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Working Group on Monitoring and Assessment

Twelfth meeting
Geneva, 2–4 May 2011
Item 5 (b) of the provisional agenda
Assessment of the status of transboundary waters in the UNECE[1] region: assessment of transboundary rivers, lakes and groundwaters in Central Asia

Assessment of transboundary waters discharging into the Aral Sea and other transboundary waters in Central Asia[2]

Note prepared by the secretariat*

Summary

This document was prepared pursuant to decisions taken by the Meeting of the Parties to the Convention on the Protection and Use of Transboundary Watercourses and International Lakes at its fifth session (Geneva, 10–12 November 2009) (ECE/MP.WAT/29, para. 81 (e)), and by the Working Group on Monitoring and Assessment at its eleventh meeting (Geneva, 6–7 July 2010), requesting the secretariat to finalize the Central Asia assessment for the second Assessment of Transboundary Rivers, Lakes and Groundwaters in time for its submission to the Seventh "Environment for Europe" Ministerial Conference (Astana, 21–23 September 2011).

This document contains the draft assessments of the different transboundary rivers, lakes and groundwaters which are located in the Aral Sea Basin or in other parts of Central

[1] United Nations Economic Commission for Europe.
[2] This document was submitted for publication without formal editing.
* The present document has been submitted on the present date due to late receipt of inputs by concerned countries and resource constraints in the secretariat.

Asia.

For background information and for the decisions that the Working Group on Monitoring and Assessment may wish to take, please refer to document ECE/MP.WAT/WG.2/2011/4−ECE/MP.WAT/WG1/2011/4.

Contents

I. Introduction

1. The present document contains the assessments of the different transboundary rivers, lakes and groundwaters which are located in the Aral Sea Basin or in other parts of Central Asia. The document has been prepared by the secretariat with the assistance of the International Water Assessment Centre (IWAC) on the basis of information provided by the countries in the Central Asia sub-region.

2. For descriptions of the transboundary aquifer types and related illustrations, Annex V of document ECE/MP.WAT/2009/8 should be referred to.

3. For background information and for the decisions that the Working Group on Monitoring and Assessment may wish to take, please refer to document ECE/MP.WAT/WG.2/2011/4−ECE/MP.WAT/WG1/2011/4.

II. Amu Darya River Basin[3]

4. 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.

5. In addition to the Pyanj and the Vakhsh, the major transboundary tributaries include the Surkhandarya and Kafirnigan. The former tributary Zeravshan does not reach the Amu Darya anymore.

Table 1
Area and population in the Amu Darya Basin.

Country	*Area in the country (km^2)*	*Country's share %*	*Population*	*Population density ($persons/km^2$)*
Afghanistan				
Kyrgyzstan	5 680[b]		60 000[c]	
Tajikistan				
Uzbekistan				
Turkmenistan				
Total	**309 000**[a]		~50 000 000	162

[a] This is the upstream catchment area of the Amu Darya contributing water to the main river at Kerki gauging station at the border between Tajikistan and Uzbekistan(?). 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 (Source: Environment and Security in the Amu Darya Basin, ENVSEC, 2011)

[b] Represents the area of Kyrgyzstan in the Kyzyl Suu sub-basin.

[c] Estimate

[3] 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 of Transboundary Rivers, Lakes and Groundwaters.

Hydrology and hydrogeology

6. The mean annual run-off in the Amu Darya Basin is about 78 km^3. Some 80 per cent of the flow is estimated to be generated in Tajikistan.[4]

Table 2
Volume of run-off in the Amu Darya Basin by country.

Country	*Volume of run-off (in 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

7. 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.

8. More than 35 reservoirs of water storage more then 10×10^6 m^3 have been built in the Amu Darya Basin and their total 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 with a design storage capacity of 3.2 km^3, is under construction.[5] The commonly smaller reservoirs inside the complex systems of canals like the Talimardjansky and Tudakulsky reservoirs in Uzbekistan have an important role for storing seasonal water.

9. 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 events of flooding between the confluence of these rivers and the Tyuyamuyunsk Reservoir.

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

Table 3
Karatag/North-Surhandarya aquifer[6]: 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.

	Tajikistan	*Uzbekistan*

4 The estimates vary somewhat depending on the source.
5 Dam safety UNECE
6 The Karatag aquifer was already assessed in the first Assessment of Transboundary Rivers, Lakes and Groundwaters in 2007 (named there as Karotog). Please note that the names of some of the aquifers have been revised since. The updated inventory is for the most part based on the inventory by UNESCO and the International Groundwater Resources Assessment Centre (IGRAC) in 2009.

Border length (km)	46	50
Area (km^2):	3428	3550
Renewable groundwater resource (m^3/d)		
Thickness in m (mean, max)	50–100, 100	70, 100
Groundwater uses and functions	Drinking water supply	Drinking water supply
Pressure factors	Water abstraction	Water abstraction
Problems	Change of water resources on the edge of sustainability; Negligible local contamination by nitrate (agriculture)	Change of water resources based on the water abstraction on the Tajikistan territory; 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; Stratigraphic horizon $arQ_{iii\text{-}iv}$	Enhancement of the monitoring network of groundwater most needed; Stratigraphic horizon $arQ_{ii\text{-}iii}$

Table 4

Kofarnihon aquifer: confined Quaternary aquifer; pebble drifts with streaks of clay loam. Groundwater flow direction towards Uzbekistan. Medium links with surface waters.

	Uzbekistan	*Tajikistan*
Border length (km)	50	
Area (km^2):	343	
Renewable groundwater resource (m^3/d)		
Thickness in m (mean, max)	70, 100	
Groundwater uses and functions		
Pressure factors		
Problems		
Groundwater management measures		
Other information	Stratigraphic horizon $arQ_{ii\text{-}iii}$	

Pressures

Table 5
Total withdrawal and withdrawals by sectors.

Country	Year	Total withdrawal $\times 10^6$ m^3/year	Agricultural %	Domestic %	Industry %	Energy %	Other %
Afghanistan							
Kyrgyzstan		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	-

Source: Amu Darya BWO through CAWATERinfo (http://www.cawater-info.net/amudarya/index_e.htm), Kyrgyzstan

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

11. Irrigated agriculture makes up some 90 per cent of the total water use. Cotton cultivation has decreased somewhat and food crops are gaining more ground. Irrigation return waters 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, pesticides as well as nitrogen and phosphorus compounds. Water losses are also associated with irrigation systems.

12. In the lowland part, large-scale irrigation schemes like 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 about 1100-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 Kyrgyzstan's part of the basin (in the Kyzyl Suu sub-basin) is 20 000 ha and in Afghanistan's 1,200,000 ha.

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

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

15. Processes like bank erosion change strongly the channel of the river. Availability of a minimum (ecological) river flow is a source of concern. The Amu Darya delta suffers from reduced flow and a poor water quality which have a negative impact on the ecosystems. Deforestation which has substantially reduced the forest cover in the past few decades is ranked widespread and severe. Notably the Tugai forests have been significantly reduced. Land degradation occurs on the left bank of the Amu Darya in Afghanistan. Dried-

up silt deposits from floods are the source of sand dunes forming in Afghanistan's part of the Amu Darya Basin.

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

17. Pressures are described in further detail in the assessments of the tributaries.

Status

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

19. Because of reduced flow into the delta and retreat of the Aral Sea's shore line, about 50 water bodies (lakes) in the delta have dried up. Nevertheless, as a result of conservation policy in several releases for the past 8 years, a number of lake systems, such as for example Sudochye, Karadzhar, Toguztur, Daukempyr and Dautkol have been gradually restored.

Response and transboundary cooperation

20. 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.

21. Efforts have been made in Uzbekistan to establish protected areas. The construction of Golden Century Lake in the Karakum desert in Turkmenistan for collection of drainage water may have a positive impact on water quality but may reduce flow in the Amu Darya.

22. The Amudarya Basin Water Organization (BWO) was established as executive body of the Inter-State Commission for Water Coordination (ICWC)[7], 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 to the canals as these need to be synchronized with water releases from the Nurek Reservoir on the Vakhsh tributary.

23. Turkmenistan and Uzbekistan cooperate in operating jointly the Tyuyamuyunsk dam.

Future trends

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

25. At present time, the withdrawal of Afghanistan is at 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 Afghanistan's development ambitions back.

26. 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: According

[7] 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.

to scenario A2[8], no significant changes in water resources of the Amu Darya by 2030 are predicted by Uzbekistan. By 2050 reduction of water resources by 10 to 15 per cent in the basin of the Amu Darya is considered possible. During the years of acute water scarcity (extremely warm and dry years), in the Amudarya Rivers Basin might decrease by 25-50 per cent.[9] Kyrgyzstan predicts an increase in river flow by 2025 because of melting of mountain glaciers and a decline after that. The predicted increased aridity and evapotranspiration in the region are expected to be reflected as increased irrigation requirements, which would have implications in the Amu Darya where around 90 per cent of the water use is for irrigated agriculture.

III. Surkhan Darya sub-basin[10]

27. The Surkhan Darya is a transboundary tributary to the Amu Darya which originates in Tajikistan. The major part of its basin is in Uzbekistan.

Table 6
Area and population in the Surkhan Darya sub-basin.

Country	*Area in the country (km^2)*	*Country's share %*	*Population*	*Population density (persons/km^2)*
Tajikistan				
Uzbekistan				
Total	**13 500**			

Hydrology

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

Pressures

29. Dushanbe, the capital of Tajikistan, is on the Surkhan Darya. Drinking water for Dushanbe is taken from the Varzob River, a tributary of the Surkhan Darya. The expanding settlements affect negatively the 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 substantial dilution of wastewater and large amount of trash.[11]

[8] 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.

