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Working Group on Integrated Water Resources Management

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Thematic assessment of the water-food-energy-ecosystems nexus

Draft assessment of the water-food-energy-ecosystems nexus in the Syr Darya

Prepared by the secretariat with the support of the Royal Institute of Technology, Stockholm

Summary

This document was prepared pursuant to a decision taken by the Meeting of the Parties to the United Nations Economic Commission for Europe Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) at its sixth session (Rome, 28–30 November 2012) (ECE/MP.WAT/37, para. 38 (i)), requesting the Task Force on the Water-Food-Energy-Ecosystems Nexus, in cooperation with the Working Group on Integrated Water Resources Management, to prepare a thematic assessment focusing on the water-food-energy-ecosystems nexus with a view to its publication prior to the seventh session of the Meeting of the Parties (Budapest, 17–19 November 2015).

The present document contains the draft nexus assessment of the Syr Darya River Basin. The draft assessment is the result of an assessment process carried out according to the methodology described in document ECE/MP.WAT/WG.1/2015/8 developed on the basis of a desk study of relevant documentation, an assessment workshop (Almaty, Kazakhstan; 2-4 December 2015), as well as inputs from local experts and officials of the Syr Darya countries.

The draft assessment of the Syr Darya was circulated for review and comments to the authorities of the riparian countries in May 2015.

For background information on the methodology and for the decisions that the Working Group on Integrated Water Resources Management may wish to take, please refer to document ECE/MP.WAT/WG.1/2015/8.

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I. Introduction

Tensions between sectoral objectives, unintended consequences of resource management and trade-offs between sectors may result in friction and possibly conflict. By assessing the situation in transboundary basins jointly by the co-riparians with the involvement of important sectors, and by improving the knowledge base, synergies can be identified and potential solutions implemented.

Recognizing this challenge and opportunity, the Parties to the Water Convention at the sixth session of the Meeting of the Parties (Rome, 28–30 November 2013) included an assessment of the water-food-energy-ecosystems nexus[1] in the programme of work for 2013–2015 under the Water Convention (ECE/MP.WAT/37/Add.1).

The Meeting of the Parties also established a Task Force on the Water-Food-Energy-Ecosystem Nexus, chaired by Finland, to oversee and guide the preparation of the nexus assessment. The Parties invited countries and joint bodies sharing transboundary basins to indicate their interest in participating in the assessment by the end of January 2013.

The set of basins to be assessed has gradually been confirmed within a series of meetings of the Water Convention's bodies, notably the Task Force on the Water-Food-Energy-Ecosystems Nexus and the Working Group on Integrated Water Resources Management.

The Syr Darya was one of the basins identified for the assessment, as a down-scaled variant of the Aral Sea Basin initially proposed by two regional organizations, the Scientific-Information Centre (SIC) of the Interstate Coordination Water Commission (ICWC) of the Central Asia and the Global Water Partnership (GWP) Caucasus and Central Asia.[2]

The present document contains the draft nexus assessment of the Syr Darya River Basin, as an edited version of the document sent for comments to the Syr Darya riparian countries in May 2015. The document has been prepared by the secretariat in cooperation with the Royal Institute of Technology, Stockholm. The draft assessment is the result of an assessment process carried out according to the methodology described in document, developed on the basis of an assessment workshop (Almaty, Kazakhstan; 2-4 December 2015),[3] a desk study of relevant documentation as well as inputs from local experts and officials of the Syr Darya countries, provided in the framework of the Task Force.

The preliminary findings presented in this report were discussed at the third meeting of the Task Force on the Water-Food-Energy-Ecosystems Nexus (Geneva, 28-29 April 2015), to which representatives from all the Syr Darya countries were invited. Complementary consultations were held in the first half of 2015 in Kazakhstan, Kyrgyzstan and Tajikistan, linked to the European Union Water Initiative's National Policy Dialogues on Integrated Water Resources Management.

The draft assessment of the Syr Darya was circulated for review and comments to the authorities of the riparian countries in May 2015. [A final summary assessment of the Syr

[1] The nexus term in the context of water, food (agriculture) and energy refers to these sectors being inextricably linked so that actions in one area commonly have impacts on the others, as well as on the ecosystems which also provide services to these sectors

[2] GWP CACENA, Presentation at the 2nd Nexus TF Meeting in Geneva, (ICWC, September 2014a) Available from http://www.unece.org/fileadmin/DAM/env/documents/2014/WAT/09Sept_8-9_Geneva/presentations/9_Nexus_issues_in_the_Syr_Darya_Basin_Mr._Vadim_Sokolov_.pdf.

[3] The presentations and documents of the Workshop on Water-Food-Energy-Ecosystems Nexus Assessment in the Syr Darya River Basin, 2 - 4 December 2014. (Almaty, Kazakhstan, 2014) are available from http://www.unece.org/index.php?id=37579#/.

Darya, shortened and revised as necessary taking into account any comments from the riparian countries and the , is foreseen to be presented as part of the stock-taking report to the seventh session of the Meeting of the Parties to the Water Convention (Budapest, 17–19 November 2015).]

For background information on the methodology, process and for the decisions that the Working Group on Integrated Water Resources Management may wish to take, please refer to document ECE/MP.WAT/WG.1/2015/8.

A. Objectives of the nexus assessment

The work of the United Nations Economic Commission for Europe (ECE) on nexus assessments of transboundary river basins in the pan-European area aims to:

- Support transboundary cooperation by identifying intersectoral synergies that could be further explored and utilized in the different basins
- Determine policy measures and actions that could alleviate negative consequences of conflicting interests of countries and sectors and help to optimize the use of available resources
- Help to move towards increased efficiency in resource use, greater policy coherence and co-management
- Build capacity in assessing and addressing intersectoral impacts.

B. Process of the Syr Darya assessment

1. Desk study

Following the nexus methodology (ECE/MP.WAT/WG.1/2015/8), the desk study included the analysis of relevant documentation on the basin in terms of resource base, socio-economy, governance and policy directions.

