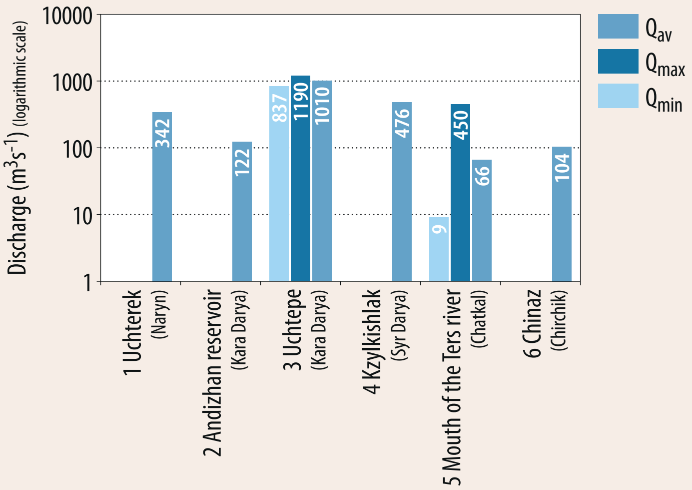
Pressures

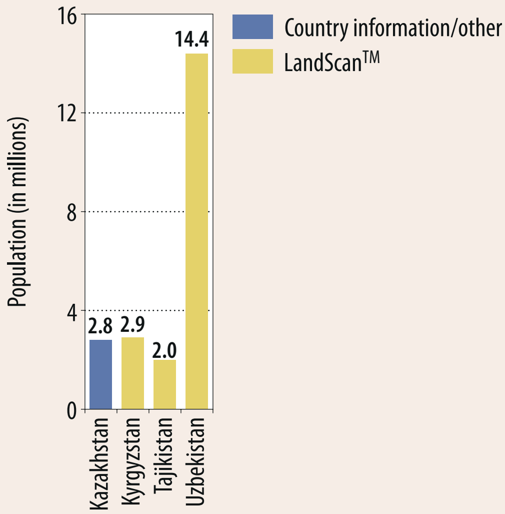
Kyrgyzstan assesses debris flows and landslides as a widespread and severe problem. The increased number of natural hazards, such as floods, is a concern. In terms of impact, Kyrgyzstan ranks all other pressure factors as local and moderate. The town of Kyzylorda and other settlements are generally flooded in winter when hydropower generation is maximized at the Toktogul Reservoir in Kyrgyzstan.

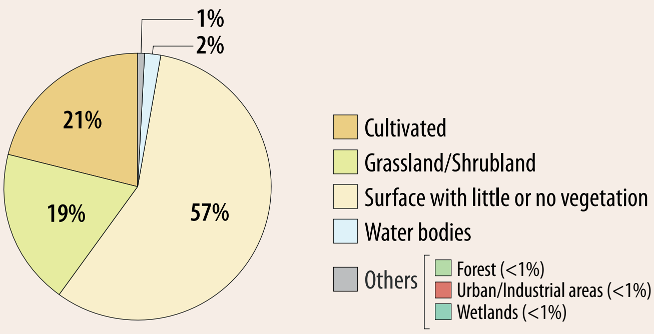
Irrigated agriculture is the biggest water user. Diversion of water for irrigation and water losses in the low-efficiency irrigation systems affect the hydrology, resulting in flow reduction below ecological flow. Because of all the withdrawals, little flow reaches Kazakhstan.

In Kazakhstan, Uzbekistan and Tajikistan, water pollution by return waters from extensively developed irrigated agriculture and from industrial wastewaters is reported. Pollution by urban wastewaters occurs also commonly, for instance in Kyrgyzstan,

DISCHARGES, POPULATION AND LAND COVER IN THE SYR DARYA RIVER BASIN







Sources: UNEP/DEWA/GRID-Europe 2011; Statistics Agency of Kazakhstan, 2006

Total water withdrawal and withdrawals by sector in the Syr Darya Basin

Country	Year	Total withdrawal $\times10^6$ m³/year	Agricultural %	Domestic %	Industry %	Energy %	Other %
Kazakhstan	2006	7 722	88.62	0.96	0.61	-	9.81
Kyrgyzstan	2007	1 665	77	10.6	12.4	-	-
Tajikistan	N/A	0.000035	N/A	N/A	N/A	N/A	N/A
Uzbekistan	2009	10 127	93.8	4.1	1.0	0.2	0.9

Water quality classification in the Syr Darya Basin

Location of observation in the Syr Darya Basin	Water pollution index[a] – water quality classification		Parameters exceeding MAC	Multiplier of MAC exceedence
	2008	2009		
Syr Darya, Kokbulak station	2.15; "moderately polluted" (class 3)	2.57; "polluted" (class 4)	sulphates	3.79
			copper (2+)	4.63
			nitrite nitrogen	3.13
			phenols	3.00
Keles tributary, at the mouth	3.76, "polluted" (class 4)	3.30, "polluted" (class 4)	sulphates	9.21
			copper (2+)	2.90
			magnesium	1.56
			phosphates	1.31

[a] The water pollution index is based on the relationship of the measured values, and the maximum allowable concentration (MAC) of water-polluting components.
Source: Kazhydromet, Ministry of Environmental Protection of Kazakhstan.

due to wastewater collection frequently lacking, or the capacity of the network being insufficient. Landfills for household waste are also a pressure factor.

Status

In 2009, the water quality of both the Syr Darya and the Keles tributary was classified as "polluted" (class 4) according to the water quality classification of Kazakhstan. From 2001 to 2006 and in 2008, the water quality was classified as "moderately polluted" (class 3). The water quality has degraded slightly based on the water pollution index, which has increased from 1.26 in 2001 to 2.57 in 2009 (Kokbulak station).

Transboundary cooperation and responses

Following the 1998 Agreement concerning the use of water and energy resources in the Syr Darya River Basin between Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan, a number of annual intergovernmental bilateral and multilateral agreements have been signed over the past fifteen years, mainly related to use of water and energy resources of the Naryn-Syr Darya cascade of reservoirs. In 2003 and subsequently, only ad-hoc annual bilateral or multi-lateral agreements have been made, and lately such agreements have been limited to Kazakhstan and Kyrgyzstan.

Since late 2005, under the regional technical assistance of the Asian Development Bank, a draft agreement has been developed on the Syr Darya, but its finalization and adoption are still pending.

From some 100 hydrological monitoring stations in Kyrgyz territory within the Syr Darya Basin in 1980, currently only 28 are operational.

Water users' associations are being established to improve agricultural water use in Kyrgyzstan, where tariffs on supply of irrigation water are also applied. The Water Resources Committee of Kyrgyzstan, plans to set up an analysis and information center and develop a unified information system on water.

AYDAR ARNASAY LAKES SYSTEM[24]

General description of the wetland

The Aydar Arnasay Lakes System is a human-made reservoir located in the salt flats of south-eastern Kyzylkum desert. It was formed as a result of an emergency measure of flood control to prevent the breaking of Chardara irrigation dam, and in order to prevent damage downstream of the Syr Darya in the territory of Kazakhstan in 1969 (21.0 km³). The System includes three brackish water lakes (Aydar-Kul, Arnasay and Tuzkan). It is one of the largest reservoirs in Uzbekistan, covering about 3,500 km², with an average depth of 8-10 meters. The water of the reservoir ranges from medium to strongly saline. Being located at the crossroads of two migratory bird flyways, the Afro-Eurasian and the Central-Asian, the lake system plays an extremely important role as a gathering site. The area is only sparsely populated.

Main wetland ecosystem services

Given that the Aydar Arnasay Lakes System could not always protect downstream of Syr Darya River from flooding in the spring and winter periods, the Koksarai Reservoir was built. Before that, large floods on Kazakh territory caused by the changing of Toktogul hydropower station's operational regime from irrigational to energetic triggered significant economic losses. The reservoir stores collector-drainage waters, which cannot be used for irrigational purposes without additional treatment. During the spring period, concentrations of polluting substances are below MACs in the most parts of the reservoir. This allows the use of the reservoir for aquaculture and subsistence, as well as industrial fishing purposes, for which a number of fish have been introduced into the lakes. Fishing accounted for 73.5 % of the total amount of fish from natural reservoirs in Uzbekistan in 2003, and 41.6 % in 2005. Besides fishing, the reservoir

[24] *Source:* Information Sheet on Ramsar Wetlands.

NARYN SUB-BASIN[25]

The 807-km long Naryn River has its source in the Tien Shan Mountains in Kyrgyzstan, and flows through the Fergana Valley into Uzbekistan where its confluence with the Kara Darya River forms the Syr Darya. The total basin area is 59,900 km^2.

Hydrology and hydrogeology

Surface water resources of the Naryn sub-basin, which are generated in the Kyrgyz part, are estimated to amount to 13.7 km^3/year (based on observations up to 2000).