[9] *Source*: Second National Communication of the Republic of Uzbekistan under the United Nations Framework Convention on Climate Change

[10] Based on information provided by Tajikistan and the first Assessment of Transboundary Rivers, Lakes and Groundwaters

[11] 2nd Environmental Performance Review of Tajikistan, UNECE, 2011.

IV. Kafirnigan sub-basin[12]

30. The Kafirnigan River[13], 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.

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

Table 7
Area and population in the Kafirnigan Basin.

Country	*Area in the country (km^2)*	*Country's share %*	*Population*	*Population density (persons/km^2)*
Tajikistan	9 780	84.4		
Uzbekistan	1 810	15.6		
Total	**11 590**			

Hydrology and hydrogeology

32. The long-term average discharge of the Kafirnigan at Tartki in Tajikistan is approximately 5.33 km^3/year. Groundwater resources in Tajikistan's part of the basin are estimated at 6.86×10^6 m^3/year.

33. 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 km^2. The thickness is on average about 35 m and reaches some 110 m at most. Links with surface waters are medium.

Pressures

Table 8
Total withdrawal and withdrawals by sectors.

Country	*Year*	*Total withdrawal $\times 10^6$ m^3/year*	*Agricultural %*	*Domestic %*	*Industry %*	*Energy %*	*Other %*
Tajikistan		90					
Uzbekistan							

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

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

12 Based on information provide by Tajikistan and the first Assessment of transboundary Rivers, Lakes and Groundwaters

13 In Tajikistan, the river is called the Obisahid in the upstream part and from the confluence with the Obi Barzangi downstream it is known as the Kafirnigan.

V. Pyanj sub-basin[14]

35. Afghanistan and Tajikistan share the sub-basin of the Pyanj River[15], a tributary of the Amu Darya, which forms the border between Afghanistan and Tajikistan (together with the Pamir River). The total length of the Vakhan Darya/Pyanj[16] is 1,137 km. Most of the catchment area is mountainous.

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

Table 9
Area and population in the Pyanj sub-basin.

Country	*Area in the country (km^2)*	*Country's share %*	*Population*	*Population density (persons/km^2)*
Afghanistan	47 670	42		
Tajikistan	65 830	58		
Total	**113 500**			

Hydrology and hydrogeology

37. 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, sands with an average thickness of 30 m (maximum 160 m) with medium links with surface waters.

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

Pressures

39. Some 30 years of war has 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 leaving fine sediment. A number of multi-purpose reservoir construction projects planned before the war, were suspended in Afghanistan, among them the Upper and Lower Kokcha (the Kokcha is a tributary of the Pyanj). With the infrastructure lacking, Afghanistan has little means to limit damage from flooding.

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

41. The limited water use for irrigated agriculture in Tajikistan concentrates in the Kyzylsu sub-basin. Tajikistan reports that its total water withdrawal from the Pyanj

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[14] Based on information provide by Afghanistan and Tajikistan, and the first Assessment of Transboundary Rivers, Lakes and Groundwaters

[15] The river is also known as the Panj.

[16] 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.

amounts to about 300,000 m^3/year. Groundwater is abstracted for drinking water and for industrial use.

42. The possibility of the earth "dam" blocking Sarez Lake (volume 16.1 km^3) on the Bartang tributary failing in this earthquake-prone area is a potential threat for the downstream.

Response and trends

43. According to the 1946 agreement between the Soviet Union and Afghanistan, Afghanistan is entitled to use up to 9 km^3 a year from the Pyanj. At present time 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.

VI. Vakhsh sub-basin[17]

44. The sub-basin of the Vakhsh[18], 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 runoff.

Table 10
Area and population in the Vakhsh sub-basin.

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

Hydrology and hydrogeology

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

46. The Vakhsh is regulated and important for hydropower generation, with the Nurek reservoir being the main one on the river (water storage volume 10.5 km^3). The Nurek dam, which is the largest dam in Tajikistan and in Central Asia, serves both irrigation and hydropower generation. The other dams on the Vakhsh in Tajikistan include the Baipazin, Golovnaya, the Prepadnaya and the Central.[19]

Table 11
Aquifer: Type 3, Quaternary; boulders, gravels, sands; Groundwater flow direction from Kyrgyzstan to Tajikistan. Medium links with surface waters.

[17] Based on information provide by Tajikistan and the first Assessment of Transboundary Rivers, Lakes and Groundwaters

[18] The river is also known as Kyzyl Suu in Kyrgyzstan and as Surkhob in Tajikistan.

[19] *Source (main)*: Dam safety in Central Asia: Capacity-Building and Regional Cooperation. UNECE. Water Series no. 5. 2007.

	Tajikistan	*Kyrgyzstan*
Border length (km)		
Area (km^2):	2 233	
Renewable groundwater resource (m^3/d)		
Thickness in m (mean, max)	35, 166	
Number of inhabitants		
Population density		
Groundwater uses and functions		
Pressure factors		
Problems		
Groundwater management measures		
Other information	Stratigraphic horizons: ap. a. P. Q	

Pressures

47. Pressures in Tajikistan's part include discharge of insufficiently treated municipal wastewaters, uncontrolled landfills, burial and pesticides A large dump of hazardous chemicals, notably pesticides, is located close to Sarband in Tajikistan. Industrial wastewaters are discharged from a nitrogen-fertilizer plant (causing nitrate pollution) and from Yavan electric-chemical plant in Tajikistan. There is also mining and aluminium processing in Tursunzade and the expansion of these activities has been expected to possibly have transboundary impact. In addition to hydropower, surface water is used for irrigation; groundwater is mainly used for household water and for industry.

48. 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 big Rogun Reservoir[20] (storage capacity 13.8 km^3) upstream of the Nurek for hydropower generation mainly for the energy-intensive aluminium-processing. A technical pre-feasibility study and socio-environmental impact assessment with funding from the World Bank are 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 of to water availability downstream.

[20] *Source*: Dam safety in Central Asia: capacity-building and regional cooperation. Water Series 5. UNECE 2007.

VII. Zeravshan Basin[21]

49. The basin of the Zeravshan River is shared by Tajikistan and Uzbekistan. The Zeravshan is a former tributary of the Amu Darya but does not reach it anymore because of the development of irrigation in the lowland part of the catchment[22].

Table 12
Area and population in the Zeravshan Basin[23].

Country	*Area in the country (km^2)*	*Country's share %*	*Population*	*Population density (persons/km^2)*
Tajikistan	17 700			
Uzbekistan				
Total				

50. Average annual discharge at Dupuli, Tajikistan is 4.86 km^3/year. Groundwater resources in the Tajikistani 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 in Tajikistan.

Table 13
Aquifer: Type 4, Quaternary; boulder-pebble, pebble; Groundwater flow direction from Tajikistan to Uzbekistan. Medium links with surface waters

	Tajikstan	*Uzbekistan*
Border length (km)		
Area (km^2):	383	
Renewable groundwater resource (m^3/d)		
Thickness in m (mean, max)	36, 110	
Number of inhabitants		
Population density		
Groundwater uses and functions	Not considered important for use	
Pressure factors		
Problems		
Groundwater management measures		
Other information		

[21] Based on information provided by Tajikistan and the first Assessment of Transboundary Rivers, Lakes and Groundwaters

[22] The most upstream weir of the irrigation system for the Karakul Oasis is considered the "mouth" of the Zeravshan River.

[23] The catchment area is difficult to define and estimates vary.

Pressures

51. The flow is regulated at the Karaultepinsky, Kattakurgansky and Kuyumazarsky dams which serve irrigation in Uzbekistan[24]. It has been estimated that some 96% of the water resources are used for irrigation, in Uzbekistan mainly.

52. The Ayni hydropower plant is planned upstream in Tajikistan.

53. 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.

54. The main uses of groundwater are as household water and for industry.

55. Factors reported to affect the quality status of waters include natural background pollution, municipal and industrial wastewaters, agriculture (nutrients, pesticides) as well as suspended sediment and debris flows.

VIII. Syr Darya Basin[25]

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

Table 14
Area and population in the Syr Darya Basin.

Country	*Area in the country[a] (km²)*	*Country's share %*	*Population*	*Population density (persons/km²)*
Kazakhstan	297 564		2 833 200[b]	10
Kyrgyzstan	167 000			
Tajikistan	150 100			
Uzbekistan				
Total				

[a] As the water divide can only be correctly established in the mountainous part, the surface area of the basin not well established. Some sources quote 782,600 km² as the total basin area.
[b] Data for 2006, Statistics Agency of Kazakhstan; Some 45 per cent of the population are urban dwellers.

Hydrology

57. In Kyrgyzstan's part the surface water flow amounts to 27.6 km³/year including the tributaries Naryn and Kara Darya.

58. In the part of the basin that is Kazakhstan's territory, surface water resources are estimated at 19.66 km³/year (14.96 km³ of it originating from outside Kazakhstan) and groundwater resources at 2.838 km³/year.

[24] *Source*: Dam safety in Central Asia: capacity-building and regional cooperation. Water Series 5. UNECE 2007
[25] Based on information provided by Kazakhstan, Kyrgyzstan and Tajikistan, as well as the first Assessment of Transboundary Rivers, Lakes and Groundwaters

59. Major reservoirs on the strongly regulated Syr Darya include the Kajrakkum reservoir (design capacity 3,400 million m^3) and the Chardarin reservoir in Kazakhstan (design capacity 5,200 million m^3). The infrastructure for the 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 started in January 2011, to supply irrigation water to the provinces of Kyzyl-Orda and Southern Kazakhstan.

Table 15
Transboundary aquifers in the Syr Darya Basin[26].