2. Participatory workshop

A participatory workshop on “Water-Food-Energy-Ecosystems Nexus Assessment in the Syr Darya River Basin” (Almaty, Kazakhstan, 2–4 December 2014) was organized by ECE in collaboration with Global Water Partnership (GWP) and the Food and Agriculture Organisation of the United Nations (FAO). The workshop was a key step in the assessment of the Syr Darya River Basin. Representatives of various ministries (e.g., natural resources, agriculture, energy and environment) from Kazakhstan, Kyrgyzstan and Tajikistan nominated by the respective countries, regional organisations based in Uzbekistan as well as NGOs and academia, participated in the workshop.[4]

The objectives of the workshop, which complemented the earlier desk study, were:

- To provide a clear picture of the status and trends of resource needs and the environmental impact of the main economic activities in the basin
- To identify the main intersectoral challenges that call for integrated or at least coordinated planning and management involving different sectors, as well as transboundary cooperation

[4] Documentation related to the workshop can be found at www.unece.org/index.php?id=37579#/.

- To identify current opportunities to improve resource efficiency, reduce negative impact across sectors and/or countries and increase sustainability with an emphasis on practical, mutually-beneficial opportunities.

3. First draft report

This draft nexus assessment of the Syr Darya River Basin has been prepared on the basis of the desk study and the intersectoral challenges and opportunities identified during the workshop. It will serve as a basis for discussion and for provision of further comments by the Syr Darya riparian countries.

II. Introduction

The Syr Darya basin is an example of river basin where there are evident trade-offs across sectors, resulting in environmental degradation and tension between riparian countries. Transboundary cooperation would benefit from an improved understanding of the different sectoral needs and how these needs can be reconciled. For this reason, previous initiatives aimed at improving the basin's environmental situation and livelihoods have been based on integrated approaches. See, for example, the Special Programme for the Economies of Central Asia (SPECA) on strengthening cooperation for rational and efficient use of water and energy resources in Central Asia,[5] the efforts of World Bank and the United States Agency for International Development (USAID) to study the Energy-Water Nexus in Central Asia,[6,7] as well as the work of the Asian Development Bank (ADB),[8] FAO and the United Nations Development Programme (UNDP) on food and energy security in the region[9] (UNDP, 2011). Previous cooperative solutions among riparian countries have also involved multi-sectoral cooperation (for example, the Framework Agreement of 1998 focused on energy exchanges and regulation of water discharges).

The aim of the nexus assessment of the Syr Darya is to identify available opportunities to reduce the negative transboundary impacts while at the same time making it possible to progress towards national development targets and improved efficiency in the use of resources. Through a participatory process of consultations and joint discussion, opportunities have been identified in the different sectors and their applicability is explored within the governance setting, including institutional and legislative frameworks. The

[5] UNECE and UNESCAP, Strengthening cooperation for rational and efficient use of water and energy resources in Central Asia. Special Programme for the Economies of Central Asia (SPECA). (New York, 2004) Available from http://www.unece.org/fileadmin/DAM/env/water/damsafety/effuse_en.pdf.

[6] World Bank, Water and Energy Nexus in Central Asia, Improving Regional Cooperation in the Syr Darya Basin. (Washington D.C., 2004) Available from http://siteresources.worldbank.org/INTUZBEKISTAN/Resources/Water_Energy_Nexus_final.pdf.

[7] USAID, "Central Asia Natural Resources Management Program", in *Transboundary Water and Energy Project. Final Report*. (Kazakhstan and Washington D.C., USAID, 2005) Available from http://pdf.usaid.gov/pdf_docs/PDACF627.pdf.

[8] ADB project "Improvement of Shared Water Resources Management in Central Asia " (project RETA 6163), 2006

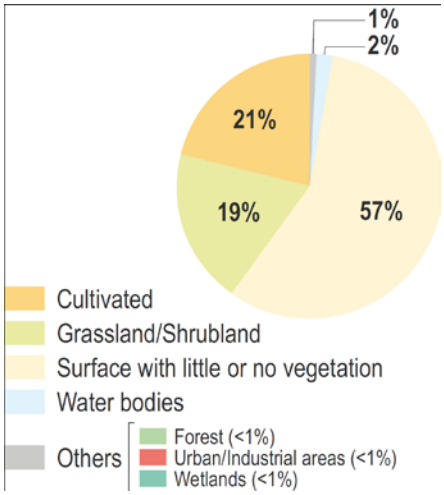
[9] David Sedik, Guljahan Kurbanova and Gabor Szentpali "The Status and Challenges of Food Security in Central Asia". Background material for the third Central Asia Regional Risk Assessment (CARRA) Meeting in Astana, Kazakhstan, 14-15 April 2011 (Budapest, FAO Regional Office for Europe and Central Asia, April 2011). Available from http://europeandcis.undp.org/uploads/public1/files/vulnerability/Senior%20Economist%20Web%20site/FoodSec_Central_Asia_April_5_2011_15h_final.pdf.

opportunities identified and selected for further analysis benefit more than one sector and country and can therefore contribute to increased cooperation and coordination.

III. Basin description and resource base

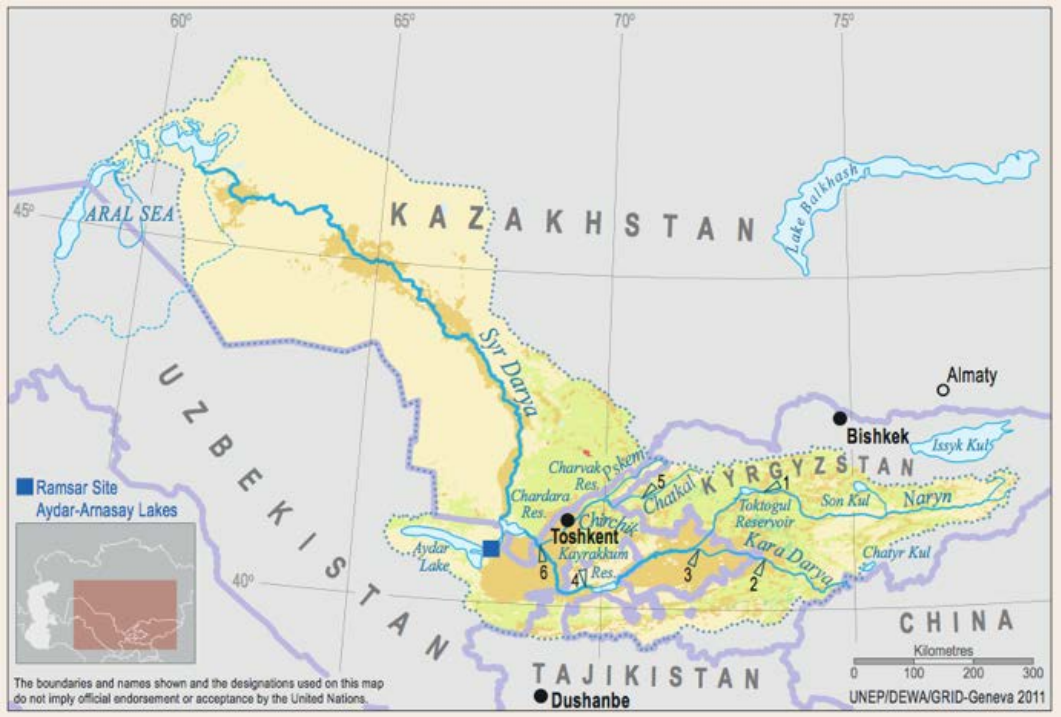
The Syr Darya is the longest river in Central Asia (3,019 kilometres from the headwaters of the Naryn) and the second largest (after the Amu Darya) in terms of water quantity (annual average runoff of 36.57 cubic kilometres).[10] It is shared by Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan. Its hydrological basin forms, together with the Amu Darya, the main water resource system of Central Asia: the Aral Sea basin.