The Toktogul Reservoir (built in 1982; volume about 19.5 km^3), which is used for hydropower in Kyrgyzstan and for irrigation and flood protection in Uzbekistan, is the biggest of the many multipurpose reservoirs on the river. Smaller dams and reservoirs on the river include for example the Kurpsai (water storage volume 370 × 10^6 m^3) and Uch-Kurgan (56.4 × 10^6 m^3).[26]

Pressures and status

Some 115,000–120,000 ha are irrigated in the Kyrgyz part of the basin. Some 1,500 ha of new irrigated land is planned in the State programme (2008-2010) in the central part of the Naryn Oblast.

Kyrgyzstan ranks both the problem of forest cover reduction and the occurrence of debris flows and landslides as widespread and severe. Pressure from water pollution is assessed also as severe but local. Other pressure factors include water losses and pollution from irrigated agriculture, household waste dumps, problems related to management of municipal and industrial

Total water withdrawal and withdrawals by sector in the Naryn Sub-basin

Country	Year	Total withdrawal ×10^6 m^3/year	Agricultural %	Domestic %	Industry %	Energy %	Other %
Kyrgyzstan	N/A	729.4[a]	68.9	0.05	0.07	-	-
Uzbekistan	N/A	N/A	N/A	N/A	N/A	N/A	N/A

[a] The withdrawal in Kyrgyzstan is expected to increase by 10–15 × 10^6 m^3/year in the near future.

is used for hunting and recreational purposes. Reed vegetation is also used by local people for the building of temporary constructions. The territory surrounding the catchment is mainly used as pastures.

Biodiversity values of the wetland area

The reservoir and its shallow water areas are a habitat for many species of flora and fauna. More than 100 species of waterbirds including grebes, pelicans, ciconiiformes, swans, geese, ducks, rails, shorebirds are present here. Among them are 24 species that are included in the Red Data Book of Uzbekistan, and 12 species which are classified as threatened in IUCN International Red List of threatened species. The lakes system plays an extremely important role as a resting area during seasonal migrations, and is also a breeding and overwintering site. During the international winter waterfowl count in 2003, some 96,600 birds of 37 species were recorded. In January 2004, 61,000 birds of 45 species were counted. The site is also an important spawning ground and nursery for 28 species of fish, including 14 food fish species. Species occurring around the reservoir are: Wild Boar, badger, Jungle Cat, golden or Indian Jackal, muskrat, nutria, pheasant, Dice Snake, and Marsh Frog. Additionally, the site is important for the Central Asian Tortoise (vulnerable, IUCN Red List), and for the Goitered Gazelle (vulnerable). The riparian vegetation consists mainly of reed communities, saltwort and tamarisk.

Pressure factors and transboundary impacts

There has been concern about the ecological balance of the lakes system coming under pressure from the construction of the Koksarai Reservoir which changes the regime of flow into the lakes system. How this will impact on the fauna and habitat of the system is not known. The desert around livestock farms is degraded by intensive cattle grazing and firewood collection. Moreover, the invasive Common Myna bird is expanding into the desert areas. Uncontrolled hunting, fishing and water use are additional pressure factors, the use of bottom gill nets presents a particularly serious threat to waterbirds.

Transboundary wetland management

Bilateral agreements between Kazakhstan and Uzbekistan exist in terms of the management of the lakes, however, there is a need for a specific agreement. The lakes system was designated as a Ramsar Site by Uzbekistan in 1983, but the area is not protected under national legislation. Nevertheless it fulfils IUCN criteria 4 as a Habitat/Species Management Area. In 1983, the Arnasay ornithological zakaznik (a type of protected area), which includes the three Tuzkan, Arnasay and Aydar reservoirs, was created, covering 63,000 ha. Most of the Aydar Arnasay Lakes System is planned to be integrated into the Nuratau-Kyzylkum biosphere reserve (project UNDP/GEF/Government of the Republic of Uzbekistan). An Action Plan for maintaining the stability of ecological conditions and the effective use of the Aydar Arnasay Lakes System for Uzbekistan in 2008-2015 was developed and approved by the Government of Uzbekistan. An Information Centre was created within the framework of the UNDP/GEF/Government of Uzbekistan project "Creation of Nuratau Kyzykkum Biosphere reserve as a model of preservation of biodiversity of Uzbekistan".

[25] Based on information provided by Kyrgyzstan and the First Assessment.
[26] *Source:* Dam Safety in Central Asia: Capacity-Building and Regional Cooperation. UNECE. Water Series No. 5. 2007.

wastewater (including lack of wastewater collection, or insufficient capacity of networks and resulting pollution), waste from mining and pollution from livestock breeding.

Pressures from pollution concentrate in the more populated downstream part, whereas in the upper reaches water quality is generally good.

Transboundary cooperation and responses

Issues related to the operation of the Naryn-Syr Darya cascade of reservoirs are settled in the framework of the Interstate Commission for Water Coordination of Central Asia, or in the bilateral intergovernmental commission.

In the Kyrgyz part of the basin, there are nine gauging stations operating at present. With the commissioning of the Kambarata dam and reservoir for hydropower generation,[27] setting one up upstream becomes necessary. Despite some recent enhancements, the monitoring network of water resources and glaciers is not adequate.

There is a lack of observations of water quality and suspended solids. Constraints to monitoring include an insufficient network of monitoring stations, a lack of equipment, as well as the poor state of gauging stations and living conditions of observers. Some of these gaps are foreseen to be addressed through the World Bank projects "Improving Water Management" and "Improving the provision of services related to weather, climate and water resources" in Kyrgyzstan. Information is exchanged between Kyrgyzstan and Uzbekistan about the Andijan Reservoir.

The Jalal-Abad River Basin Council was established from 2008 to 2009 in the Kara Darya Basin in Kyrgyzstan. The council is expected to increase public participation in decision-making. The above-mentioned World Bank project also involves preparation of basin plans for development, use and protection of water resources. Specifically, a plan for development, use and protection of water resources is being developed for the Kugart tributary of the Kara Darya.

Trends

The inauguration of some new irrigated land is planned in the near future, according to the Kyrgyz State Programme of construction of water facilities and development of new irrigated land for the period 2008-2010.

KARA DARYA SUB-BASIN[28]

The 180-km long Kara Darya is a tributary of the Syr Darya, originating in Kyrgyzstan and flowing into Uzbekistan in the Fergana Valley. The catchment area of the Kara Darya is 30,100 km^2.

Hydrology and hydrogeology

In Kyrgyzstan, surface water resources are estimated at 7.10 km^3/year (based on observations up to 2000).

The flow is heavily regulated. The reservoirs in the sub-basin include the Andijan[29] (constructed in 1978 with storage capacity of 1.75 km^3), the smaller Teshiktash, and Kujganya Reservoirs, and the Bazar-Kurgansky Reservoir (built 1962) on the Kara Unkur tributary.

Pressures

In the area of the Mailuu-Suu (a tributary of the Kara Darya) in Kyrgyzstan, 23 uranium tailings ponds and 13 mining dumps pose a contamination risk. The total area of the tailings and waste rock dumps is 606,800 m^2, and the total volume of material dumped is about 2 million m^3. An accidental release of the contents, due to the failure of a tailings pond wall, would affect downstream.

An increase in the occurrence of natural hazards such as floods, is a concern. Debris flows and landslides are ranked as a widespread and severe pressure factor by Kyrgyzstan.

Responses

Rehabilitation of irrigation canals and water diversion structures, and strengthening of river banks has been carried out in Kyrgyzstan.

CHIRCHIK SUB-BASIN[30]

Kazakhstan, Kyrgyzstan and Uzbekistan are riparian countries to the Chirchik River. The total catchment area is 14,240 km^2. The Chirchik originates in Kyrgyzstan at the confluence of the Chatkal (shared by Kyrgyzstan and Uzbekistan) and the Pskem. Currently, both rivers supply the Charvak Reservoir.

Hydrology and hydrogeology

Downstream from the Charvak Reservoir, the Chirchik is fully regulated, for example at Charvaksky (for hydropower, irrigation) and Tashkentsky (for irrigation).

Flow is transferred to the Keles[31] and Akhangaran Basins from time to time.

Pressures

The main uses of the Chirchik's water are irrigation and hydropower generation. The Chirchik is used intensively in the lowland part for irrigation through a canal system, which includes the Zakh, Bozsu and Northern Tashkent canals.

Main industries in the basin include the Khodjikent asphalt and concrete plant, the Electrokhimprom manufacturing firm, and the Uzbek metal manufacturing complex. Pollution emissions from these industries in many cases exceed allowed standards.

The high sediment load in the upstream part of the river has required setting up facilities to protect the Chirchik-Bozsu Cascade of hydropower stations.

Total water withdrawal and withdrawals by sector in the Kara Darya Sub-basin

Country	Year	Total withdrawal $\times 10^6$ m^3/year	Agricultural %	Domestic %	Industry %	Energy %	Other %
Kyrgyzstan	N/A	831.4 [a]	93	4.3	0.3	-	0.2
Uzbekistan	2009	2 542	86.5	6.0	0.1	-	7.3

[a] Withdrawal in Kyrgyzstan is expected to increase by 160 $\times 10^6$ m^3/year.

[27] Kambarata 2 has been constructed, Kambarata 1 is pending.
[28] Based on information provided by Kyrgyzstan and the First Assessment.
[29] The reservoir is also known as Kampyrravatsk, due to the location in the gorge with that name.
[30] Based on information provided by Kazakhstan and the First Assessment.
[31] The Keles is a non-transboundary tributary of the Syr Darya in Kazakhstan.