Name	*Country (country shared with)*	*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 surfacewater*
Osh-Aravan*	Kyrgyzstan	718,3		Mostly unconfined	boulder-pebble, pebble	200-250	400	towards Uzbekistan	medium
	Uzbekistan	1266	90	confined	boulder-pebble drifts	90-150	300	towards Uzbekistan	medium
Almos-Vorzik*	Uzbekistan (Kyrgyzstan)	485	20	unconfined	pebbles with streaks of clay loam	100	300	towards Uzbekistan	medium
Maylusu*	Uzbekistan (Kyrgyzstan)	387	25	confined	pebble with streaks of clay and loam	150	300	towards Uzbekistan	medium
Sokh*	Uzbekistan (Kyrgyzstan)	1810	55	confined	boulder-pebble drifts with streaks of clay loam,	200	350	towards Uzbekistan	medium
Dalverzin*	Tajikistan (Uzbekistan)	1029	100		boulder, cobble sediments	20-120	120	towards Uzbekistan	
Zafarobod*	Tajikistan, (Uzbekistan)	3833	229		boulder, cobble sediments	60-70	70	towards Uzbekistan	
Sulyukta-Batken-Nau-Isfara*	Tajikistan (Kyrgyzstan, Uzbekistan)	3339	323		boulder, cobble sediments	50-120	120	towards Tajikistan, Uzbekistan	
Syr-Darya 1	Kazakhstan (Uzbekistan)	189000	960	Confined, intergranular/multilayered	sand, gravel, pebbles	0.5-40	500-3000	Along the border towards north-west	weak
Naryn	Uzbekistan (Kyrgyzstan)	1424	36	confined	boulder-pebble drifts.	200	350	towards Uzbekistan	medium
Chust-Pap	Uzbekistan (Kyrgyzstan)	456	55	confined	pebble, boulder, gravel.	100	200	towards Uzbekistan	medium

[26] The aquifers indicated with an asterisk were already assessed in the first Assessment of Transboundary Rivers, Lakes and Groundwaters (2007). Please note that the names of some of the aquifers have been revised since. The updated inventory is for the most part based on the inventory by UNESCO and the International Groundwater Resources Assessment Centre (IGRAC) in 2009.

Kasansay	Uzbekistan (Kyrgyzstan)	164	30	confined	pebble with streaks of clay loam	80	200	towards Uzbekistan	medium
Shorsu	Uzbekistan, Tajikistan	658	35	confined	boulder, pebble with streaks of clay loam	175	350	towards Uzbekistan	medium
	Kazakhstan	17020	394[a]	Confined, intergranular/multilayered	sand, clay	200	400	towards Uzbekistan/ N-S	weak
Pretashkent*	Uzbekistan	1079	85	confined/artesian	boulder and pebble sediment with streaks of clay loam	300	550	towards Uzbekistan	medium
Iskovat-Pishkaran	Uzbekistan (Kyrgyzstan)	444	32	confined	pebble with boulders.	100	350	towards Uzbekistan	medium

[a] Length of the border between Kazakhstan and Uzbekistan on the Pretashkent aquifer according to Kazakhstan.

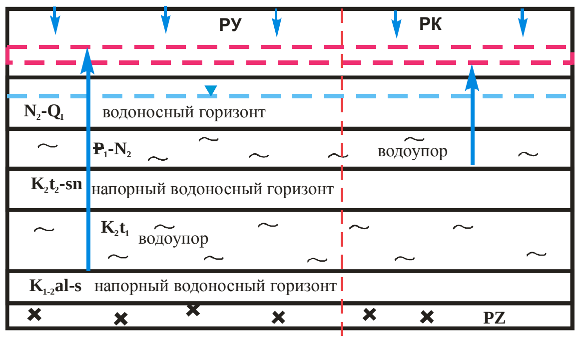
Table 16

Syr Darya 1 aquifer: Does not correspond with the described model aquifer types (see the conceptual sketch, figure 1); Intergranular/multilayered aquifer (confined); sand, gravel and pebbles; Groundwater flow direction along the border towards north-west); weak links with surface waters.

	Kazakhstan	*Uzbekistan*
Border length (km)	960	
Area (km^2):	189 000	
Renewable groundwater resource (m^3/d)		
Thickness in m (mean, max)	0.5–40, 500–3 000	
Number of inhabitants		
Population density		
Groundwater uses and functions	Some 67.73 × 10^6 m^3/year was abstracted in 2009, mainly for household water (88 %) and some for agriculture (8%) and industry (4%))	
Pressure factors	Groundwater abstraction	
Problems	Depletion of the groundwater resource	
Groundwater management measures	Joint (Kazakhstan-Uzbekistan) modelling and assessment of exploitable groundwater resources (of Pretashkent aquifer), and their allocation between the sharing countries	

Other information	Stratigraphic horizons: N_2-Q, K_2, K_{1-2}

Figure 1. **Conceptual sketch of the Syr Darya aquifer (provided by Kazakhstan).**



Pressures

Table 17
Land cover/use in the area of the Syr Darya Basin (% of the part of the basin extending in each country).

Country	*Water bodies (%)*	*Forest (%)*	*Cropland (%)*	*Grassland (%)*	*Urban/ industrial areas (%)*	*Surfaces with little or no vegetation (%)*	*Wetlands/ Peatlands (%)*	*Other forms of land use (%)*
Kazakhstan	7.9	18.2	57.7	53.0[a]				
Kyrgyzstan								
Tajikistan								
Uzbekistan								

Source: Scheme of complex use and protection of water resources.

[a] Less than one per cent of this consists of flood meadows.

Table 18
Total withdrawal and withdrawals by sectors.

Country	*Year*	*Total withdrawal ×10^6 m^3/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		0.000035					
Uzbekistan							

60. Kyrgyzstan assesses debris flows and landslides as a widespread and severe problem. Increased number of natural hazards like 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 get commonly flooded in winter when hydropower generation is maximized at the Toktogul reservoir in Kyrgyzstan.

61. Irrigated agriculture is the biggest water user, and 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. Diversion of water for irrigation and water losses in the low-efficiency irrigation systems affect the hydrology, resulting in flow reduction below ecological flow. Pollution by urban wastewaters occurs in Kyrgyzstan due to wastewater collection commonly lacking or the capacity of the network being insufficient and landfills for household waste are also a pressure factor.

Status

62. In 2009, 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, water quality was classified as "moderately polluted" (class 3), and the water quality seems to degraded slightly based on the water pollution index which has increased from 1.26 and 1.36 in 2001 and 2002, respectively. The hardness of water was 7.30 in the Syr Darya and 14.20 mg/l in the Keles. The pH was 7.84 in the Syr Darya and 7.62 in the Keles, and the oxygen content — meeting the national requirement — 9.57 and 10.89 mg/l, respectively.

Table 19

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

Source: Kazhydromet, Ministry of Environmental Protection of Kazakhstan

[a] Water pollution index is based on the relationship of the measured values and the maximum permissible concentration of water-polluting components

Measures

63. From some 100 hydrological monitoring stations in Kyrgyzstan's territory within the Syr Darya Basin in 1980 currently only 28 are operational

64. Following the 1998 intergovernmental Agreement on the use of water and energy resources in the Syr Darya Basin between Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan, a number of annual intergovernmental bilateral and multilateral agreements were signed over the past fifteen years mainly related to use of water and energy resources of Naryn-Syr Darya cascade of reservoirs. In 2003 and after, only ad-hoc annual bilateral or multi-lateral agreements have been made and lately agreements made have been limited to Kazakhstan and Kyrgyzstan. For a list of individual agreements (also regional ones), annex II of document ECE/MP.WAT/WG.1/2011/4 - ECE/MP.WAT/WG.2/2011/4 should be referred to.

65. 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.

66. Water users' associations are being established to improve agricultural water use in Kyrgyzstan, where tariffs on supply of irrigation water are also applied. In the Water Resources Committee of Kyrgyzstan, setting up an analysis and information center and development of a unified information system on water is planned.

67. An overall agreement on water use is needed and development of a regional strategy for adaptation to climate change is also called for.

IX. Aydar Arnasay Lakes System (Uzbekistan and Kazakhstan)[27]

General description of the wetland

68. 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 Chardarya irrigation dam and in order to prevent damage downstream of the Syr Darya in the territory of Kazakhstan in 1969 (21.0 km^3). The Lakes System includes three brackish water lakes (Aydar-Kul, Arnasay and Tuzkan) which are fed by drainage and surplus river waters. It is one of the largest reservoirs in Uzbekistan, covering about 3,500 km^2 with an average depth of 8-10 meters. The water of the reservoir ranges from medium to strongly saline. Being located at the cross-roads of two migratory bird flyways: the Afro-Euroasian and the Central-Asian, the lake system plays an extremely important role as a congregation site for a high number of migratory and wintering waterbirds. The area is only sparsely populated.

Main wetland ecosystem services

69. The Aydar-Arnasay Lakes System (AALS) is a buffer zone for the prevention of damage from flooding by Chardara water basins which would otherwise affect the territory of Kazakhstan. 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 maximum allowable concentration in the most part 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 in AASL 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 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.

[27] *Source*: RIS Information Sheet 2008 (http://www.wetlands.org/rsis/)

Biodiversity values of the wetland area

70. The reservoir and its shallow water areas are a habitat for many species of flora and fauna. More than 100 species of waterbirds including grebs (*Podicipediformes*), pelicans (*Pelecaniformes*), ciconiformes (*Ciconiformes*), swans, geese, ducks (*Anseriformes*), rails (*Rallidae*), shorebirds (*Charadriiformes*) 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`s International Red List of threatened species. Not only AALS plays an extremely important role as a resting area during seasonal migrations, but is also 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 occuring around the reservoir are: wild boar (*Sus scrofa*), badger (*Meles meles*), jungle cat (*Felis chaus*), golden or Indian jackal (*Canis aureus*), muskrat (*Ondatra zibethicus*), nutria (*Myocastor coypus*), pheasant (*Phasianus colchicus*), dice snake (*Natrix tessellate*) and marsh frog (*Rana ridibunda*). Additionally, the site is important for the Central Asian Tortoise *Testudo horsfieldii* (vulnerable, IUCN Red List) and for the Goitered Gazelle *Gazella sub- gutturosa* (vulnerable). The riparian vegetation consists mainly of reed communities, saltwort and tamarisk.