The basin area is characterized by mountains in the east and flat areas, with decreasing altitudes going towards north-west. Its main geomorphologic features are the Alpine ranges of Tien Shan (over 5,000 metres of altitude, located in Kyrgyzstan), the Ferghana Valley (an alpine depression at 250–500 metres of altitude, shared by Kyrgyzstan, Tajikistan and Uzbekistan), the lowlands of Golodnaya Steppe (shared by Uzbekistan and Kazakhstan, and some territories of North Tajikistan) and the Kysyl-Kum desert downstream, in Kazakhstan.[11] An overview of the land use and land cover is presented in the pie chart below.



[10] FAO, "Aral Sea Basin", AQUASTAT database (2012) Available from http://www.fao.org/nr/water/aquastat/basins/aral-sea/index.stm.

[11] Savoskul and others, "Water, Climate, Food, and Environment in the Syr Darya Basin, Contribution to the project *ADAPT: Adaptation strategies to changing environments. An adaptation framework for river basins*." (Institute of Environmental Studies of Amsterdam, 2003) Available from http://www.weap21.org/downloads/adaptsyrdarya.pdf



Major tributaries in the upper part of the river are the Naryn (Kyrgyzstan and Uzbekistan), Kara Darya (Kyrgyzstan) and the Chirchik (Kazakhstan, Kyrgyzstan and Uzbekistan). The Chu and the Talas Rivers are a transboundary sub-basin (Kazakhstan and Kyrgyzstan) of the Syr Darya, but these rivers have lost connection to the main stream of Syr Darya.[12] For this reason, the Chu-Talas basins are not taken into account in this assessment.

The main catchment area of the Syr Darya basin is located in Kyrgyzstan where the Naryn, Kara Darya and other tributaries are generated. The flow of the river is generated by glacier melt and is therefore highly variable both seasonally and inter-annually. The extremes include dry years—characterized by droughts,—and high-flow years—characterized by floods[13]—, both potentially damaging for the economy in the basin.[14]

A series of reservoirs on the Naryn—the most important of which is the Toktogul—regulate its flow. Their operation schedule is critical for the provision of water to the large irrigation schemes downstream (to the Ferghana Valley and further downstream in Uzbekistan and Kazakhstan) and for electricity production upstream. Due to the high capacity of Toktogul (19 cubic kilometres) its release regime heavily affects the flow of the Syr Darya downstream. None of the other existing and planned reservoirs have a comparable capacity.

[12] UNECE, “Second Assessment of Transboundary Rivers, Lakes and Groundwaters”. (New York and Geneva, 2011) Available from http://www.unece.org/fileadmin/DAM/env/water/publications/assessment/English/ECE_Second_Assessment_En.pdf.

[13] Note that flow of the Syr Darya is highly regulated and many reservoirs are used for flood protection. The most flood-prone area of the basin, in Kazakhstan, is now further protected by the recently built Koksarai dam, which acts as a counter-regulator.

[14] UNECE,”Strengthening Water Management and Transboundary Water Cooperation in Central Asia: the role of UNECE Environmental conventions”. (UNECE, 2011) Available from http://www.unece.org/fileadmin/DAM/env/water/publications/documents/Water_Management_En.pdf.

Other important large reservoirs in the basin are the Andijan on the Kara Darya (Uzbekistan), Kayrakkum on the Syr Darya (Tajikistan), the Charvak on the Chirchik (Uzbekistan) and Chardara and Koksarai on the Syr Darya (Kazakhstan). They are used mainly for irrigation and flood control with the exception of Andijan and Koksarai, which also produce electricity. The Kairakkum reservoir, in turn, is a seasonal storage reservoir (not long-term) and serves mainly the irrigation of agriculture.

The population of the basin exceeds 24 million people, as can be seen table 1 (CAWATER 2015).

Table 1. Population in the Syr Darya River Basin by country and by administrative unit.

Country	Administrative unit	Population (in thousands)
Kazakhstan	South-Kazakhstan Oblast	2,678.9
	Kzyl-Orda Oblast	726.7
	Total	**3,405.6**
Kyrgyz Republic	Batkentskaya Oblast	458.9
	Jalal-Abadskaya Oblast	1,076.7
	Narynskaya Oblast	268.0
	Oshskaya Oblast	1,433.6
	Total	**3,237.2**
Tajikistan	Sogdiskaya (total)	2,349.0
	Sogdiiskaya (excluding Zeravsjan)	**1,739.1**
Uzbekistan	Andizhanskaya	2,756.4
	Dzizakskaya	1,205.0
	Namanganskaya	2,458.7
	Syrdaryinskaya	750.6
	Tashkentskaya	5,036.6
	Ferganskaya	3,329.7
	Total	**15,537.0**
Total Syr-Darya basin (including/excluding Zeravsjan)		**24,528.8 / 23,918.9**

More than half of the population is concentrated in the Ferghana Valley, the most important agricultural area in the basin.[15] Large parts of population are either employed in the agricultural sector or are dependent on subsistence agriculture. According to the World Bank, the highest share employed in agriculture (by country) is 52.9 per cent in Tajikistan and the lowest is 25.5 per cent in Kazakhstan.