CHATKAL SUB-BASIN[32]

The 217-km long Chatkal River originates in Kyrgyzstan and flows into the Chirchik in Uzbekistan. Some 5,520 km^2 of the total catchment area (7,110 km^2) is reported to be in Kyrgyzstan's territory.

Surface water resources in the Kyrgyz part of the sub-basin are estimated at 2.71 km^3/year.

Pressures

Water pollution by return waters and water losses related to irrigation are reported among the pressures. The area of irrigated land in the Kyrgyz part of the basin is 6,451 ha.

Wastewaters are not collected, and their untreated or insufficiently-treated discharges cause water pollution. Only Kanysh-Kiya, out of eight villages in the sub-basin, has a wastewater treatment plant. Dumps of household waste also exert pressure.

According to Kyrgyzstan, the increase in the number of floods is a concern. Mudflows and landslides are assessed as a widespread and severe problem. Suspended solids degrade water quality.

Responses and trends

The former gauging station at the mouth of the tributary Ters in Kyrgyzstan is out of operation since 1992. The Hydrometeorological Service of Uzbekistan has an operating gauging station in Khudajdodsaj.

Due to climate change impacts, in Kyrgyzstan river flow is expected to increase by 2025, and decline after. Under such circumstances, the formation and breaking of proglacial lakes is considered possible, increasing the risk of floods and flood debris along the river.

ARAL SEA[33]

The Aral Sea is an endorheic lake (or presently a group of lakes) shared by Kazakhstan and Uzbekistan. The basin of the lake consists of the basins of the rivers Amu Darya, Syr Darya and Zeravshan.

Since the 1960s, due to the intensive use for irrigation (mainly for cotton) of the rivers that feed it, the lake has shrunk, and its water level has dropped. The Aral Sea first split into two, separate lakes: the North Aral Sea and the South Aral Sea. Later, in 2003, the latter split into eastern and western lakes.

Pressures and status

The surface area of the South Aral Sea is still shrinking, and the pollution and increased salinity have killed most of its natural flora and fauna. The water situation from year to year is, however, highly variable. A significant proportion of the Aral Sea (some 33,000 km^2) has dried up, leaving plains covered with salt and toxic chemicals from weapons testing, industry and agriculture (fertilizers), which are blown around by the wind.

The lack of freshwater and the dust impact negatively on human health.

Responses

There has been a partial reversal in the loss of the North Aral Sea in Kazakhstan, which is sustained by the Syr Darya. The Kok-Aral Dam project (completed in 2005) separating this lake raised its water level from 30 to 42 meters, causing the salinity to drop. An important positive effect was the revival of fisheries. This effort is planned to be followed up, and a possible increase of the water level is being discussed. Efforts have also been made in the Amu Darya delta in Uzbekistan to establish water bodies and artificially regulated lakes.

Various donors have supported projects aimed at improving the Aral Sea conditions under different frameworks, including the Global Environmental Facility, TACIS, the World Bank, and individual donors. Efforts to improve the microclimate, combat erosion, and limit desertification, deforestation, and the loss of biodiversity, have been carried out with variable success.

Considerable social efforts are also made by the respective countries to alleviate the situation of the population suffering from the drying out of the Sea. The Heads of State of the Central Asian countries have reiterated in declarations their concern for the situation of the Aral Sea.

A third phase of the Aral Sea Basin Programme (ASBP-3) has been prepared to improve the socio-economic and environmental situation in the Aral Sea Basin, and donor funding is sought for the portfolio of projects. The four main directions of the ASBP-3 are: IWRM; environmental protection; socio-economic development; and improving institutional and legal instruments.

Trends

The deltas and delta lakes of the Amu Darya and Syr Darya are important for the local population for their livelihoods, and for the quality of the environment. Efforts to support their conservation are needed.

The situation of the South Aral Sea is only expected to change if the (consumptive) withdrawals from the Amu Darya River are reduced. The efforts that have been made to increase water efficiency should be continued and further increased.

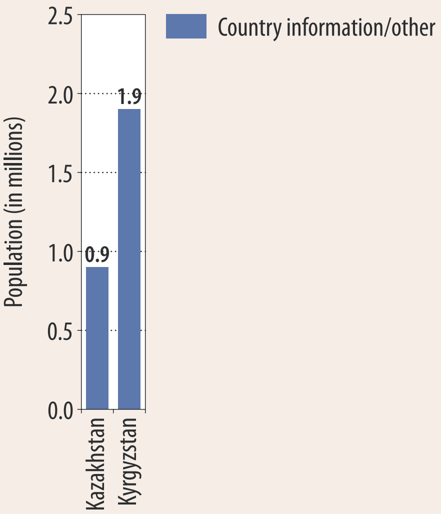
The management of drainage water from irrigation also influences the situation. The collection of drainage water into the Golden Century Lake by Turkmenistan aims to reduce discharges of drainage water into the Aral Sea. However, the consequences of the decreased water flow in the lower Amu Darya are to be assessed.

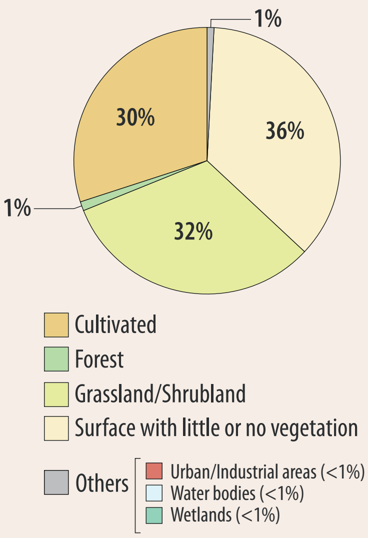
CHU-TALAS RIVER BASINS[34]

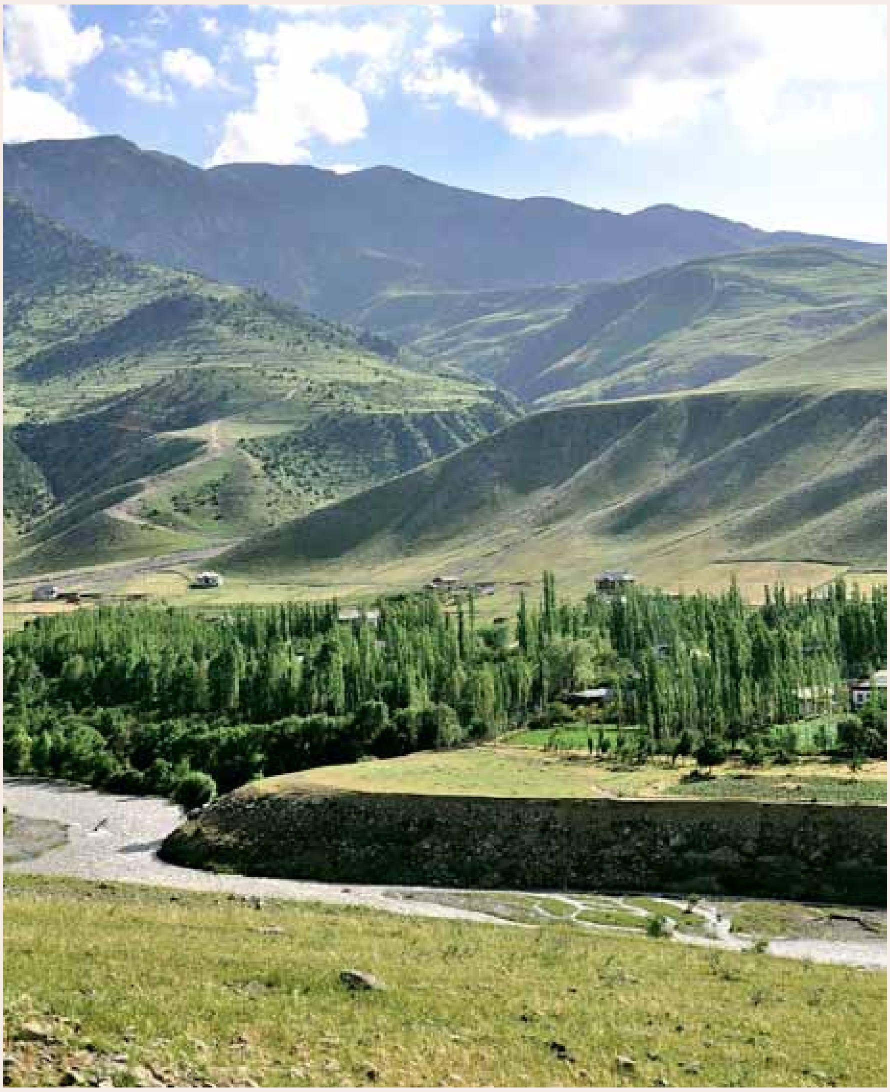
The Chu-Talas Basins, which are shared by Kazakhstan and Kyrgyzstan, include the basins of three transboundary rivers: the Chu,[35] the Talas and the Assa. Most of the run-off of the Chu, Talas and Assa forms in Kyrgyzstan. The flow of the three rivers is regulated. In addition to 204 smaller rivers, the Chu-Talas Basins encompass 35 lakes and a few large water reservoirs.