Pressure factors and transboundary impacts

71. The ecological balance of the lakes system is under pressure by the construction of an additional dam upstream of Chardarya. This will change the regime of flow into the lakes system. This will result in a drastic fall of water level which can in turn lead to a reduction of water area, an increase of mineralization of water, a reduction of the amount of migratory bird species as well as fish resources and to degradation and shrinking of vegetation cover. The desert around livestock farms degrades as the result of intensive cattle grazing and firewood collection. Moreover, the invasive Common Myna Acridotheres tristis is expanding into the desert areas. Uncontrolled hunting, fishing and water use is putting further pressure on the system's resources and particularly the use of bottom gill nets presents a serious threat to waterbirds, especially diving species.

Transboundary wetland management

72. 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 AALS have been designated as a Ramsar site by Uzbekistan in 1983, but the area is not protected under national legislation. Nevertheless it fulfills IUCN criteria 4 as a Habitat/Species Management Area. In 1983 the Arnasay ornithological zakaznik (a type of protected area) which comprises of the three reservoirs Tuzkan, Arnasay and Aydar was created by the state of Arnasay and covers 63,000 hectares. Most of the AALS territory is planned to be integrated into the Nuratau-Kyzylkum biosphere reserve (project UNDP/GEF/Government of the Republic of Uzbekistan). An «Action Plan for maintenance of stability of ecological conditions and effective use of Aydar Arnasay Lakes System (AALS) for Uzbekistan for 2008-2015 years» was developed and approved by the Government of Uzbekistan. It aims to preserve and maintain stable conditions for Aydar Arnasay Lakes System as a reservoir that is of high importance for fishery and the social economic value of Uzbekistan. An Information Centre was created within the framework of the project UNDP/GEF/Government of Uzbekistan "Creation of Nuratau Kyzykkum Biosphere reserve as a model of preservation of biodiversity of Uzbekistan" in the territory of Tuzkan and Aydar Lakes. The State Nature Protection bodies, hunter and fisher associations hold meetings with local people on a regular basis in order to inform them about the importance of wetlands.

X. Naryn sub-basin[28]

73. 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.

Table 20

Area and population in the Naryn sub-basin.

Country	*Area in the country (km^2)*	*Country's share %*	*Population*	*Population density (persons/km^2)*
Kyrgyzstan			300 000–350 000[a]	
Uzbekistan				
Total	**59 900**			

[a] A rough estimate. Population information at basin level is lacking.

Hydrology and hydrogeology

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

75. 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 one 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)[29].

Pressures

Table 21

Total withdrawal and withdrawals by sectors.

Country	*Year*	*Total withdrawal $\times 10^6$ m^3/year*	*Agricultural %*	*Domestic %*	*Industry %*	*Energy %*	*Other %*
Kyrgyzstan		729.4	68.9	0.05	0.07	-	-
Uzbekistan							

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

76. Some 115,000–120,000 ha are irrigated in the Kyrgyzstani 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 valley Kulanakskoy Naryn rayon of the Naryn Oblast in Kyrgyzstan.

[28] Based on information provided by Kyrgyzstan and the fist Assessment of Transboundary Rivers, Lakes and Groundwaters

[29] *Source*: Dam safety in Central Asia: capacity-building and regional cooperation. Water Series 5. UNECE 2007.

77. Kyrgyzstan assesses the problem of forest cover reduction as widespread and severe. Also the occurrence of debris flows and landslides is ranked as widespread and severe. Pressure from water pollution is assessed also as severe but local. Of comparable importance is the shrinking of the monitoring networks of water resources and glaciers. Other pressure factors include water losses and pollution in irrigated agriculture, dumps of household waste, problems related to management of municipal and industrial wastewater (a lack of wastewater collection, insufficient capacity of networks and resulting pollution), waste from mining and livestock.

Status

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

Response and transboundary cooperation

79. In the Kyrgyzstani part of the basin, there are nine gauging stations operating at present time[30]. With the commissioning of the Kambarata dam and reservoir for hydropower generation[31], setting up one upstream becomes necessary.

80. 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.

XI. Kara Darya sub-basin[32]

81. The 180-km long Kara Darya is a tributary of the Syr Darya originating in Kyrgyzstan and flowing into Uzbekistan in the Fergana Valley.

Table 22
Area and population in the Kara Darya sub-basin.

Country	*Area in the country (km^2)*	*Country's share %*	*Population*	*Population density (persons/km^2)*
Kyrgyzstan			850 000[a]	
Uzbekistan				
Total	**30 100**			

[a] A rough estimate. Population information at basin level is lacking.

82. In Kyrgyzstan's part of the basin, surface water resources are estimated at 7.10 km^3/year (based on observations up to 2000).

83. The flow is heavily regulated. The reservoirs in the sub-basin include the Andijan[33] (constructed in 1978 with storage capacity of 1.75 km^3), the smaller Teshiktash and

[30] In the first Assessment of Tranboundary Rivers, Lakes and Groundwaters (2007), when three out 15 former gauging stations were operational, it seems the monitoring situation — in the case of this particular river — has improved somewhat.
[31] Kambarata 2 has been constructed, Kambarata 1 is pending.
[32] Based on information provided by Kyrgyzstan and the first Assessment of Transboundary Rivers, Lakes and Groundwaters

Kujganya Reservoirs, and the Bazar-Kurgansky Reservoir (built 1962) on the Kara Unkur tributary.

Pressures

Table 23
Total withdrawal and withdrawals by sectors.

Country	Year	Total withdrawal $\times 10^6$ m^3/year	Agricultural %	Domestic %	Industry %	Energy %	Other %
Kyrgzystan		831.4	93	4.3	0.3	-	0.2
Uzbekistan							

[a] The withdrawal in Kyrgyzstan is expected to increase by 160×10^6 m^3/year.

84. 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. Accidental release of the contents upon a failure of a tailings pond wall would affect downstream.

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

Response

86. Kyrgyzstan reports that rehabilitation of irrigation canals, water diversion structures, and strengthening of river banks has been carried out.

87. There is a lack of observations of water quality and solid load. Constraints to monitoring include an insufficient network of monitoring stations, a lack of material and equipment, as well as poor state of gauging stations and living conditions of observers. Some of these gaps are foreseen to be addressed in the World Bank project "Improving Water Management" and the project "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.

88. Jalal-Abad river basin council was established from 2008 to 2009 in the Kara Darya Basin. The council is hoped 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.

Future trends

89. Introduction of some 16 ha of new irrigated land is planned in the near future according to the state program of construction of water facilities and development of new irrigated land in the Kyrgyz Republic for the period 2008-2010.

[33] The reservoir is also known as Kampyrravatsk due to the location in the gorge with that name.

XII. Chirchik sub-basin[34]

90. The Chirchik originates at the confluence of the Chatkal and the Pskem which flow into the Charvak Reservoir.

Table 24
Area and population in the Chirchik sub-basin.

Country	*Area in the country[a] (km²)*	*Country's share %*	*Population*	*Population density (persons/km²)*
Kazakhstan				
Kyrgyzstan				
Uzbekistan				
Total	**14 240**			

Hydrology and hydrogeology

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

92. Flow is transferred to the Keles[35] and Akhangaran Basins from time to time.

Pressures

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

93. Main industries in the basin include the Khodjikent asphalt and concrete plant, the manufacturing firm Electrokhimprom and the Uzbek metal manufacturing complex.

94. The high sediment load in upper has required setting up facilities for protecting the Chirchik-Bozsu Cascade of hydropower stations.

XIII. Chatkal sub-basin[36]

95. The 217-km long Chatkal River originates in Kyrgyzstan and flows into the Chirchik in Uzbekistan.

Table 25
Area and population in the Chatkal sub-basin.

Country	*Area in the country (km²)*	*Country's share %*	*Population*	*Population density (persons/km²)*

[34] Based on information provided by Kazakhstan and the first Assessment of Rivers, Lakes and Groundwaters

[35] The Keles is a non-transboundary tributary of the Syr Darya in Kazakhstan

[36] Based on information provided by Kyrgyzstan and the first Assessment of Transboundary Rivers, Lakes and Groundwaters

Kyrgyzstan	5 520	25 100
Uzbekistan		
Total	**7 110**	

Hydrology and hydrogeology

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

Pressures and transboundary impact

97. Water pollution by return waters and water losses related to irrigation are reported among the pressures. The area of irrigated land in the part of the basin that is Kyrgyzstan's territory is 6 451 ha.

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

99. According to Kyrgyzstan, 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.

Response

100. There monitoring of flow in Kyrgyzstan's part of the sub-basin. The former gauging station at the mouth of the tributary Ters is functioning since 1992. The Hydrometeorological Service of Uzbekistan has one in Khudajdodsaj.

Future trends

101. In Kyrgyzstan river flow is expected to increase by 2025 and decline after. Under duch circustances, formation and breaking of proglacial lakes is considered possible, and the passage of flood debris along the rivers.

XIV. Chu-Talas Basins[37]

102. The Chu-Talas basins, which are shared by Kazakhstan and Kyrgyzstan, include the basins of three transboundary rivers: the Chu, the Talas and the Assa. Most of the runoff of the Chu, Talas and of the tributary Kukureusu in the case of the 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.

[37] Based on information provided by Kazakhstan and Kyrgyzstan, and the first Assessment of Transboundary Rivers, Lakes and Groundwaters

Transboundary cooperation

103. 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 between Kazakhstan and Kyrgyzstan 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 expenses in accordance with the Agreement.