Half of the agricultural land is found in naturally-drained oases while the other half is the result of reclamation projects (i.e., drainage, land levelling and improvements of the soil structure), which can be expensive in terms of construction and maintenance. Kazakhstan has good agricultural land availability, while Kyrgyzstan and Tajikistan together with some

[15] Karen Franken, ed. “Irrigation in Central Asia in Figures. AQUASTAT Survey 2012”, in *FAO Water Reports 39*. (Rome, FAO, 2012b) Available from http://www.fao.org/docrep/018/i3289e/i3289e.pdf.

parts of Uzbekistan, have less ample land resources.[16] Land is not only used for crop production, but also largely for pasture. Land degradation (i.e., loss of humus or soil quality degradation for example as the result of salinization) is severe in the basin, undermining the sustainability of agricultural activities.

Some of the world's largest oil, coal and natural gas reserves are found in Kazakhstan and Uzbekistan. Although these are mainly concentrated in the west, close to the Caspian Sea and in the south towards Turkmenistan, existing and planned pipelines cross the basin. This network delivers fossil fuels from Turkmenistan, Uzbekistan and Kazakhstan to the Russia Federation and China. However, for example, gas from Karacheganak field (Kazakhstan) is sent to the Orenburg (Russian Federation) for processing and then partially returned to Kazakhstan. These pass through Tajikistan and Kyrgyzstan, making these two countries important energy corridors.[17]

Hydropower contributes to the energy mix in all basin countries but it is particularly important for the economies of Kyrgyzstan and Tajikistan. The latter have only marginal exploitable fossil fuel reserves. Thermal power plants are mainly fuelled with coal and natural gas and constitute the main electricity production for Uzbekistan and Kazakhstan. The Central Asian Power System (CAPS), the regional electricity grid, connects all the countries in the basin but it is presently not fully functional. High-voltage transmission lines are being planned or developed to export electricity produced in Central Asia to China[18] and South Asia (CASA 1000 Project).

In Kyrgyzstan and Tajikistan, as well as in some areas of Uzbekistan, poverty levels are high, while they are relatively low in Kazakhstan.[19] The poorest tend to live in rural areas and may have limited access to safe water resources, sanitation facilities, clean and constant energy supplies and food. Severe power cuts and unaffordable food prices in the period 2007–2010 brought entire communities to a state of emergency. This was especially pronounced in Kyrgyzstan and Tajikistan as a result of independent events that amplified each other. These events included: low water levels in the reservoirs, volatile food prices and the global economic crisis. The outcome of the combination of these conditions illustrated the low resilience of the economies to natural and external shocks.[20,21]

[16] FAO, "The Status and Challenges of Food Security in Central Asia" (Budapest, April 2011) Available from http://europeandcis.undp.org/uploads/public1/files/vulnerability/Senior%20Economist%20Web%20site/FoodSec_Central_Asia_April_5_2011_15h_final.pdf.

[17] Petroleum Economist, "Pipeline puts Tajikistan on energy map", in *Petroleum Economist*. (December 2014) Available from http://www.petroleum-economist.com/Article/3409502/Pipeline-puts-Tajikistan-on-energy-map.html

[18] Chen Yang and Liang Fei, "Regional grid connection planned", in *Global Times* (2014) Available from http://www.globaltimes.cn/content/891105.shtml.

[19] Reference. The index of the depth of poverty, for example, in Kyzylorda region (Syr Darya basin) decreased from 6.8% in 2001 to 0.1% in 2012, and in the South - Kazakhstan region (Syr Darya basin) from 19.9% in 2001 to 1.0% in 2012

[20] FAO, National Aquaculture Sector Overview. Uzbekistan. National Aquaculture Sector Overview Fact Sheets. Text by Karimov, B.K. In: *FAO Fisheries and Aquaculture Department* [online]. (Rome, 11 October 2011) Cited 25 March 2015. Available from http://www.fao.org/fishery/countrysector/naso_uzbekistan/en.

[21] UNDP, "Central Asia Regional Risk Assessment: Responding to Water, Energy, and Food Insecurity".(UNDP Regional Bureau for Europe and CIS NY, January 2009) Available from http://amudaryabasin.net/sites/amudaryabasin.net/files/resources/0D4D43F5273097AC49257583000EC1F4-Full_Report.pdf.

IV. Governance aspects

Transboundary water governance in the Syr Darya basin requires clear and comprehensive governance frameworks, which are flexible enough to accommodate current and future challenges for the water resource as well as the sectors and users that depend on it, such as agriculture, energy and ecosystems. The existing intersectoral dependence requires the strengthening of resource management on the following levels of institutional cooperation:

(a) Firstly, at the level of interstate institutions including: (i) the regional level of the Aral Sea basin, of which Syr Darya is a part, (ii) the basin level and(iii) the bilateral and international level;

(b) Secondly, at the national level including basin-specific organizations developing and implementing national policies

(c) Finally, at the local level.

A. The institutional set-up during the period of Soviet Union

During the last ten years of the Soviet Union, the principal water economy organizations were the republican ministries of water resources, which were responsible for the allocation of water and infrastructure development. Today they remain the basis for transboundary water resources management, with a certain change in status and mandate. For quick and efficient management of water resources of the two main rivers in 1986–87, two basin water organizations (BWO "Amudarya" and "Syr-Darya") were established. These organizations are, in principle, responsible for all water facilities on main canals on the stem stream and for the development, together with riparian republics, of annual (seasonal) plans of flow regulation by the reservoirs and water intake within the basin. These plans were approved by the Union of Soviet Socialist Republics (USSR) Ministry of Land Reclamation and Water Management. Depending on the hydrological forecasts, the BWOs could reduce or increase national quotas by 10 per cent. The BWOs were not responsible for monitoring water quality.[22]

The Soviet Federal Government introduced compensation schemes for ensuring compromise between the republics in the development of agriculture, energy and other sectors. Because of this, there was no serious competition for water resources among the republics (EU, 2007).

In the Soviet period, the Syr Darya River Basin was managed as an integrated economic unit. Economic priorities identified by the State Planning Committee dictated a distribution of water resources that optimized agricultural production, while hydropower generation was of lower priority. Following independence of the former republics, the integrated economic system was no longer upheld. Each country began to review and revise its own economic priorities. The countries have become acutely aware of the importance of their resources and the products they provide. It became clear that the existing system of water use (in terms of volumes and mode of the water use) was suboptimal in relation to the priorities within the individual countries.