[32] Based on information provided by Kyrgyzstan and the First Assessment.
[33] Based on the First Assessment and the Second Environmental Performance Review of Uzbekistan, UNECE, 2010.
[34] Based on information provided by Kazakhstan and Kyrgyzstan, and the First Assessment.
[35] In Kazakhstan the river is known as the Shu.

POPULATION AND LAND COVER IN THE CHU-TALAS RIVER BASINS







Sources: UNEP/DEWA/GRID-Europe 2011; Sources: Report on activities in the period 2008–2009, Commission of the Republic of Kazakhstan and the Kyrgyz Republic on the Use of Water Management Facilities of Intergovernmental Status on the Rivers Chu and Talas; Joint communication by the Ministries of Environment Protection of Kazakhstan and Kyrgyzstan; Integrated water resources management plan of the Talas, Kazakhstan, 2007.

Reservoirs in the Chu and Talas Basins in Kyrgyzstan

Name	River	Year taken into use	Reservoir volume, $\times 10^6$ m^3	Dam height
Ortotokoisk	Chu	1958	470	52.0
Ala-Archinsky river bed	Ala-Archa (Chu)	1989	80	35.0
Ala-Archinsky flooded area	Chu	1964	52	24.5
Spartak	Sokuluk (Chu)	1975	22	15
Sokuluksky	Sokuluk (Chu)	1968	9.3	22.5
Kirovsk	Talas	1974	550	86
Kara-Burinsky	Kara-Bura (Talas)	2007	17	49

Transboundary cooperation

The Commission of the Republic of Kazakhstan and the Kyrgyz Republic on the Use of Water Management Facilities of Intergovernmental Status on the rivers Chu and Talas was established in 2006 for the implementation of the Agreement of 2000 on the Use of Water Management Facilities of Intergovernmental Status on the Rivers Chu and Talas. The Commission is responsible for the joint management of the water management facilities listed in the Agreement, for the exploitation of which Kyrgyzstan has a right to compensation from Kazakhstan for a share of the expenses.

Kyrgyzstan underlines the importance of developing a new agreement that reflects the principles of IWRM (a draft concept exists). Initial steps have also been taken to extend the existing Agreement with protocols to include more water facilities.

Establishment of an Interstate Chu Talas Basin Council has been proposed, and a concept for it developed. A project on adaptation to climate change in the Chu and Talas Basins with the support of UNECE and UNDP has also started.

Trends

Kyrgyzstan expects the condition of water infrastructure for irrigation, industrial and municipal water supply, and for wastewater treatment to deteriorate, negatively influencing the availability and quality of water resources. Groundwater quality will likely be adversely impacted by increasing contamination resulting from the non-respect of water protection zones.

CHU RIVER BASIN[36]

The 1,186 km-long Chu River is fed mainly by glaciers and melting snow, but groundwater contribution to flow is also important, particularly in the foothills and lowlands.

Basin of the Chu River

Country	Area in the country (km^2)	Country's share (%)
Kazakhstan	26 600	42.5
Kyrgyzstan	35 900	57.5
Total	**62 500**	

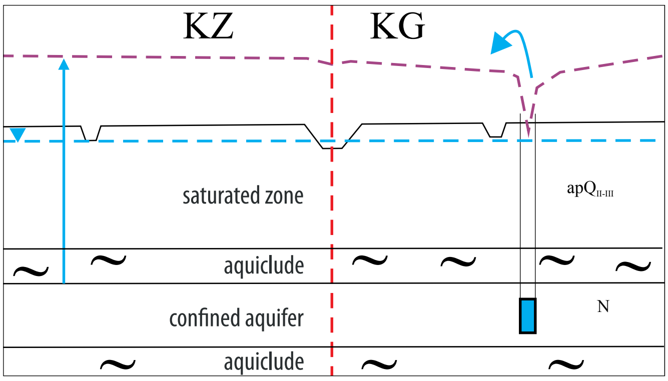
Source: Report on activities in the period 2008–2009, Commission of the Republic of Kazakhstan and the Kyrgyz Republic on the Use of Water Management Facilities of Intergovernmental Status on the Rivers Chu and Talas.

Hydrology and hydrogeology

Surface water resources in the Kyrgyz part of the Chu basin amount to 6.64 km^3/year. This is the total volume of flow based on which the agreed water allocation was made (1983), of which Kazakhstan's share is 42% (2.79 km^3/year) and that of Kyrgyzstan 58% (3.85 km^3/year).

Surface water resources forming in the Kyrgyz part of the basin are estimated at 5.0 km^3/year on average. Surface water resources in the Kazakh part are estimated at 4.502 km^3/year, and groundwater resources at 0.807 km^3/year.

FIGURE 2a: Sketches of the Chu/Shu aquifer (No. 29) (provided by Kazakhstan)



CHU/SHU AQUIFER (NO. 29)

	Kazakhstan	Kyrgyzstan
Type 3 and other (see Figure 2a and 2b); intergranular/multilayered, partly confined and partly unconfined; boulders, pebbles, gravel, sand, loam, clay; groundwater flow direction along the border from Kyrgyzstan (south) to Kazakhstan (north); strong links with surface waters.		
Border length (km)	200	
Area (km^2)	7 516	10 000
Thickness: mean, max (m)	250–300, 500	
Renewable groundwater resource (m^3/d)	~682 500	
Groundwater uses and functions	Drinking water 40%, irrigation 60%.	Drinking water, irrigation, industry mining, livestock, thermal spa (<25%).
Pressure factors	Water abstraction, and lack of data and information to make proper predictions.	Water abstraction, degradation of ecosystems, salt water upcoming and lack of data and information to make proper predictions.
Groundwater management measures	Need to introduce monitoring (quantity and quality) and data exchange. Need to improve transboundary institutions and abstraction management. Need to apply good agricultural practices and integrated river basin management.	Need to introduce monitoring (quantity and quality) and data exchange. Need to improve transboundary institutions, urban and industry wastewater treatment and abstraction management. Need to apply good agricultural practices and integrated river basin management, and to introduce protection zones.

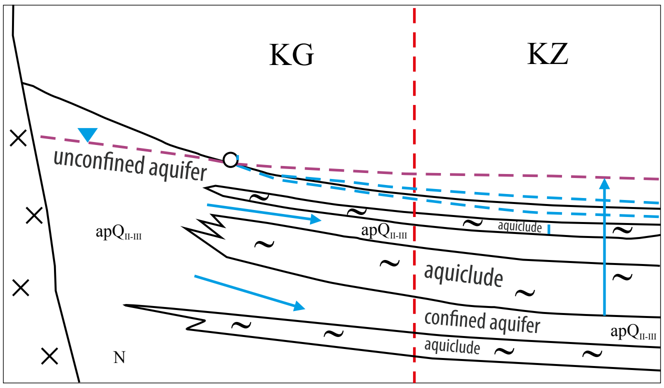
[36] The input from Kazakhstan is based on the Integrated Water Management Plan for the Chu Basin.

Total water withdrawal and withdrawals by sector in the Kara Darya Sub-basin

Country	Year	Total withdrawal $\times10^6$ m^3/year	Agricultural %	Domestic %	Industry %	Energy %	Other %
Kyrgyzstan	N/A	2 800	41.4	2.6	29.1	N/A	N/A
Kazakhstan	2006	641	98.5	0.19	0.81	-	0.5
	2010[a]	1 087	96.48	0.19	0.48	-	2.85

[a] The figures are estimates.

FIGURE 2b: Sketches of the Chu/Shu aquifer (No. 29)



In both riparian countries, irrigated agriculture exerts pressure on water resources. The irrigated area is 131,000 ha in Kazakhstan and 330,000 ha in Kyrgyzstan. In addition, in Kyrgyzstan, the main pressure factors include untreated industrial and municipal wastewaters (e.g. Gorvodokanal in Bishkek), animal husbandry, mining (in the mountainous part), and unauthorized waste disposal close to settlements. Kyrgyzstan ranks wastewater discharges as widespread but moderate in impact. Radioactive substances are also among the problems. The flow regulation has decreased flooding of the lowlands, but this has adverse impacts on vegetation. Kyrgyzstan also reports problems with rising groundwater tables, as well as the waterlogging of irrigated lands and settlements. Water scarcity and drought are locally a concern in Kyrgyzstan.

Status

The river Chu was classified as "polluted" (class 4) in 2010 according to the water resources quality classification in Kazakhstan; the water pollution index being 2.65. With the exception of 2002, when it was classified as "polluted" (class 4), water quality has consistently been "moderately polluted" from 2001 to 2006. The concentrations of the following substances exceeded the MAC in 2009: copper (4.37 MAC), BOD_5 (2.14 MAC), phenols (1.90 MAC), oil (1.05 MAC), nitrite nitrogen (1.66 MAC).