104. Kyrgyzstan underlines the importance of developing a new agreement so that it 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. Linked to the water code, a decision was made in Kyrgyzstan to create a Chu-Talas Basin Water Management Department (?) under the newly established Committee of Water Resources and Land Reclamation.

105. Establishment of an Interstate Chu Talas Basin Council has been proposed and a concept for it developed.

106. A project on adaptation to climate change in the Chu and Talas Basins is to be initiated with the support of UNECE.

Table 26
Reservoirs in the Chu and Talas Basins.

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

Trends

107. Kyrgyzstan expects the condition of water infrastructure for irrigation, industrial and municipal water supply, and for wastewater treatment to deteriorate, with influencing negatively on the availability and quality of water resources. Groundwater quality will likely be adverse impacted by increasing contamination resulting from the worsening status of water protection zones.

XV. Chu Basin[38]

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

Table 27
Area and population in the Chu Basin

Country	*Area in the country (km^2)*	*Country's share %*	*Population*	*Population density (persons/km^2)*
Kazakhstan	26 600	42.5	381 650	14
Kyrgyzstan	35 900	57.5	1 675 000	47
Total	**62 500**			

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.

Hydrology and hydrogeology

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

110. Surface water resources forming in Kyrgyzstan's part of the Chu Basin are estimated at 5.0 km^3/year on average. Surface water resources in the Kazakhstani part of basin are estimated at 4.502 km^3/year and groundwater resources at 0.807 km^3/year.

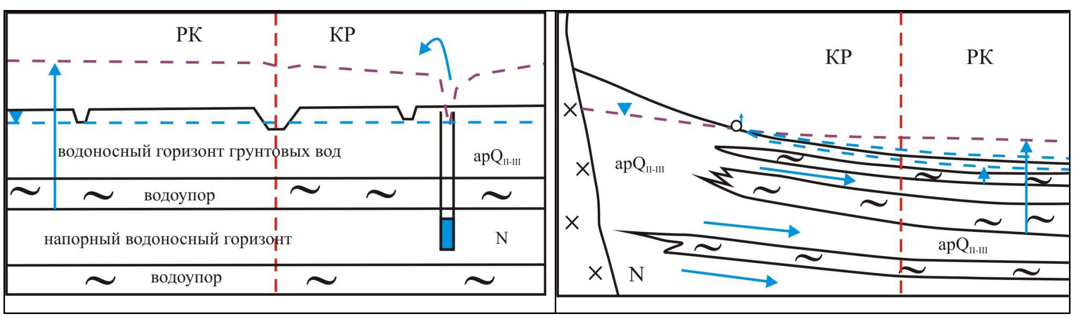
Table 28
Chu/Shu aquifer: type 3 and other, intergranular/multilayered, partly confined and partly unconfined; boulders, pebbles, gravel, sand, loam, clay; Groundwater flow direction along the border from Kyrgyzstan (south) to Kazakhstan (north). Strong links with surface waters.

	Kazakhstan	*Kyrgyzstan*
Border length (km)	200	
Area (km^2):	7 516	10 000
Renewable groundwater resource (m^3/d)		
Thickness in m (mean, max)	250–300, 500	
Number of inhabitants		
Population density		
Groundwater uses and functions	Drinking water 50%, irrigation 50%	Drinking water, irrigation, industry, mining, livestock, thermal spa

[38] The input from Kazakhstan is heavily based on the integrated water management plan for the Chu Basin.

		(<25%)
Pressure factors	water abstraction	water abstraction
Problems	a lack of data and information to make proper predictions	Degradation of ecosystems and salt water upcoming; a lack of data and information to make proper predictions
Groundwater management measures	Effective: quantity, quality monitoring Need to be improved: transboundary institutions, abstraction management Need to be applied: good agricultural practices, integrated river basin management, data exchange	Effective: quantity, quality monitoring, mapping, urban and industry wastewater treatment. Need to be improved: transboundary institutions, abstraction management, protection zones. Need to be applied: good agricultural practices, integrated river basin management, data exchange
Other information	Stratigraphic units: $apQ_{II-IIII}$, N; partly confined and partly unconfined;; monitoring programme needs to be enhanced	Confined; monitoring programme needs to be enhanced

Figure 2 **Conceptual sketch of the Chu/Shu aquifer (provided by Kazakhstan).**



Pressures

Table 29
Land cover/use in the area of the Chu basin (% of the part of the basin extending in each country).

Country	*Water bodies (%)*	*Forest (%)*	*Cropland (%)*	*Grassland (%)*	*Urban/ industrial areas (%)*	*Surfaces with little or no vegetation (%)*	*Wetlands/ Peatlands (%)*	*Other forms of land use (%)*
Kyrgyzstan			9.2[a]					

Kazakhstan	4.9[b]

Notes: [a, b] These figures represent the irrigated agricultural land only.

Table 30
Total withdrawal and withdrawals by sectors

Country	*Year*	*Total withdrawal* $\times 10^6$ *m³/year*	*Agricultural* %	*Domestic* %	*Industry* %	*Energy* %	*Other* %
Kyrgyzstan	?	2 800[a]	41.4	2.6	29.1	N/A	N/A
Kazakhstan	2006	641	98.5	0.19	0.81	-	0.5
	2010[b]	1 087	96.48	0.19	0.48	-	2.85

[b] The figures are predictions.

111. 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 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. The flow regulation has decreased flooding of the lowlands, but this has adverse impacts on vegetation. Kyrgyzstan reports also problems with rising groundwater tables as well as waterlogging of irrigated lands and settlements. Water scarcity and drought is locally a concern in Kyrgyzstan as are radioactive substances, but the former is potentially severe in impact, whereas the latter only moderate.

109. The impact of water resources availability and quality is significant to internal migrant population in Kyrgyzstan.

Status

110. Water quality in Chu in Blagoveshchensk, Kazakhstan (water quality monitoring station downstream from the border with Kyrgyzstan) was classified 2009 as “moderately polluted” (class 3) according to the water quality classification of Kazakhstan. The Water Pollution Index (WPI) was 2.06. With the exception of year 2002 when it was classified as “polluted” (class 4), water quality at this station has consistently been “moderately polluted” from 2001 to 2006[39]. The concentrations of the following substances exceeded in 2009 the Maximum Allowable Concentrations (MAC): copper (4.37 MAC), BOD_5 (2.14 MAC), phenols (1.90 MAC), oil (1.05 MAC), nitrite nitrogen (1.66 MAC). The observed oxygen (10.1 mgO_2/l) met the requirements. The total concentration of dissolved solids (TDS) was 5.15 mg/l and pH was 7.84.

Response

111. Since the 1970s, the number of hydrological monitoring stations on the Chu and its tributaries has decreased by more than two thirds; seven remain operational. Below Ortotokoisk reservoir there is not a single gauging station operating. Gauging stations on the major tributaries are not functioning, and existing are in need of repair.

[39] Based on data of the Ministry of Environment Protection of Kazakhstan .

112. The Kara-Burinsky dam was constructed and commissioned in 2007 in Kyrgyzstan for irrigation. 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.

XVI. Talas Basin[40]

113. 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 it reaches Lake Aydyn.

Table 31
Area and population in the Talas Basin

Country	*Area in the country (km^2)*	*Country's share %*	*Population*	*Population density (persons/km^2)*
Kazakhstan	41 270	78.3	485 900	12
Kyrgyzstan	11 430	21.7	200 300	18
Total	**52 700**			

Sources: 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

114. The flow based on which the water allocation on the Talas — 50 per cent for Kyrgyzstan and 50 per cent for Kazakhstan —has been made (1983) is 1.616 km^3/year.

Table 32
South Talas aquifer: does not correspond with the illustrated 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 gets increasingly fine-grained. The deeper Pliocene (Neogene) aquifer horizon is dominated by clays, conglomerates, breccias with interlayers of sands and gravels; Groundwater flow direction along the border from Kyrgyzstan (south) to Kazakhstan (north).

	Kazakhstan	*Kyrgyzstan*
Border length (km)	54	
Area (km^2):	1160	
Renewable groundwater resource (m^3/d)	Exploitable resources in the apQ_{II-III} aquifer in Kazakhstan are estimated at 3 m^3/s.	
Thickness in m (mean, max)	50, 500	
Number of inhabitants		
Population density		

[40] Information on the Kazakhstani part of the basin based heavily on the Intergrated water resources management plan of the Talas (2007)

Groundwater uses and functions	Some 0.33×10^6 m^3/year was abstracted for household water (80%) and for agriculture (20%) in 2009
Pressure factors	
Problems	
Groundwater management measures	
Other information	Stratigraphic horizons apQ_I, apQ_{II-III}; recharged by water losses from streams flowing over pre-mountain (alluvial) cones