[22] Strengthening cooperation for rational and efficient use of water and energy resources in central Asia, the United Nations Special Programme for the Economies of Central Asia (SPECA), Report of 2004, p. 48.

In the field of energy, CAPS was established in 1970 as a common power grid linking the Soviet republics—Uzbekistan, southern Kazakhstan, Kyrgyzstan, Turkmenistan and Tajikistan—with the aim of optimizing the production and use of energy. [23]

B. Current interstate institutional set up

After the collapse of the Soviet Union, the Central Asian republics have continued to use the Soviet water legislation. However, their legal obligations could no longer be carried out under that framework, because the management of water resources has become an issue of international rather than federal relations. With the establishment of five independent States, most of the former internal cross-border river basins became transboundary and the water has become a source of potential inter-State disputes, which have environmental, economic and political consequences.

In order to avoid the collapse of the agricultural sector, the countries decided to continue the use of water management principles and the quota (limits) system, inherited from the Soviet era. In February 1992, the five countries of the region signed an agreement on cooperation in the joint management of use and protection of transboundary water resources, confirming the existing structure and principles of the distribution of transboundary waters. By signing this agreement, the Central Asian States have pledged to comply strictly with the agreed procedures and rules for the use and protection of the water resources, recognizing the Aral Sea as the subject of a common interest for these five countries. According to the agreement, ICWC was established, which was established above the two existing basin water organizations and was given the authority to determine the annual limits on water use in accordance with the actual water availability during the year.

In 1993, the Interstate Council for the Aral Sea (ICAS) and the International Fund for Saving the Aral Sea (IFAS) were established. Soon thereafter the international donor community, by providing its support, confirmed the legitimacy of the new institutional structure, which included ICAS, IFAS, ICWC, the Interstate Commission for Sustainable Development (ICSD) and their subsidiary organizations.

Table 2. Overview of institutions relevant to managing the resources in the Syr Darya Basin discussed in this report at the various levels.

Regional level	Commonwealth of Independent States
	Eurasian Economic Community (Kazakhstan, in 2015 Kyrgyzstan is expected to join)
Subregional level	International Fund for Saving the Aral Sea
	Interstate Coordination Water Commission (incl. Basin Water Organization “ Syrdarya”)
	Interstate Commission for Sustainable Development
	Central Asian Power Council
	Central Asian Power System, Coordination dispatching Centre “Energy”

[23] Load Dispatch and System Operation Study for Central Asian Power System, World Bank, 2010

	Kazakhstan	Kyrgyzstan	Tajikistan	Uzbekistan
	Presidents and Cabinets of Ministers			
Central Government	Ministry of Foreign Affairs	Ministry of Foreign Affairs	Ministry of Foreign Affairs	Ministry of Foreign Affairs
	Ministry of Agriculture	Ministry of Energy and Industry	Ministry of Energy and Water Resources	Ministry of Agriculture and Water Resources
	Ministry of Energy	Ministry of Agriculture and Melioration	Ministry of Agriculture	Ministry of Emergency Measures
	Ministry of National Economy	Ministry of Emergency Situations	Ministry of economy and trade	Ministry of Healthcare
	Ministry of Healthcare and Social Development	Ministry of Healthcare	Ministry of Healthcare and Social Protection	Ministry of Economy (responsible for fuels and hydropower)
	Ministry of Investment and Development	Ministry of Education and Science	Ministry of Industry and New Technologies	
	Ministry of Education and Science		Ministry of Education and Science	
	Ministry of Internal Affairs			
Committees and agencies	Water Comittee of the Ministry of Agriculture	State Agency of the Environmental Protection and Forestry at	Committee on Emergency Measures and Civil Defence	State Committee of Geology and Mineral Resources
	Committee of Geology and Subsoil of Ministry of Investment and Development	State Agency of Geology and Mineral Resources	Committee of Environmental Protection	State Committee of Nature Protection
	Committee on Protection of Consumers' Rights of the Ministry of National Economy	State Agency for Construction and Communal Utilities Development	State committee on investments and State Property management	Centre of Hydrometeorology
	Committee of Forestry and Hunting Ministry of Agriculture	Department of Water Economy and Melioration Ministry of Agriculture and Melioration	Agency for Land Reclamation and Irrigation	State Inspectorate for Supervision of the Energy Sector
	Committee for Construction, Housing and Communal Services and Land Resource Management of the Ministry of National Economy	Department of Sanitary and Epidemiological Surveillance at Ministry of Healthcare	Water and Energy Coordination Council under the Government of the Republic of Tajikistan	Agency for Communal and Utility Service

	Committee of environmental regulation, control and state inspection in oil and gas sector of the Ministry of Energy		General Directorate of Geology	State Inspection on Supervision of Geological Examination of Subsoil, Safety Works in Industry, Mining and Communal Sector
	Committee for Industrial Development and Industrial Safety of the Ministry for Investments and Development		State Committee of Land Planning and Geodesy	State Inspection on control and supervision of the technical condition and safety operation of large and particularly important water facilities under the Cabinet of Ministers
	Committee for Emergency Measures Ministry of Internal Affairs		State Committee on Land Management and Geodesy	
			Agency for Forestry	
		State Agency on Hydrometeorology at Ministry of Emergency Situations	State Authority on Hydrometeorology	Centre of Hydrometeorological Service at Cabinet of Ministers
Intersectoral state bodies		National Water Council		
State enterprises	Kazakh Water Industry		State Unitary Enterprise Khojagii Manziliu Kommunali (KMK)	
	“Kazhydromet” State National Enterprise under the Ministry of Energy			
Energy producers	Samruk-Energy Joint Stock Company	“Electropower Stations” Joint Stock Company	“Barki Tojik”	State Joint Stock Company Uzbekenergo
	Local branches		“Pamir Energy”	
Energy transmission	“Kazakhstan Company for Management of the Electricity Grids” “KEGOC” Joint Stock Company	National energy grid of Kyrgyzstan “NESK” Joint Stock Company	Hukumati Viloyati (Oblast Administrations)	*Local branches*
Energy distribution	*Local branches*	Joint Stock Company “Severelectro”, Vostokelectro Oshelectro and Jalalabadelectro	*Local branches*	
Energy tariffs	Ministry of National Economy	State agency for energy and fuel complex regulation		Uzbekenergo
	Parliament			