Responses

Since the 1970s, the number of hydrological monitoring stations on the Chu and its tributaries has decreased by more than two thirds; only seven remain operational. Below Ortotokoisk reservoir, there is not a single gauging station operating. Departmental gauging stations of Zhambylhydrometcenter are built on the Aksy, Shargo and Karabalta tributaries. The Swiss Agency for Development and Cooperation has supported setting up a supervisory control and data acquisition system at irrigation facilities on the West Big Chu Canal to provide real-time information on water availability.

The technical status of water construction works, including irrigation channels, has been deteriorating. However, investments have been made, including the construction of the Kara-Burinsky dam in Kyrgyzstan for irrigation.

TALAS RIVER BASIN[37]

The 661-km long Talas River is formed by the confluence of the Karakol and Uchkosha rivers, which originate from the Kyrgyz Ridge and the Talas Alatau. The river disappears into the Moinkum sands before reaching Lake Aydyn.

Basin of the Talas River

Country	Area in the country (km^2)	Country's share (%)
Kazakhstan	41 270	78.3
Kyrgyzstan	11 430	21.7
Total	**52 700**	

Source: Joint communication by the Ministries of Environment Protection of Kazakhstan and Kyrgyzstan; Integrated water resources management plan of the Talas, Kazakhstan, 2007.

Hydrology and hydrogeology

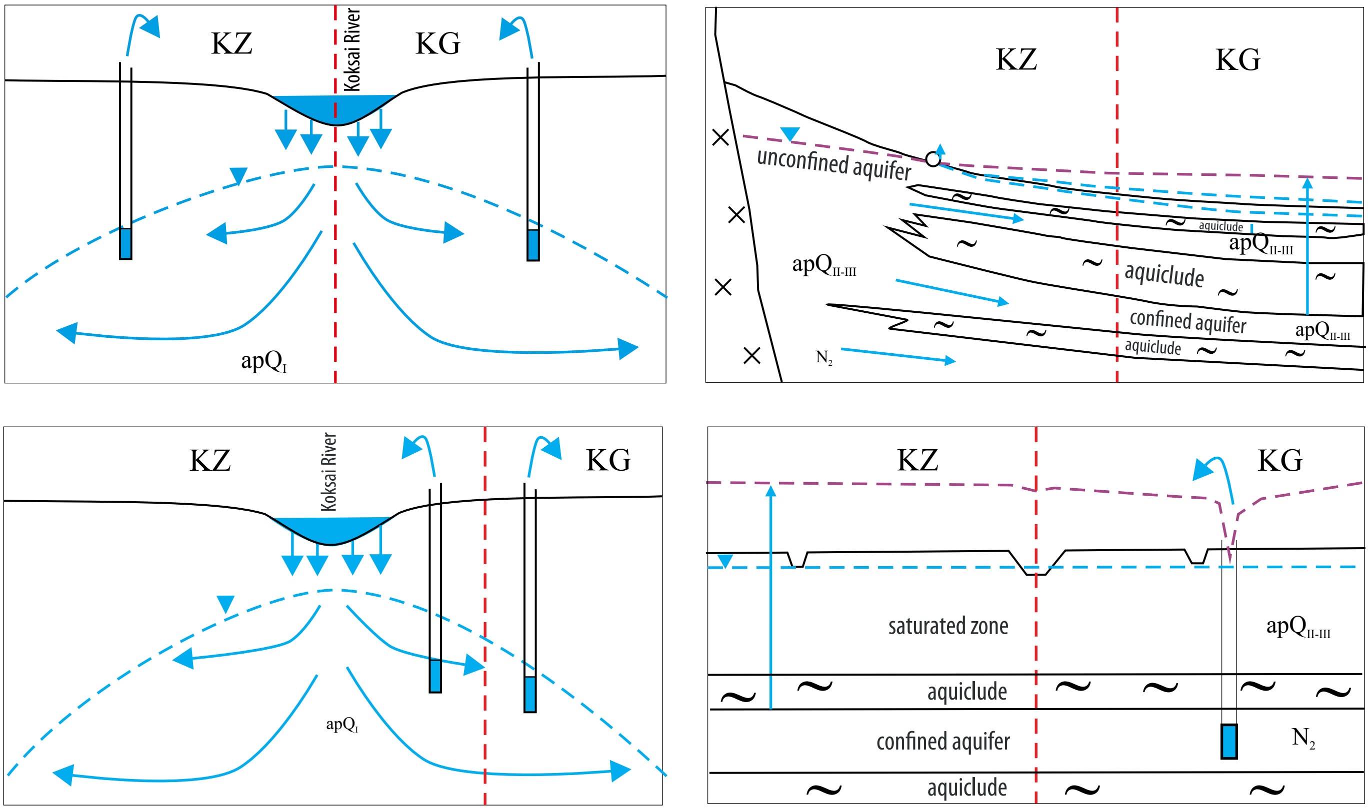
An investigation of channel water balances and an assessment of surface and groundwater resources are needed, due to absence of updated data. The estimated flow on which the equally-shared water allocation on the Talas has been made is 1.616 km^3/year (based on the flow in 1983).

SOUTH TALAS AQUIFER (NO. 30)

	Kazakhstan	Kyrgyzstan
Does not correspond to any of the described model aquifer types (see Figure 3); intergranular/multilayered, partly confined (weak links with surface waters) and partly unconfined (strong links with surface waters); the Quaternary aquifer in the foothills consists of boulders-pebbles and towards north the sediment is increasingly fine-grained; the deeper Pliocene (Neogene) aquifer horizon is dominated by clays, conglomerates, and breccias with interlayers of sands and gravels; groundwater flow direction along the border from Kyrgyzstan (south) to Kazakhstan (north).		
Border length (km)	54	N/A
Area (km^2)	1 160	
Renewable groundwater resource (m^3/d)	Exploitable resources in the Quaternary aquifer in Kazakhstan are estimated at 3 m^3/s.	N/A
Thickness: mean, max (m)	50, 500	N/A
Groundwater uses and functions	Some 0.33×10^6 m^3/year was abstracted for household water (80%) and for agriculture (20%) in 2009.	N/A
Other information	Recharged from streams flowing over pre-mountain (alluvial) cones.	N/A

[37] The input from Kazakhstan is based on the Integrated Water Management Plan for the Talas Basin (2007).

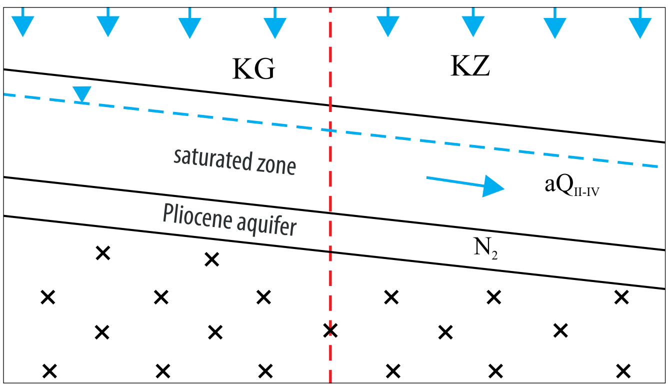
FIGURE 3: Sketches of the South Talas aquifer (No. 30) (provided by Kazakhstan)



NORTH TALAS AQUIFER (NO. 31)

	Kazakhstan	Kyrgyzstan
Does not correspond to any of the described model aquifer types (see Figure 4); intergranular/multilayered, partly confined and partly unconfined; consists of an upper Quaternary and a lower Pliocene aquifer; the Quaternary aquifer is made of pebbles, boulders and sand, the Pliocene one of conglomerates and sandstone; groundwater flow direction along the border from Kyrgyzstan (south) to Kazakhstan (north); strong links with surface waters.		
Border length (km)	58	N/A
Area (km^2)	689	N/A
Renewable groundwater resource	Exploitable resources in the Quaternary aquifer in Kazakhstan are estimated at 8.4 m^3/s.	N/A
Thickness: mean, max (m)	25, 98	N/A
Groundwater uses and functions	Some 37.72 × 10^6 m^3/year was abstracted for household water in 2009. Supports agriculture.	N/A
Other information	Quaternary aquifer has the maximum groundwater flow rate in the area between the Assa and Talas rivers. Pliocene aquifer has been studied little.	N/A

FIGURE 4: Sketch of the North Talas aquifer (No. 31) (provided by Kazakhstan)



Total water withdrawal and withdrawals by sector in the Talas Basin

Country	Year	Total withdrawal $\times 10^6$ m^3/year	Agricultural %	Domestic %	Industry %	Energy %	Other %
Kyrgyzstan	N/A	850	73.2	0.2	N/A	N/A	N/A
Kazakhstan	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Status

Water quality classification in the Syr Darya Basin

Location of observation in the Talas Basin	Water pollution index[a] – water quality classification		Parameters exceeding MAC	Multiplier of MAC exceedence
	2008	2009		
Talas, Zhasorken station	1.18; "moderately polluted" (class 3)	1.17; "moderately polluted" (class 3)	copper (2+)	2.73
			total iron	1.1
Aksu	2.09, "moderately polluted" (class 3)	2.35, "moderately polluted" (class 3)	copper (2+)	4.46
			total iron	2.85
			sulphates	2.36
			phenols	2.00
Toktash	N/A	2.97, "polluted" (class 4)	copper (2+)	5.92
			sulphates	3.40
			BOD_5	2.98
			phenols	2.08
			Oil products	1.06
Karabalta, at the border with Kyrgyzstan	3.96, "polluted" (class 4)	3.41, "polluted" (class 4)	sulphates	7.14
			copper (2+)	5.32
			total iron	3.00
			BOD_5	2.19
			manganese	2.2
			phenols	2.0

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

Pressures

Agriculture is an important water user in both countries, and exerts pressure on water quantity. The irrigated area is 90,000 ha (including 27,000 ha of meadows and grasslands) in Kazakhstan, and 115,000 ha in Kyrgyzstan.