Figure 3. **Sketches of the South Talas aquifer (provided by Kazakhstan).**

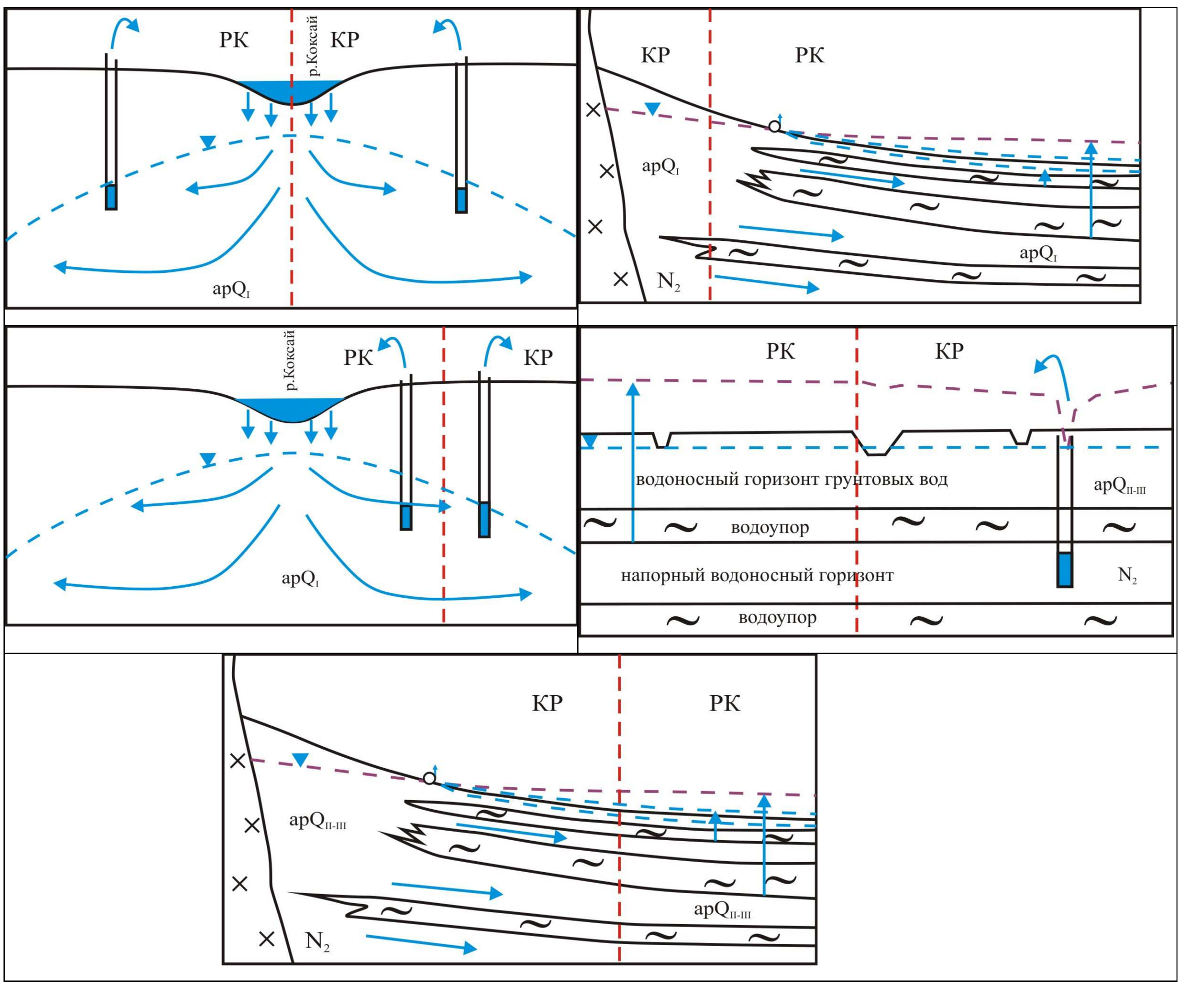


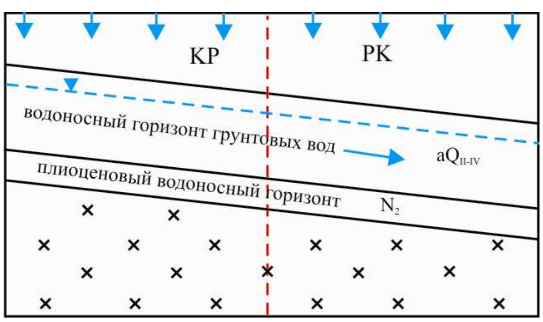
Table 33

North Talas aquifer: does not correspond with the illustrated types (see figure 4);

intergranular/multilayered, partly confined and partly unconfined; Consists of an upper Quaternary and a lower Pliocene aquifer; Pebbles and boulders and pebbles, sand, conglomerates, sand, sandstone; Groundwater flow direction along the border from Kyrgyzstan (south) to Kazakhstan (north). Strong links with surface waters.

	Kazakhstan	*Kyrgyzstan*
Border length (km)	58	
Area (km^2):	689	
Renewable groundwater resource (m^3/d)	Exploitable resources in $aQ_{II\text{-}IV}$ aquifer in Kazakhstan are estimated at 8.4 m^3/s	
Thickness in m (mean, max)	25, 98	
Number of inhabitants		
Population density		
Groundwater uses and functions	Some 37.72×10^6 m^3/year was abstracted for household water in 2009; Supports agriculture	
Pressure factors		
Problems		
Groundwater management measures		
Other information	Stratigraphic horizons $aQ_{II\text{-}IV}$, N_2; Horizon $aQ_{II\text{-}IV}$ has maximum groundwater flow rate in the area between the Assa and Talas rivers. Pliocene aquifer (N_2) has been studied little.	

Figure 4. **Sketches of the North Talas aquifer (provided by Kazakhstan).**



Pressures

Table 34
Total withdrawal and withdrawals by sectors from the Talas

Country	*Year*	*Total withdrawal ×10⁶ m³/year*	*Agricultural %*	*Domestic %*	*Industry %*	*Energy %*	*Other %*
Kyrgyzstan	?	850[a]	73.2	0.2	N/A	N/A	N/A
Kazakhstan						-	

115. The main pressure factors in Kyrgyzstan are untreated municipal and industrial wastewaters, discharges from livestock breeding, mining in the mountainous parts and unauthorized disposal of waste next to settlements. Irrigated agriculture as an important water user 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[41]. In Kazakhstan, there is also pressure on water quality from return waters from wastewater infiltration fields of the sugar and alcohol industries.

116. In the Kyrgyzstani part of the Talas basin, the pressure factors are as reported for the Chu Basin above.

Status

117. In general in 2009, the oxygen content at the monitoring locations in Kazakhstan specified in table 35 met the national requirements, ranging from 9.79 to 10.1 mgO_2, the total concentrations of dissolved solids (TDS) was from 7.06 to 11.8 mg/litre and pH was from 8.04 to 8.16, depending on the monitoring location.

Table 35
Water quality classification.

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

[41] In the first Assessment (2007) the irrigated area was reported to be 105,000 ha in Kazakhstan and 137,600 ha in Kyrgyzstan.

				BOD_5	2.19
				manganese	2.2
				phenols	2.0

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

Response

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

119. An advisory basin council has been established in 2009 on the Talas in Kyrgyzstan. A plan for development, use and protection of water resources of the Talas has also been developed in Kyrgyzstan, which will be adopted for implementation after consideration by the National Council on Water (established in 2006). Water users' associations are being established.

XVII. Ili Basin[42]

120. The basin of the 1,439-km long Ili River is shared by China and Kazakhstan. The river has its source in the eastern Tien Shan at the confluence of the Tekes and Kunes rivers. The Kash, Šaryn and Šilik are other tributaries to the Ili. Where the Ili discharges to Lake Balkhash (605 km long), it forms a vast delta (see the related Ramsar site assessment).

Table 36
Area and population in the Ili Basin

Country	*Area in the country (km^2)*	*Country's share %*	*Population*	*Population density (persons/km^2)*
Kazakhstan	123 500	68.8	2 393 980	
China	56 100	31.2		
Total	**179 600**			

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

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121. In Kazakhstan's part of the basin, surface water resources are estimated at 18.1 km^3/year (11.8 km^3 of it estimated to flow from outside the borders of Kazakhstan) and groundwater resources at 3.51 km^3/year.

122. Until recently, there were 15 reservoirs on the tributaries to the Ili (Kash, Kunes, Tekes) in China but some 40 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

[42] Based on information provided by Kazakhstan and on the first Assessment of Transboundary Rivers, Lakes and Groundwaters

tributaries. Water is transferred from the Ili Basin to the Tarim and Karamay Basins in China.

Table 37

Zharkent aquifer: Aquifer type does not correspond with the described 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.

	Kazakhstan	*China*
Border length (km)	115	
Area (km^2):	12 080	
Renewable groundwater resource (m^3/d)	$1\ 340 \times 10^6$	
Thickness in m (mean, max)	1 300, 2 830	
Number of inhabitants		
Population density		
Groundwater uses and functions	In 2009, groundwater abstraction about 3.52×10^6; 50 per cent for agricultural use , 50 per cent for other use	
Pressure factors	Abstraction is substantially less than exploitable groundwater resources	
Problems	None	
Groundwater management measures	Early warning and (regular) surveillance monitoring	
Other information	Stratigraphic horizons: aQ_{II-III}, apQ_{II-III}, apQ_I, N_2, K_2-P_{11} (no flow)	

Figure 5. **Conceptual sketches of the Zharkent aquifer 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 lie at considerable depth. (provided by Kazakhstan).**

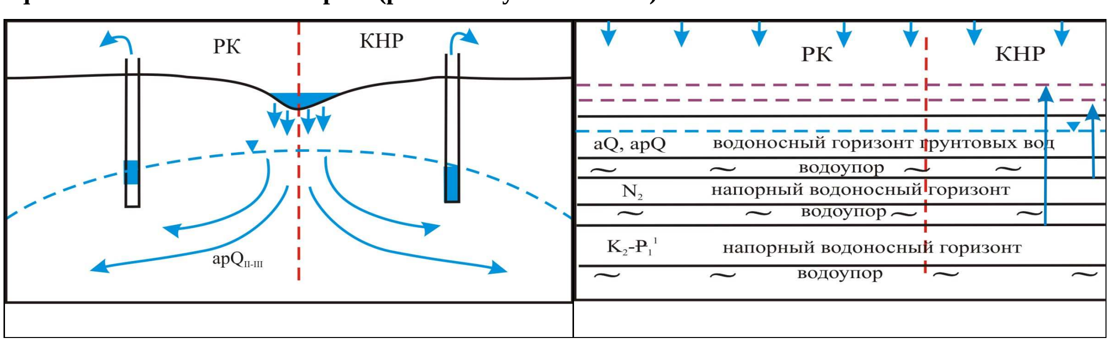
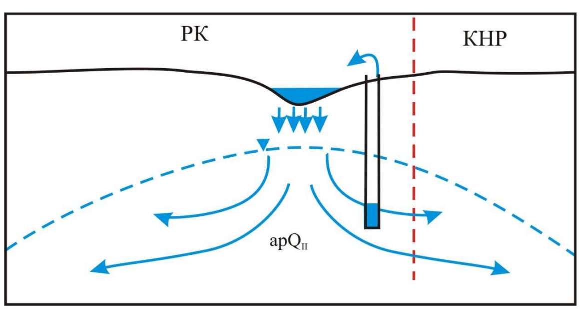


Table 38

Tekes aquifer: Aquifer type does not correspond with the described 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.