Basin level	Water Basin Inspections	Basin Water Economy Administrations	Water Basin Counci (the reform is not finished yet, the councils are not created yet)l	Basin Irrigation System Authorities
	Basin Councils		River Basin Organisation	
Local administration	Maslikhat and Akimat	Kenesh and Mayor	Madjlis and Head of local Hukumats (City, region and district Administrations)	Kengash and Hokimiat
Local level	Water user associations (WUAs)	WUAs	WUAs	WUAs

C. Regional institutions for interstate cooperation of the Syr Darya riparian States

The existing hierarchy of the principal organizations managing water resources (including in the Syr-Darya River Basin) was agreed by the Heads of States on 9 April 1999 in Ashgabat (so-called Ashgabat Declaration).[24] The agreement provides for the following distribution of responsibilities among the regional organizations:

(a) The IFAS Board, in which the five States are represented by their deputy prime ministers, is the highest political-level body for decision-making and for final approval of actions prior to approval (if necessary) by the Heads of State;

(b) The Executive Committee of IFAS (EC-IFAS) is a permanent body, which employs two representatives from each country, and which carries out all the necessary actions to implement the decisions taken by the IFAS Board through the national branches of IFAS. Also, EC-IFAS, on behalf of the Board, can organize the agencies or GUKP for various projects (of the international financial institutions and individual donors);

(c) ICWC is responsible for the management of transboundary water resources, the distribution of water resources and the monitoring of water sources and water use, as well as a preliminary evaluation of proposals for improvement or change in the organizational, technical, financial and environmental approaches and solutions related to water resources at the State level;

(d) The BWOs, SIC and the ICWC Secretariat are the executive bodies of ICWC.

Regional cooperation is provided by the institutional framework for water resources management. However, while this institutional structure allocates water annually, regional water resources are not managed effectively.

The existing relationship between the key organizations in the field of water and energy resources, their mandates, functions, obligations and responsibilities do not quite correspond to the actual requirements of the situation. This system has been criticized for its lack of clarity regarding the functions of the various organs of the same organization, with the unclear division of responsibilities between the decision-making and executive

[24] The Agreement about the status of IFAS and its organizations, Ashgabat, 9 April 1999. Available at www.icwc-aral.uz/statute3.htm

bodies and duplication of functions by various organizations (Vinogradov, 2002).[25] Improving the efficiency of the responsible institutions operating in the area of water and related resources in Central Asia (ICSD, ICWC and IFAS) still requires harmonization, better coordination and the improvement of their relations.

The Central Asian States cooperate on energy within two frameworks: the Commonwealth of Independent States (CIS) and CAPS. The CIS Electric Power Council was established according to the Agreement on coordination of intergovernmental relations in the CIS power sector of 1992. The Coordinating Council of the Central Asia United Power System (CCCA UPS) acts within CAPS and consists of national transmission system operators (KEGOC from Kazakhstan, NESK from Kyrgyzstan, Barki Tojik from Tajikistan, Kuvvat from Turkmenistan and Uzenergo from Uzbekistan). The Regional Dispatch Centre of Central Asia was established in 1960 by the Ministry of Energy and Electrification of the Soviet Union. The existing Regional Dispatch Centre (RDC) for Central Asia is situated in Tashkent, in the building of the Ministry of Energy and Electrification of Uzbekistan. Today, RDC has a direct connection and operational communication through national control centres with all national energy agencies and companies carrying out their activities. RDC is not engaged in the planning of production and consumption of electric power, but controls the planned production and performs the redistribution of the electrical load in the system during excessive loads or faults in the network. Currently, RDC does not have a sufficient flexibility as every decision requires coordination with the national energy authorities and RDC lacks direct access to the Governments. For the same reason, it is not used as a platform for intersectoral coordination. Additionally, RDC lacks authority for strategic policy decisions, providing only recommendations to governments.

D. Basin level of the institutional set-up in Syr Darya

BWO “Amu Darya” has an office in Urgench and BWO “Syr Darya” in Tashkent. In accordance with the 1992 Agreement, both BWOs were transferred under the jurisdiction of ICWC.

The actual mandate of BWO “Syrdarya” includes:

(a) Provide timely and guaranteed water supply to water users in compliance with the limits established by ICWC for water withdrawals from the main stem of the Syr Darya;

(b) Develop plans for the main water intake structures and modes of operation of cascades of reservoirs and prepare and coordinate with ICWC the water use limits for all users in the Syr Darya River Basin;

(c) Organize joint work with hydrometeorological centres for measurement of the water flow at the border measuring stations, providing an accurate accounting of the flow of the Syr Darya for the organization of water distribution.

The BWO is not flexible enough, since every decision must be approved by the ICWC (and national ministries of water resources) without direct access to governments. For the same reason, BWOs cannot serve as a platform for cross-sectoral coordination, except in cases when it is necessary to solve operational problems with the Regional Dispatch Centre (RDC) "Energy". The BWOs do not cover the entire territory of the basin: in the Syr Darya

[25] S. Vinogradov, Managing Transboundary Water Resources in the Aral Sea Basin: In Search of a Solution, *International Journal for Global Environmental Issues*, Vol. 1, Nos. 3/4, 345-361.

basin about 1,000 kilometres of the lower reaches in Kazakhstan is not under the jurisdiction of BWOs. Additionally, BWOs do not monitor the quality of water in the basin.

E. Bilateral cooperation between neighbouring States within the Syr Darya basin

At present there is no formal bilateral cooperation between basin States specifically on the management of the Syr Darya.[26] However, in the Ferghana Valley, there is a problem with the settlement of cross-border relations for small rivers. Water of the small rivers is used mainly for local irrigation, or as an additional source of water for major inter-State or inter-regional stem irrigation systems, such as the Big Fergana, South Fergana, Big Andijan and Big Namangan channels. Only some of the water reaches the large rivers (the Naryn, Syr Darya and Kara Darya). In Soviet times, the management and distribution of the water resources along the small river was governed by Moscow (USSR Ministry of Water Resources) in coordination with the Ministries of Water Resources of the neighbouring republics (now independent states), and the immediate implementation of the local administrations of the regional level (Regional Executive Committee of the Communist Party of the republics). One example of such regulation is the Protocol on inter-republican decadal percentage (proportional) distribution of water flow in the Ferghana Valley. This Protocol was signed by the ministries of the two republics, Kyrgyzstan and Uzbekistan, and approved by the Ministry of Water Resources of the USSR on 10 April 1980 for the rivers Isfairam, Shahimardan and Sokh. The Protocol was signed in the city of Osh with the agreement of the Executive Committee of the Communist Party of Fergana and Osh regions on 14 June 1981.