The main pressure factors in Kyrgyzstan are similar to those reported for the Chu River Basin, including untreated municipal and industrial wastewater discharges, animal husbandry, mining in the mountainous parts and unauthorized disposal of waste next to settlements.

In Kazakhstan, there is also pressure on water quality from return waters from wastewater infiltration fields of the sugar and alcohol industries.

Responses

According to Kyrgyzstan, 13 gauging stations are still operational on the Talas (out of 21 formerly).

An advisory basin council was established in 2009 on the Talas in Kyrgyzstan. A plan for the development, use and protection of water resources of the Talas has also been developed in Kyrgyzstan. The plan is expected to be implemented after consideration by the National Council on Water (established in 2006). Water users' associations are being established.

ASSA RIVER BASIN[38]

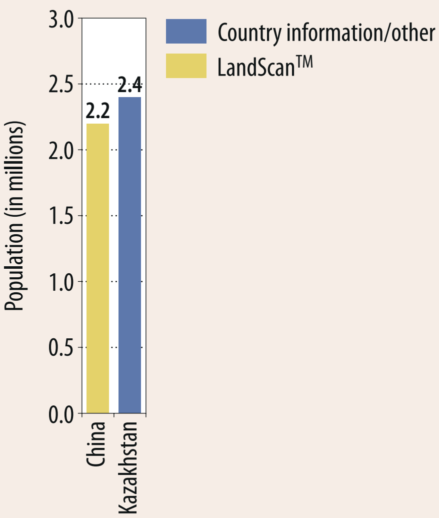
The Assa River, shared by Kyrgyzstan and Kazakhstan, is formed by the confluence of two rivers – the Ters and Kukureusu (the last one is on the territory of Kyrgyzstan). The river is 253 km long, and the catchment area is 8,756 km^2.

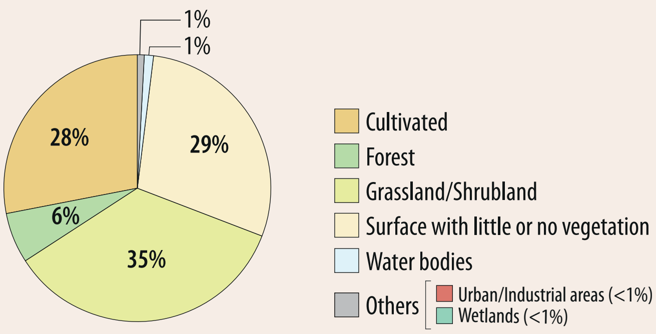
Water resources at the maximum run-off cross section in an average year is 12.5 m^3/s. The flow of the Assa River is regulated by the Ters-Ashibulak Reservoir. Groundwater resources in the basin are estimated at 930,500 m^3/day.

The water quality of the river Assa is classified as moderately polluted (class 3); the water pollution index is 1.2. There is no discharge of wastewaters into the river.

[38] Based on information provided by Kazakhstan.

POPULATION AND LAND COVER IN THE ILI RIVER BASIN





Sources: UNEP/DEWA/GRID-Europe 2011; Ministry of Environment Protection of Kazakhstan; Scheme of complex use and protection of water resources, Kazakhstan, 2008; Ministry of Environment Protection of Kazakhstan; Scheme of complex use and protection of water resources, Kazakhstan, 2008.

ILI RIVER BASIN[39]

The basin of the 1,439-km long Ili[40] River is shared by China and Kazakhstan. The river has its source in the central Tien Shan, at the confluence of the Tekes and Kunes[41] rivers. The Kash, Šaryn and Šilik are other tributaries to the Ili. In flowing into Lake Balkhash, it forms a vast delta on Kazakh territory (see the assessment of the Ili delta).

Basin of the Ili River

Country	Area in the country (km^2)	Country's share (%)
Kazakhstan	123 500	68.8
China	56 100	31.2
Total	**179 600**	

Source: Ministry of Environment Protection of Kazakhstan; Scheme of complex use and protection of water resources, Kazakhstan, 2008.

Hydrology and hydrogeology

In the Kazakh part of the basin, surface water resources are estimated at 18.1 km^3/year (an estimate of 11.8 km^3 generated outside Kazakhstan), and groundwater resources at 3.51 km^3/year.

Until recently, there were 15 reservoirs on the tributaries to the Ili (Kash, Kunes, Tekes) in China, and some 40 additional small reservoirs were planned. In Kazakhstan, the flow is regulated at the Kapchagai Reservoir, which is used for irrigation, drinking water supply, and hydropower production. A number of smaller hydropower stations operate on the tributaries. Water is transferred from the Ili Basin to the Tarim and Karamay Basins in China.

Pressures and transboundary impacts

The main pressure factors include irrigated agriculture (with a low water efficiency), animal husbandry, industry (mining, manufacturing and refining), and urbanization. Flow regulation adversely affects vegetation and the riverine ecosystem in general (see the assessment of the Ili delta for more details).

Status

The water pollution index, after a high value in 2001 (4.01, water quality class 4, "polluted"), decreased, indicating some improvement of the quality, and the index value has since varied between 2.14 and 2.70.

Responses

A Kazakh-Chinese joint commission operates to address issues concerning cooperation in use and protection of transboundary waters, on the basis of the 2001 bilateral agreement. Cooperation was originally mostly focused on hydrological data exchange. The recent signature in 2011 of an agreement on the protection of the water quality of transboundary rivers marks a positive development and the expansion of the cooperation.

At present, there is no approved Integrated River Basin Management Plan on the Ili-Balkhash Basin.

Trends

A further increase of withdrawals, as planned by China, will exert higher pressure on the vulnerable ecosystem of the Ili delta and Lake Balkhash. During the hydrological observation history, natural fluctuation has also resulted in water scarce periods (e.g. the 1990s).[42] Nevertheless, the withdrawals importantly affect the level of Lake Balkhash.

Forest cover tends to decrease, and loss of pastures through land degradation is a concern.

Total water withdrawal and withdrawals by sector in the Ili Basin

Country	Year	Total withdrawal $\times 10^6$ m^3/year	Agricultural %	Domestic %	Industry %	Energy %	Other %
Kazakhstan	2006	2 917	85.5	9.4	3.7	-	1.4
	2010[a]	3 064	85.2	7.95	3.4	-	3.45
China	N/A	N/A	N/A	N/A	N/A	N/A	N/A

[a] The figures from Kazakhstan for 2010 are estimates.

Water quality classification in the Ili Basin

Location of observation in the Tobol Basin	Water pollution index[a] – water quality classification 2008	2009	Parameters exceeding MAC	Multiplier of MAC exceedence
Ili, Dobunj station (downstream from the border with China)	2.70; "moderately polluted" (class 3)	2.14; "moderately polluted" (class 3)	copper (2+)	7.13
			total iron	3.12
Tekes, Tekes station	1.89; "moderately polluted" (class 3)	1.73; "moderately polluted" (class 3)	copper (2+)	5.28
			total iron	2.53
Korgas, Baskunshy station	1.83; "moderately polluted" (class 3)	1.19; "moderately polluted" (class 3)	copper (2+)	4.42
Karkara, at the foot of the mountains	1.45; "moderately polluted" (class 3)	1.68; "moderately polluted" (class 3)	copper (2+)	1.68

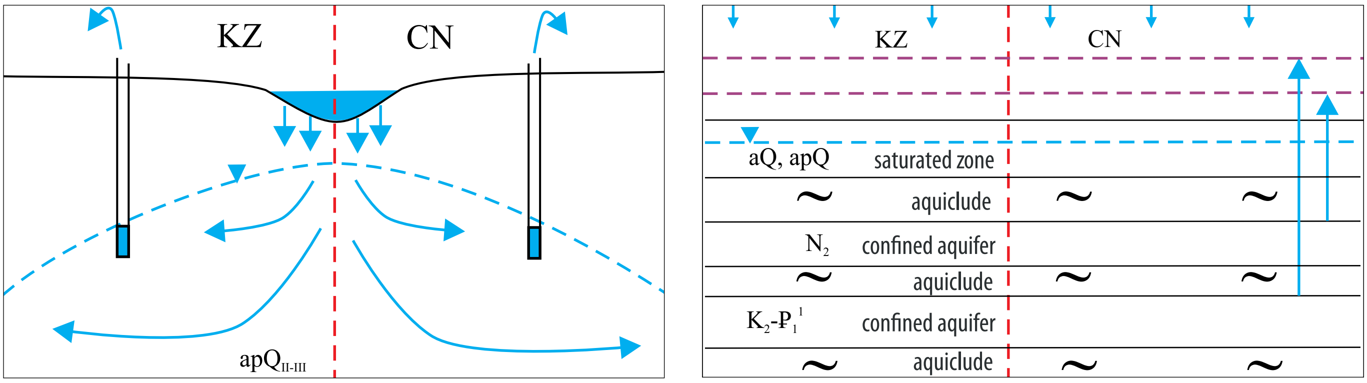
[a] The water pollution index is defined on the basis of the ratios of measured values and the maximum allowable concentration (MAC) of the water-quality determinands.
Source: Kazhydromet, Ministry of Environmental Protection of Kazakhstan.