	Kazakhstan	*China*
Border length (km)	70	
Area (km^2):	1 876	
Renewable groundwater resource (m^3/d)		
Thickness in m (mean, max)	25, 50	
Number of inhabitants		
Population density		
Groundwater uses and functions		
Pressure factors	Abstraction is substantially less than exploitable groundwater resources	
Problems	None	
Groundwater management measures	Early warning and (regular) surveillance monitoring	
Other information	Stratigraphic horizon apQ_{II}	

Figure 6. **A conceptual sketch showing a part of the Tekes aquifer at Naryngolsky groundwater abstraction site where only aquifer horizon apQ_{II} occurs at the surface (as unconfined) (provided by Kazakhstan).**



Pressures and transboundary impact

Table 39
Land cover/use in the area of the Ili Basin (% of the part of the basin extending in each country).

Country	*Water bodies (%)*	*Forest (%)*	*Cropland (%)*	*Grassland (%)*	*Urban/ industrial areas (%)*	*Surfaces with little or no vegetation (%)*	*Wetlands/ Peatlands (%)*	*Other forms of land use (%)*
Kazakhstan	77 400 km^2	11.3[a]	5.0[b]	61.2				
China								

Note: Protected areas make up some 15 per cent of Kazakhstan's surface area within the basin.

[a] This is the actual forest covered area, but forest soil (?) extends over a larger area, 23.2 per cent of Kazakhstan's area share.

[b] Of the cropland area, some 64 per cent was irrigated in 2006 according to the report of land resources.

Table 40
Total withdrawal and withdrawals by sectors.

Country	*Year*	*Total withdrawal ×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							

[a] The figures of Kazakhstan for 2010 are a forecast.

123. The main pressure factors include irrigated agriculture (low water use efficiency), animal husbandry, industry (mining, manufacturing and refining) and urbanization. The flow regulation affects adversely vegetation and the riverine ecosystem in general (see the Ramsar site assessment for more details).

Status

124. Looking at the water pollution index, after a clearly high value in 2001 (4.01, water quality class 4, "polluted") it decreased, indicating some improvement of the quality, and the index value has since varied between 2.14 and 2.70. In 2009, the oxygen content met the requirements, ranging from 9.26 to 10.2 mg O_2/l. The total concentration of dissolved solids (TDS) varied depending on the station from 2.97 to 3.95 mg/l and pH from 7.66 to 7.99 in 2009.

Table 41
Water quality classification in the Ili Basin.

Location of observation in the Tobol Basin	*Water pollution index[a] – water quality classification*		*Parameters exceeding MAC*	*Multiplier of MAC exceedence*
	2008	2009		

Ili, Dobunj station (downstream from the border with China)	2.70; "moderately polluted" (class 3)	2.14; "moderately polluted" (class 3)	copper (2+) total iron	7.13 3.12
Tekes, Tekes station	1.89, "moderately polluted" (class 3)	1.73, "moderately polluted" (class 3)	copper (2+) total iron	5.28 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

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

Response

125. A Kazakhstan-China joint commission operates to address issues concerning cooperation in use and protection of transboundary waters on the basis of the 2001 bilateral agreement. Earlier there was cooperation on hydrological data between the countries but not in the recent years.

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

Trends

127. Further increase of withdrawals planned by China will exert higher pressure on the vulnerable ecosystem of the Ili delta Lake Balkhash. During the hydrological observation history, natural fluctuation has also resulted in water scarce periods (like the 1990s). Nevertheless, the withdrawals importantly affect the level of Lake Balkhash.

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

XVIII. Ili Delta – Balkhash Lake (Kazakhstan, China)[43]

General description of the wetland

129. Where the Ili discharges into the Lake Balkhash, it forms a vast and species rich delta. Lake Balkhash belongs to the largest lakes in Asia covering 16 400 square kilometres with Ili river being its major freshwater source. Most of the sedimentation of suspended particles happens in the Kapchagai reservoir, resulting in enhanced water quality and clarity downstream. Balkhash lake itself is divided into two distinct parts forming a western part which contains freshwater and an eastern part containing saline water. There are 43 islands within the lake, while the decrease in water inflow will result in the increase of the number of islands. The lake shares its name with the major city in the area, Balkhash, with 66 000 inhabitants. The evaporation rate within the delta is quite high.

Main wetland ecosystem services

130. Different species of fish and invertebrates have been introduced into the lake for the purpose of fishing and aquaculture which mainly constitutes the economic importance of the lake. 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 increases. 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

131. The Ili delta has archaeological significance as it is a find spot of 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 which date back to the 8th to the 12th century.

Biodiversity values of the wetland area

132. Since the 1970s the rich biodiversity of the delta has 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 riparian forest left is composed of poplar species (*Populus spec.*). Other plants surrounding the lake include common reed *Phragmites australis*, elephant grass *Typha angustata*, tule species (*Schoenoplectus)* and the endemic species of bulrush (*Scirpus kasachstanicus)*. Moreover, several species of pondweed *Potamogeton* occur. The delta still supports major populations

[43] *Sources of information:*
Marine, Freshwater, and Wetlands Biodiversity. Topics in Biodiversity and Conservation. 2006. D.L. Hawksworth, A.T. Bull (Ed.). Springer. Dordrecht
Habitat Analysis of Pelicans as an Indicator of Integrity of the Arid Ecosystems of Central Asia. Y. Morimoto, M. Horikawa,Y. Natuhara (http://src-h.slav.hokudai.ac.jp/coe21/publish/no19_ses/7_morimoto.pdf)
Lake Balkhash, Kazakhstan. T. Petr. International Journal Salt Lake Res. 1. 1992. 21-46 (http://www.springerlink.com/content/j541uqh5k4972x63/)
Integratives und nachhaltigkeitsorientiertes Wassermanagement: Kooperationspotenziale zwischen Deutschland und Zentralasien. 2009. M. Kramer (publ.) Gabler. Wiesbaden
Decrease of river runoff in the Lake Balkhash basin in Central Asia. 2006. Hydrological Processes.K. Kezer, H. Matsuyama. (http://onlinelibrary.wiley.com/doi/10.1002/hyp.6097/abstract)

of Pelican species such as the Dalmatian Pelican (*Pelecanus crispus)* and Great White Pelican (*P. onocrotalus)* as well as approximately 120 additional types of birds, also including spoonbills, whoopers and ernes.

Pressure factors and transboundary impacts

133. The ecosystem Ili Delta is extremely variable as small changes within the river system directly affect the conditions of the river delta. Consequently, the delta is 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 and the continuous increase of water demand as well as the accompanying diversion of water in Kazakhstan and China (resulting in a decrease of flow). This has contributed to a process of desiccation and 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. While human interference is one of the main reasons for the decrease in water inflow, the climate change may further contribute to a changing hydrology[44]. 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 e.g. by an inappropriate choice of agricultural crops as well as 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, hunters, etc. Additionally, the water quality is affected by wastewater 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

134. Although a resolution containing suggestions of how to improve the management of the Balkhash lake basin with the aim of avoiding the replication of the Aral Sea crisis has been adopted at the international conference “Balkhash 2000”, 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, to reduce its emissions by 80-90 per cent. 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 Kazakhstan government, for instance, made a proposition to decrease the price of Kazakh products sold to China if China reduces its take of water from Ili River in return. However, China did not accept. A 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.

[44] According to the Intergovernmental Panel on Climate Change, the observed changes in climate over the 20th century show an increase in mean annual air temperature of 1-2°C while the changes in precipitation show no clear trends (Climate Change and Water, Technical Paper, IPCC, June 2008).

XIX. Murgab Basin[45]

135. 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 in 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.

Table 42
Area and population in the Murgab River Basin.

Country	*Area in the country (km^2)*	*Country's share %*	*Population*	*Population density (persons/km^2)*
Afghanistan				
Turkmenistan				
Total	**46 880**			

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

137. Agriculture is the predominant water user in the Murgab Basin, feeding many irrigation channels for example in Turkmenistan. Some 80 per cent of the population in the area in Afghanistan live from agriculture. Damage to irrigation and water supply infrastructure is a problem in Afghanistan. The efficiency of irrigation networks is estimated to be from 25 to 30 per cent.

138. Increase of organic pollution in the past few years has been observed.

139. Afghanistan has started rehabilitation of irrigation infrastructure.

XX. Tejen/Harirud Basin[46]

140. Afghanistan, the Islamic Republic of Iran and Turkmenistan share the basin of the 1,124-km long Tejen/ Harirud[47] River.The Harirud (Tejen). The character of the basin varies from upland to lowland, and it originates from high mountain terrain in Afghanistan. The Karukh is a major transboundary tributary.

Table 43
Area and population in the Harirud/Tejen Basin.