Currently, with the support of individual donors (the German Federal Enterprise for International Cooperation (GIZ), the Swiss Agency for Development and Cooperation and UNDP), projects for the regulation of bilateral relations on small rivers in the Syr Darya River Basin (e.g., Isfara and Khodjabakirgan) are being investigated.

F. Water management on the national level

At the national level, the management of natural resources in Syr Darya riparian States and the regulatory and operational functions within the relevant institutions are frequently not clearly separated This may be a feature remaining from the Soviet time where governing bodies were assigned also with operational functions. With the exception of Uzbekistan, recent reorganisations of State institutions make the situation difficult to assess.

An effective implementation of the national policy on water resources, agriculture, energy and environmental resources in the Syr Darya basin States requires a large degree of coordination between the relevant national authorities. Currently, the agricultural and energy agencies dominate the field of water management, with issues such as the protection of ecosystems and water quality management attracting a limited interest from the authorities.

[26] The Commission of the Republic of Kazakhstan and the Kyrgyz Republic on the Use of Water Management Facilities of Intergovernmental Status on the rivers Chu and Talas was established in 2006 for the implementation of the Agreement of 2000 on the Use of Water Management Facilities of Intergovernmental Status on the Rivers Chu and Talas. However, the Chu and Talas Basins are not a part of the Syr Darya Basin.

1. Kazakhstan

In Kazakhstan, the Ministry of Agriculture is responsible for the development and implementation of agricultural and regional policy, among others in the field of water management. Its Committee on Water Resources is an agency with competency to conduct and control the use and protection of water resources via its subdivisions as River Basin Organizations and Republican State Enterprises. With exception of issuing relatively small abstraction licences, groundwater remains in the competence of the Ministry for Investment and Development and Committee of Geology and Subsoil Use.

Environmental aspects of water resource management were assigned to the Ministry of Energy according to the reform of late 2014. The Ministry of Energy is in charge of the policy related to environmental protection and management, the protection, control and supervision of natural resources and energy (including hydropower). The Ministry of National Economy is responsible for water supply and sewerage, for which its Committee on Consumer Protection is responsible for sanitary, epidemiological control. Emergency situations, including water-related ones (floods and droughts in particular), are under the competence of the Ministry of Investment and Development.

2. Kyrgyzstan

In Kyrgyzstan, an institutional reform (2005) in the water sector and related areas assigned to bodies the relevant functions, which have yet to be assumed. The National Water Council received competences as an oversight and coordination body between all agencies involved in water resources management, but it was convened only in 2013. A new body, the State Water Administration, has not yet been established as an independent administration so, since 2012, its responsibilities have been carried out by the Department of Water Economy and Melioration of the Ministry of Agriculture and Melioration. The Department fulfils both regulatory and operational functions. Competence regarding environmental quality and water sanitary standards was assigned to the State Agency on Environment Protection and Forestry and to Department of Sanitary and Epidemiological Surveillance of Health Ministry, respectively.

The prevention of water pollution as a whole rests with the State Agency for Geology and Mineral Resources and with local state administration bodies. Land management in Kyrgyzstan is currently divided between several departments: the Department of cadastre and registration of real estate rights are located at the State Registration Service, State Design Institute of Land Management "Kyrgyzgiprozem", and the State cartographic and geodetic service.[27]

3. Tajikistan

In Tajikistan**,** policy and regulatory functions are carried out by two bodies: the National Water and Energy Council (NWEC), which consists of heads and experts of various ministries and State agencies and can invite external experts; and the Ministry of Energy and Water Resources (MEWR). The water sector reform of November 2013 separated the policymaking and operational functions. The water resources management role of the Ministry of Land Reclamation and Water Resources (MRWR) was been merged with the

[27] A debate is ongoing about establishment a single body in the form of the State Committee for Land Management, which would be established through the merger of the Department of cadastre and registration of real estate rights at GDSthe State Registration Service, State Design Institute of Land Management “Kyrgyzgiprozem”, and the State cartographic and geodetic service. Currently development of the State’s strategy on land management is not a part of the functions of any of these institutions.

Ministry of Energy and Industry and formed MEWR. NWEC remains the principal body responsible for policy development in the water sector, including land reclamation and irrigation. Power generation, as one of the most important water uses, together with its transmission, distribution and supply remains under the management of the State-owned company “Barki Tojik”.

The operation and maintenance of irrigation and drainage systems were transferred from the former MRWR to a newly established institution, the Agency for Land Reclamation and Irrigation (ALRI). ALRI is also responsible for development of a state policy and regulations for land reclamation and irrigation, use and preservation of water bodies, water supply and water conservation. The Ministry of Agriculture remained the central executive authority for development and implementation of the integrated State policy in agriculture.

Urban and rural water supply and sanitation services are provided for public utilities by newly established State Unitary Enterprise KMK and its subsidiary companies at city and town levels.

The Committee for Environmental Protection (CEP) under the Government of the Republic of Tajikistan is the central executive authority on environmental protection. Annually, CEP sets the limits for total water diversion from natural water sources for MEWR. CEP is also in charge of monitoring water resources, discharges and pollution and has functions in licensing water withdrawals and effluent discharges.

4. Uzbekistan

In Uzbekistan, public administration and control over water management and use is implemented by the Cabinet of Ministers and local public authorities, as well as specifically authorized governmental administrative authorities, to regulate water management and use either directly or through basin (territorial) administrations and other relevant authorities. The Ministry of Agriculture and Water Resources is responsible for surface water resources, operation and maintenance of the primary irrigation and drainage infrastructure network. The State Committee on Geology and Mineral Resources is responsible for ground waters and the State Inspection on Supervision of Geological Examination of Subsoil, Safety Works in Industry, Mining and Communal Sector is responsible for thermal and mineral waters.

The State Committee on Nature Protection is responsible for environmental protection and monitoring water quality including pollution, together with the Centre of Hydrometeorological Service. The Agency for Communal and Utility Service is a government body responsible for interregional water pipes and overall policy regarding delivery of drinking water and wastewater services. The Council for the Rational Use of Land and Water Resources, Irrigation Development and Improvement of Soil Fertility offers support of the relevant public administration. A State control in the electricity sector is ensured by the State Energy Inspectorate ion for Supervision of the Energy Sector (subordinate to the Government). State electricity generation, transmission and distribution assets are managed by the State Joint Stock Company “Uzbekenergo”.