[39] Based on information provided by Kazakhstan and the First Assessment.
[40] In Kazakhstan the river is known as Ile.
[41] In Kazakhstan the river is known as Kunges.
[42] Dostai, Zh. D. Management of the Hydroecosystem of Lake Balkhash Basin. Institute of Geography, Almaty. 2009.

ZHARKENT AQUIFER (NO. 32)

	Kazakhstan	China
Does not correspond to any of the described model aquifer types (see Figure 5); intergranular/multilayered, unconfined and confined aquifer in the Kopa-Ili intermountain artesian basin; Quaternary and Paleogene aquifer layers, underlain by Cretaceous-Palaeogene deposits; sand, gravel, pebbles, sandy loam; groundwater flow direction from both South to North and from North to South; links with surface waters range from strong to weak.		
Border length (km)	115	N/A
Area (km²)	12 080	N/A
Renewable groundwater resource (m³/d)	3.672×10^6	N/A
Thickness: mean, max (m)	1 300, 2 830	N/A
Groundwater uses and functions	In 2009, groundwater abstraction about 3.52×10^6 m³/year; 50% for agricultural use, 50% for other uses.	N/A
Pressure factors	Abstraction is substantially less than exploitable groundwater resources. No problems present.	N/A
Groundwater management measures	Early warning and (regular) surveillance monitoring need to be set up.	N/A

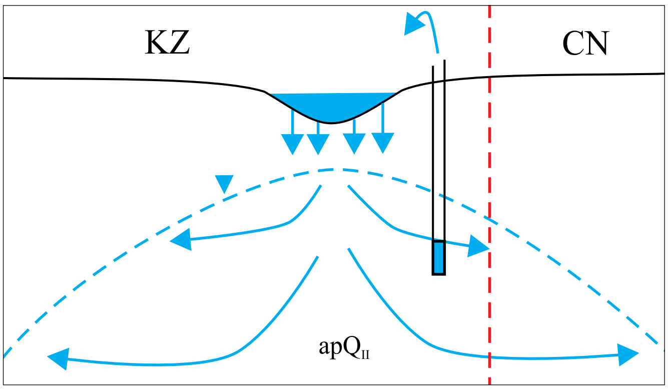
FIGURE 5: Sketches of the Zharkent aquifer (No. 32) showing the aquifer in the foothills of the Dzhungaria in the northern part, where infiltrating surface water recharges the aquifer. The upper aquifer horizon is unconfined, and the lower aquifers lies at considerable depth (provided by Kazakhstan)



TEKES AQUIFER (NO. 33)

	Kazakhstan	China
Does not correspond to any of the described model aquifer types (see Figure 6); intergranular/multilayered, unconfined and confined aquifer in an intermountain artesian basin; boulders, pebbles, sand and gravel, with interbedded clays; groundwater flow direction from Kazakhstan (west) to China (east); strong links with surface waters.		
Border length (km)	70	N/A
Area (km²)	1 876	N/A
Thickness: mean, max (m)	25, 50	N/A
Renewable groundwater resource (m³/d)	~25 600	
Pressure factors	Abstraction is substantially less than exploitable groundwater resources. No problems present.	N/A
Groundwater management measures	Early warning and (regular) surveillance monitoring are needed.	N/A

FIGURE 6: Sketch showing a part of the Tekes aquifer (No. 33) at Naryngolsky groundwater abstraction site (provided by Kazakhstan)



ILI DELTA – BALKHASH LAKE[43]

General description of the wetland

Where the Ili discharges into Lake Balkhash, it forms a vast and species-rich delta. Lake Balkhash is among the largest lakes in Asia, covering 16,400 km^2, with the Ili River being its major freshwater source. Most of the sedimentation of suspended particles occurs in the Kapchagai Reservoir, resulting in enhanced water quality and clarity downstream. Balkhash Lake itself is divided into two distinct parts, with a western part containing fresh water, and an eastern part containing saline water. There are 43 islands within the lake, but the decrease in water inflow will result in the increase of the number of islands. The major city in the area, Balkhash, has 66,000 inhabitants. The evaporation rate within the delta is quite high.

Main wetland ecosystem services

Different species of fish and invertebrates have been introduced into the lake for the purpose of fishing and aquaculture, which constitute highly important economic sectors. The delta is also used for agriculture, mainly cotton. The water of the Western part of the lake (freshwater) is used for industrial purposes and as drinking water. Moreover, the water of the Ili is already being used for irrigation and freshwater supply along the course of the river, as well as for hydropower production before it reaches the delta. The importance of the area for tourism is increasing. There are several guest-houses, resorts and spas around the lake. Additionally, recreational fishing such as "catch and release" fishing has become more popular.

Cultural values of the wetland area

The Ili delta has archaeological significance, with 10,000 graves and historic settlements which date back to the 5th – 3rd century B.C. Many different tribes and peoples have lived in this region. Additionally, rock paintings and Buddhist inscriptions can be found dating back to the 8th to the 12th century.

Biodiversity values of the wetland area

Since the 1970s, the rich biodiversity of the delta started to decrease, mainly due to the decrease in water level and the accompanying deterioration of water quality which resulted in the reduction of wetland area and riparian forest. Most of the remaining riparian forest is composed of poplar species. Other plants surrounding the lake include common reed, elephant grass, tule species, and the endemic species of bulrush. Moreover, several species of pondweed occur. The delta still supports major populations of Pelicans, such as the Dalmatian Pelican and Great White Pelican, as well as approximately 120 additional types of birds, including spoonbills, whoopers and ernes.

Pressure factors and transboundary impacts

Small changes within the river system directly affect the conditions of the river delta, making the delta ecosystem quite sensitive in terms of anthropogenic influences. The major pressure factor is the disruption of the natural flow regime, mainly due to the construction of Kapchagai reservoir in 1969, together with the continuous increase of water demand and the accompanying diversion of water in Kazakhstan and China (resulting in a decrease of flow). This has contributed to a process of degradation of the delta ecosystem which resulted in the reduction of lake surface area, the transformation of smaller lakes into marshland, and the siltation of smaller river arms. Climate change may also further contribute to a changing hydrology.

The changes in hydrological conditions result in turn in changes in the abundance of plant species. Hydrophilic species are being replaced by species characteristic for arid zones. Moreover, the delta is negatively affected by an inappropriate choice of agricultural crops, as well as by fish species such as pikeperch or catfish. Underlying these factors are socio-political conflicts of interest between different stakeholders such as hydropower station operators, fish farmers, and hunters. Additionally, the water quality is affected by discharges from agricultural and industrial processes (such as mining and ore processing), as well as from municipal sewage systems and highly mineralized groundwater. Emissions from mining and ore processing also affect the integrity of the ecosystem.

Plans by China to further increase its withdrawal of water for irrigation purposes will put even higher pressure on this sensitive ecosystem. Thus, a sustainable transboundary water management strategy is urgently needed for this region to avoid a scenario similar to the Aral Sea crisis.

Transboundary wetland management

Although a resolution containing suggestions of how to improve the management of the Balkhash Lake Basin has been adopted at the international "Balkhash 2000" conference, a management plan for the area does not exist. However, some positive developments include the declaration of Kazakhmys, a large copper producing company located close to the lake, that it would reduce its emissions by 80-90%. Additionally, a moratorium on the further filling of Kapchagai Reservoir has decreased the environmental impacts on the delta. Bilateral dialogue between China and Kazakhstan exists. The Government of Kazakhstan, for instance, has proposed to decrease the price of Kazakh products sold to China, if China reduces its take of water from Ili River in return. However, China has not accepted.

The future protection of this wetland under international regulations, such as the Ramsar Convention, could be an important step towards a more sustainable management of the delta, and the conservation of its ecosystem services, as well as its biodiversity.

[43] *Sources:* Hawksworth, D.L., Bull, A.T. (eds.). Marine, Freshwater, and Wetlands Biodiversity. Topics in Biodiversity and Conservation. Springer, Dordrecht. 2006; Morimoto, Y., Horikawa, M., Natuhara, Y. Habitat Analysis of Pelicans as an Indicator of Integrity of the Arid Ecosystems of Central Asia; Petr, T. Lake Balkhash, Kazakhstan.International Journal Salt Lake Res. 1, 21-46. 1992; Integrative and sustainability-oriented water management: potential for cooperation between Germany and Central Asia (in German). Gabler, Wiesbaden. 2009; Kezer, K., Matsuyama, H., Decrease of river run-off in the Lake Balkhash basin in Central Asia. Hydrological Processes. 2006.