Country	*Area in the country (km^2)*	*Country's share %*	*Population*	*Population density (persons/km^2)*
Afghanistan	39,300	39.5	129 000	3
Iran	49 264	43.7	3 525 018	72
Turkmenistan	23 640	20.9	1 680 000	63
Total	**117 477**			

[45] Based on information provided by Afghanistan and on the first Assessment of Transboundary Rivers, Lakes and Groundwaters

[46] Based on information provided by the Islamic Republic of Iran and the first Assessment of Transboundary, Rivers, Lakes and Groundwaters

[47] The river is called Harirud in Iran and Tejen in Turkmenistan. It is also known as the Tedshen and Gerirud.

Source: Ministry of Nature Protection of Turkmenistan, Ministry of Energy and Water of Afghanistan, Ministry of Energy (Water & Electricity) of I.R.Iran, East West Institute (Making the most of Afghanistan's River Basins opportunities for more cooperation, 2010)
Note: There is substantial variation in the surface area of the basin depending on the source. The total surface area quoted in the first Assessment of Transboundary Rivers, Lakes and Groundwaters was 70,360 km^2.

Hydrology and hydrogeology

141. 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 add up to a total of 3,082 ×10^6 m^3/year which equals 874 m^3/year/capita. Iran and Turkmenistan have agreed on a 50-50 allocation of the river flow, with each country being entitled to 535× 10^6 m^3/year.)

142. Only the Sarakhs sub-basin of the sub-basins of the Qara-Qum basin in the border area has been studied; the other are considered to have low transboundary groundwater potential. (impermeable formations). Karstic aquifers may have some potential but would need to be studied. Aquifers in the basin include Karat, Taybad, Torbat-e-jam, Janatabad, Aghdarband and Sarakhas. The Sarakhs aquifer is estimated to recharge by about 110 × 10^6 m^3/year, mostly from the Tejen/Harirud River[48].

143. There is no permanent flow in the river, only seasonal.

Table 44
Aquifer Karat: Type 3, Alluvial, Quaternary, dominant groundwater flow in direction to Afghanistan, Medium links with surface water.

	Iran	*Afganistan*
Area (km^2)	350	
Renewable groundwater resource (m^3/d)		
Thickness in m (mean, max)	65	
Number of inhabitants		
Population density		
Groundwater uses and functions	Support of ecosystems Support of agriculture Preventing land subsidence Maintaining base flow and springs	
Pressure factors		
Problems		
Groundwater management measures		
Other information		

48 According to a water balance study in the Islamic Republic of Iran

Table 45
Aquifer Taybad: Type 3, Alluvial, Quaternary, dominant groundwater flow in direction to Afghanistan, Medium links with surface water.

	Iran	*Afganistan*
Area (km^2)	896	
Renewable groundwater resource (m^3/d)		
Thickness in m (mean, max)	60, 250	
Number of inhabitants		
Population density		
Groundwater uses and functions	Support of ecosystems Support of agriculture Preventing land subsidence Maintaining base flow and springs	
Pressure factors		
Problems		
Groundwater management measures		
Other information		

Table 46
Aquifer Torbat-e-jam: Type 3, Alluvial, Quaternary, dominant groundwater flow in direction to Afghanistan, Weak links with surface water.

	Iran	*Afganistan*
Area (km^2)	2 142	
Renewable groundwater resource (m^3/d)		
Thickness in m (mean, max)	65, 300	
Number of inhabitants		
Population density		
Groundwater uses and functions	Support of ecosystems Support of agriculture Preventing land subsidence Maintaining base flow and springs	
Pressure factors		
Problems		
Groundwater management measures		

Other information	

Table 47

Aquifer Janatabad: Type 3, Alluvial, Quaternary, dominant groundwater flow in direction to Afghanistan and Turkmenistan, Medium links with surface water.

	Iran	*Afganistan*	*Turkmenistan*
Area (km^2)	350		
Renewable groundwater resource (m^3/d)			
Thickness in m (mean, max)	35		
Number of inhabitants			
Population density			
Groundwater uses and functions	Support of ecosystems Support of agriculture Preventing land subsidence Maintaining base flow and springs		
Pressure factors			
Problems			
Groundwater management measures			
Other information			

Table 48

Aquifer Aghdarband: Type 3, Alluvial, Quaternary, dominant groundwater flow in direction to Turkmenistan, Weak links with surface water.

	Iran	*Turkmenistan*
Area (km^2)	100	
Renewable groundwater resource (m^3/d)		
Thickness in m (mean, max)	30 (mean)	
Number of inhabitants		
Population density		
Groundwater uses and functions	Support of ecosystems Support of agriculture Preventing land subsidence Maintaining base flow and springs	
Pressure factors		
Problems		

Groundwater management measures	
Other information	

Table 49
Aquifer Sarakhas: Type 3, Alluvial, Quaternary, dominant groundwater flow in direction to Turkmenistan, Strong links with surface water.

	Iran	*Turkmenistan*
Area (km^2)	710	
Renewable groundwater resource (m^3/d)		
Thickness in m (mean, max)	45, 130	
Number of inhabitants		
Population density		
Groundwater uses and functions	Support of ecosystems Support of agriculture Preventing land subsidence Maintaining base flow and springs	
Pressure factors		
Problems		
Groundwater management measures		
Other information		

Pressures

Table 50
Land use/land cover in the Harirud (Tejen) sub basin.

Country	*Water bodies (%)*	*Forest (%)*	*Cropland (%)*	*Grassland (%)*	*Urban/ industrial areas (%)*	*Surfaces with little or no vegetation (%)*	*Wetlands/ Peatlands (%)*	*Other forms of land use (%)*
Iran		3	20[c]	12.5		15		45[b]
Afghanistan			[a]					
Turkmenistan								

Note: Protected areas in the Iranian part of the basin include Bagh keshmir National Park, Bazangan lake-national monument,- Jangal Khajeh protected area.
[a] 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.

[b] Pasture, Rain feed and irrigated area

[c] Irrigated cropland (irrigated by both surface waters and groundwaters) makes up 292,920 ha in the Islamic Republic of Iran, which is 5.9 per cent of the country's share of the basin.

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

Table 51

Water use in different sectors (per cent).

Country	*Total withdrawal $\times 10^6$ m³/year*	*Agricultural %*	*Domestic %*	*Industry %*	*Energy %*	*Other %*
Iran	2 894	88	11	1	-	-
Afghanistan						
Turkmenistan						

Notes: In Iran, surface waters are mainly withdrawn for agriculture and for urban use.

145. Because of city development and increase of population together with water scarcity water will be polluted by heavy metals and other pollutions in the future. 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. Industry sector is expected to develop in the Iranian part with the general urbanization and modernization, exerting widespread and severe influence.

146. Flooding causes damage to houses and agricultural land, displacing people. At present 3000 m^3 water flow seasonally Change in seasonality of peak flow, more severe flood in future is predicted. Afghanistan lacks infrastructure for controlling the river flow. The Shirtappeh diversion dam between Iran and Turkmenistan is under construction for supplying water to agricultural areas of Sarakhs in both countries.

147. Insufficiency of water for irrigation is experienced both in Afghanistan and the Islamic Republic of Iran .Less water in region will effect on forestry. 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 Sarakhs aquifer. (about 500 wells) Salinity of groundwater has become a problem. Irrigation return waters affect water quality. In Afghanistan, about 90 per cent of the irrigation systems are traditional and irrigation network's efficiency is estimated at 25-30 per cent.

148. At present, wastewater is insufficiently treated and used (local an moderate impact) but Iran foresees provision of fully treated and purified wastewater to farmers in future.

149. An important holy place in Mashhad is visited by more than 20 million people each year from Iran and other countries, which also puts pressure on water resources.

Status and transboundary impacts

150. To better satisfy agricultural water demand, the I.R. Iran and Turkmenistan completed in 2005 the construction of the Dosti (Frienship) Dam and reservoir on the

Harirud (Tejen) (volume 1,250 million m^3). Following a bilateral agreement between the two countries, the reservoir's water resources are equally shared.

151. The most serious water-quality problems are, organic pollution, bacterial pollution, eutrophication, and pollution by hazardous substances. In this region are inappropriate wastewater treatment and agricultural practices. Main problem is with insufficient water for irrigation, which also will effect on forestry.

Response measures

152. Turkmenistan has continued implementing the agreements on the Tejen/Harirud signed by the Soviet Union with Iran (1921, 1926 and 1989; see the list of agreements in annex II of document ECE/MP.WAT/WG.1/2011/4 - ECE/MP.WAT/WG.2/2011/4). On the basis of a new signed agreement, the Dosti [49](Friendship) Dam was constructed on Harirud (Tejen) River in 2004, mainly to better satisfy agricultural water demand.

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

154. The Islamic Republic of Iran reports that in line with the Long-Term Development Strategies for Iran's Water Resources[50], which refers to the necessity of coordination between different sectors, application of the principles of integrated water resources management is strived at also in the Harirud River Basin. Eight water user cooperatives with 3,256 water right holders in total have been established in Iran.

155. 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.

Future trends

156. An increase of 1.8 to 2.35 ºC in the mean temperature is predicted the Islamic Republic of Iran for Mashhad plain by 2050[51], and 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 to 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.

157. Strategies of Iran to adapt to the climate change include the following[52]:

• Development of agriculture and aquaculture activities based on brackish water use and increasing water use efficiency,

• Development and implementation of national response strategies utilizing innovative technology and engineering solutions for installation of flood and drought warning systems,

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[49] The dam/reservoir is known as Dostluk in Turkmenistan.

[50] Deputy Minister for Water Affairs, Ministry of Energy. Iran Water resources Management Company, Tehran. 2003

[51] *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

[52] The National Communication of the Islamic Republic of Iran to UNFCCC (2003).

• Construction of water resources facilities such as dams, aqueducts, well fields, levees, banks and drainage channels,

• Non-structural measures including water conservation, integrated ground and surface water management and improved water supply, and

• Drought control, improved operation of reservoirs, water saving policy, and water recycling and reuse.