MURGAB RIVER BASIN[44]

The basin of the 852-km long Murgab River is shared by Afghanistan and Turkmenistan. The river originates in Afghanistan at about 2,600 m a.s.l., and disappears into a desert sink in Kara Kum in Turkmenistan. The Abikajsar River is a major transboundary tributary. Other transboundary tributaries are the Gulrom, Khash and Kushan. The total basin area is approximately 46,880 km^2.

The long-term mean discharge of the river in Turkmenistan is 1,657 × 10^6 m^3/year. In the part of the basin that is Afghanistan's territory, the run-off is 1,480 ×10^6 m^3/year.

Agriculture is the predominant water user in the Murgab Basin, feeding many irrigation channels. Some 80% of the population in the basin in Afghanistan live from agriculture. The bad conditions of the irrigation and water supply infrastructure are a problem in Afghanistan. The efficiency of irrigation networks is estimated to be from 25 to 30%. However, the country has started to rehabilitate its irrigation infrastructure.

An increase of organic pollution has been observed in the past few years.

TEJEN/HARIRUD RIVER BASIN[45]

Afghanistan, the Islamic Republic of Iran, and Turkmenistan share the basin of the 1,124-km long Tejen/Harirud[46] River. The river originates in the high mountains in Afghanistan. The Karukh is a major transboundary tributary.

Basin of the Harirud/Tejen River

Country	Area in the country (km^2)	Country's share %
Afghanistan	39 300	39.5
Iran	49 264	43.7
Turkmenistan	23 640	20.9
Total	**112 204**	

Sources: Ministry of Nature Protection of Turkmenistan, Ministry of Energy and Water of Afghanistan, Ministry of Energy (Water and Electricity) of the Islamic Republic of Iran, East West Institute (Making the most of Afghanistan's River Basins opportunities for more cooperation, 2010).

Hydrology and hydrogeology

In the Iranian part of the basin, surface water resources for the whole basin are estimated at 535 ×10^6 m^3/year (average for the years 1950 to 2007), and groundwater resources at 2,547 ×10^6 m^3/year. These represent 874 m^3/year/capita. There is no permanent flow in the river, only seasonal.

Only the Sarakhs sub-basin in the border area has been studied; the rest of the basin is considered to have low transboundary groundwater potential (impermeable formations). Karstic aquifers may have some potential, but would need to be studied.

In Iran, in the Karat, Taybad, Torbat-e-jam, Janatabad and Aghdarband aquifers there is an extreme water deficit and water withdrawal from the aquifers is forbidden.

Pressures and status

The Tejen/Harirud River is important to Afghanistan, not only because of its economic significance in Herat Province, but also due to its political importance as the border between Afghanistan and the Islamic Republic of Iran. In the Islamic Republic of Iran, the river is important for regional development in all sectors, and is vital for supplying water to the eastern part of Khorasan Razavi Province.

The total irrigable land area in Afghanistan's part of the basin is 100,000 ha, but, due to the limited water availability, only 40,000 ha is being irrigated. Irrigated cropland (both by surface waters and groundwaters) makes up 292,920 ha in the Islamic Republic of Iran, representing 20% of the country's share of the basin. Irrigation return waters affect water quality.

In Afghanistan, about 90% of the irrigation systems are traditional, and the irrigation network's efficiency is estimated at 25-30%. At the same time, insufficiency of water for irrigation is experienced both in Afghanistan and the Islamic Republic of Iran. The Shirtappeh diversion dam between Iran and Turkmenistan is under construction to supply water to agricultural areas around Sarakhs in both countries.

Water scarcity also affects forests.

Name	Country to which the information refers (country also sharing the aquifer)	Area (km^2)	Mean thickness (m)	Max thickness (m)	Dominant flow direction	Link with surface water
Karat aquifer (no. 34)	Islamic Republic of Iran (Afghanistan)	350	65	N/A	towards Afghanistan	medium
Taybad aquifer (No. 35)	Islamic Republic of Iran (Afghanistan)	896	60	250	towards Afghanistan	medium
Torbat-e-jam aquifer (No. 36)	Islamic Republic of Iran (Afghanistan)	2 142	65	300	towards Afghanistan	weak
Janatabad aquifer (No. 37)	Islamic Republic of Iran (Afghanistan, Turkmenistan)	350	35	N/A	towards Afghanistan, Turkmenistan	medium
Aghdarband aquifer (No. 38)	Islamic Republic of Iran (Turkmenistan)	100	30	N/A	towards Turkmenistan	weak
Sarakhas aquifer (No. 39)[a]	Islamic Republic of Iran (Turkmenistan)	710	45	130	towards Turkmenistan	strong

Notes: All the aquifers in the table are of Type 3, alluvial and Quaternary in age. In the Islamic Republic of Iran , in the Karat, Taybad, Torbat-e-jam, Janatabad and Aghdarband aquifers there is an extreme water deficit and water withdrawal from the aquifers is forbidden. Groundwater supports ecosystems and agriculture, maintains base flow and springs, and prevents land subsidence.
a According to a water balance study in the Islamic Republic of Iran, the Sarakhas aquifer is estimated to recharge by about 110 × 106 m3/year, mostly from the Tejen/Harirud River.
Source: Islamic Republic of Iran.

[44] Based on information provided by Afghanistan and on the First Assessment.
[45] Based on information provided by the Islamic Republic of Iran and the First Assessment.
[46] The river is called Harirud in Iran and Tejen in Turkmenistan. It is also known as the Tedshen and the Gerirud.
[47] According to a water balance study in the Islamic Republic of Iran.

The heavy abstraction of scarce groundwater resources has a local and moderate importance in the Islamic Republic of Iran. Some 255 × 10^6 m^3/year is estimated to be abstracted from the Sarakhas aquifer (No. 39). Salinity of groundwater has become a problem.

In the Iranian part of the Tejen/Harirud sub-basin, surface waters are mainly withdrawn for agriculture and urban use. Total water withdrawal in Iran is 2,894 ×10^6 m^3/year, of which 88 % is for agriculture, 11% for domestic use and 1% for industry.

Because of urbanization and population increase, water is threatened by pollution, including pollution by heavy metals. Such risks might be further aggravated by growing water scarcity. There are dump sites near Mashhad, but these are controlled. Industrial wastewater discharges pollute water locally (but severely) in the Kashaf Rud, a branch of Harirud north of Mashhad. The industry sector is expected to develop in the Iranian part.

Flooding causes damage to settlements and agricultural land, displacing people. Afghanistan lacks infrastructure for controlling the river flow.

At present, wastewater is insufficiently treated, with a local and moderate impact on water resources, but the Islamic Republic of Iran foresees that settlements will be connected to wastewater treatment plants in the future.

The city of Mashad is an important holy place, and is visited by more than 20 million people each year from the Islamic Republic of Iran and other countries, which also puts pressure on water resources.

The above pressures generate problems of organic pollution, bacterial pollution, eutrophication, and pollution by hazardous substances.

Transboundary cooperation and responses

Turkmenistan has succeeded to the agreements on the Tejen/Harirud signed by the Soviet Union with Iran (1921 and 1926). On the basis of a new agreement signed in 1999, the Dosti[48] (Friendship) Dam was completed in 2005 (reservoir volume 1,250 × 10^6 m^3), mainly to better satisfy agricultural water demand. In accordance with the bilateral agreement, the reservoir's water resources are equally shared, with each country being entitled to 535× 10^6 m^3/year.

Two treatment plants were constructed in Mashhad in the Islamic Republic of Iran for treatment of urban wastewaters.

The Islamic Republic of Iran reports that in line with the Long-Term Development Strategies for Iran's Water Resources,[49] which refers to the necessity of coordination between different sectors, application of the principles of Integrated Water Resources Management is also striven for in the Harirud River Basin. Eight water user cooperatives, with 3,256 water right holders in total, have been established in Iran.

Afghanistan has not signed an agreement with its downstream riparian countries. Iran underlines the importance of signing a trilateral agreement and establishing basin-wide transboundary cooperation.

Trends

An increase of 1.8 to 2.35 °C in the mean temperature is predicted in the Islamic Republic of Iran for the Mashhad plain by 2050,[50] and a probable increase of temperature in Sarakhs (main basin). This is expected to change the seasonal flow, evaporation, and also the quantity and quality of surface water and groundwater. River discharge distribution and occurrence of extreme events is predicted to be severely impacted, with implications on hydromorphology. Groundwater level has decreased severely, and this trend is expected to continue, accompanied by deterioration of groundwater quality. Agricultural water requirements are expected to be considerably affected, as is land use and cropping patterns.

[48] The dam/reservoir is known as Dostluk in Turkmenistan.
[49] Deputy Minister for Water Affairs, Ministry of Energy. Iran Water resources Management Company, Tehran. 2003.
[50] *Source:* Dr. Alizadeh, 2010, "Comparison of Climate Change Scenarios and GCM Models for Kashafrood Basin of Iran" (in Persian), University of Ferdousi, Mashhad, the Islamic Republic of Iran.