G. Institutional set-up on the basin level within the states’ boundaries

The introduction of basin management in the Syr Darya riparian States by legislative reforms requires creation of basin-based organizations[28] that will be able to develop the

[28] The introduction of governing institutions at the basin level was initiated in Kazakhstan from 2005 to 2008 (River Basin Councils), in Uzbekistan from 2003 (Basin Irrigation System Authorities), in

river basin plans. At present, basin inspections exist in Kazakhstan, where the river basin councils have an advisory role. In Kyrgyzstan, the first basin councils have also been created. Despite of the legal recognition of the need for creation of basin councils (with the exception of Uzbekistan), their practical work is far from satisfactory. Also, there is a lack of financial mechanisms for public participation in water governance and management. Only in Kazakhstan are the meetings of the basin councils financed, though insufficiently, from the state budget. A number of relevant competences still remain with state administration bodies established mainly according to administrative territorial units.

1. Kazakhstan

In Kazakhstan, to strengthen the implementation of basin management principle, two main organizations were created: River Basin Organizations and Republican State Enterprises (RSE). RBOs serve as local branches of the Water Committee, receiving annual quotas for their basins from the Water Committee. Additionally, they work to monitor the use, protection and control of reservoirs. The River Basin Councils were established at each RBO starting from 2005 until 2008. Despite rather low institutional capacities, they have been successful in increasing participation by water users from all levels of management in the decision-making process. RSEs work according to administrative territorial units (provinces), operating and maintaining water infrastructure (canals, reservoirs, etc.), as well as allocating water to users on the local level. An integrated water resources management (IWRM) plan prepared under the UNDP project was not authorized at the level of the Government. In recent years, with the support of GIZ, a basin plan for the Kazakh part of the Syr Darya has been developed.

2. Kyrgyzstan

The main public authority in the organization of basin planning in Kyrgyzstan is the Department of Water Economy and Melioration. Within its structure, only basin water management units are to be created. The first basin-based organization was the Talas Basin Council created in 2008 with only an advisory function. Later on, a number of councils in other basins were created, but their practical work has so far remained limited. The river basin plans were developed first for two pilot river basins, Talas and Kugart, and then for Isfara (2013) and Aspara (2014). The Basin Plan for the Chu Basin is under development.

3. Tajikistan

In Tajikistan**,** the use and protection of water resources was based on the combination of the reservoir and administrative-territorial division principles and implemented by the national government (NWEC), MEWR, specialised state agencies (ALRI and CEP) and local executive authorities. According to the ongoing sector reform, River Basin Organizations will be formed under MEWR and will be responsible for the planning and monitoring of water resources management. The River Basin Councils are to be established in all basins and provide a multi-stakeholder approach, including involvement of WUAs.

4. Uzbekistan

In Uzbekistan, 10 Basin Irrigation System Authorities (BISAs) were established in 2003, subordinated directly to the Ministry of Agriculture and Water Resources. This reform abolished provincial and district water departments as an important step towards the application of the basin principle. However, a number of these BISAs were created within

Kyrgyzstan in 2008 (Talas Basin Council), and in Tajikistan the establishment of such structures is in process

the former administrative borders of provincial water departments. Most of the subordinated Irrigation System Authorities (ISAs), which were created along main irrigation systems, were mainly designed according to the hydrographical boundaries.

H. Institutional set-up at the local level in Syr Darya riparian states

The potential for conflicts at the local level of management in Syr Darya Basin could be lowered by strengthening local institutions. The process of dismantling collective farms gave rise to peasant farms and finally to the reform of management of water and relevant management structures (decentralization and privatization), including the establishment of WUAs in the States of the Syr Darya Basin. WUAs, which assumed control over irrigation networks, need strengthening to make them less legally dependent on state water management structures. The additional challenges that WUAs face include financial difficulties due to reliance on irrigation service fees that are difficult to implement effectively , as well as their territorial competence responding to administrative boundaries of former collective farms.

In Kazakhstan, the management of water resources is carried out by the Water Basin Inspections and distribution of water resources within the approved limits is carried out by the local authorities and WUAs.

In Kyrgyzstan, the executive power structure below the national level of decision making includes regional, district and local (municipal) levels of management. Since 2000, operation of secondary canals has been moved from District Water Departments to WUAs. Also, a Federation of WUAs was established. WUAs in Kyrgyzstan have been created to assume control of irrigation networks. However, they are still under development, challenged by numerous financial, legal and organizational problems that hinder regular operation and development of the networks.

In Tajikistan**,** at provincial (viloyati) and district (nohiya) levels, local executive state bodies representing the central government carry out water management functions. WUAs are generally underrepresented and only the village administrations (Jamoat) have the right to manage water resources and maintain and operate irrigation and other water systems. The State Unitary Enterprise KMK is responsible in the field of water supply and sewerage in the towns and districts, except some major cities including Dushanbe and Khujand.

In Uzbekistan, the Ministry of Agriculture and Water Resources draws up water distribution plans for the BISAs, which then create water distribution plans for their Irrigation System Authorities (ISA). The obligation of BISAs is to control and maintain canals and reservoirs through the Main Canal System Authority and only tertiary canals are under the administration of water consumer associations. WUAs emerged in Uzbekistan between 2003 and 2007. Since water brings significant inputs into the cotton-wheat production, quotas also to WUAs are defined by the administration, according to the quota system that Uzbekistan has preserved. In the regions, responsibility for drinking water and sanitation stays with the local administration, as does land management.

V. Sectors and resources

Water and other natural resources in the basin are vital for the economies of all the riparian countries, for their economic development and to sustain the livelihoods of large parts of their populations.

The table below illustrates, with a few selected indicators, the dependence of each riparian country on the natural resources of the basin. For example, it can be seen that both

Kyrgyzstan and Uzbekistan are highly dependent on the basin water for energy production. This is the case for hydropower, on which Kyrgyzstan is heavily reliant, but thermoelectric power plants also require water for cooling. By far the majority of Uzbekistan's thermal power plants require Syr Darya basin water for that cooling. Evident also is that the share of agricultural land and population living in the basin is significant for all countries. This is true even for Tajikistan, with the lowest share.

Table 3: Dependency of riparian countries on resources from the Syr Darya Basin (all data are in % of country data)

	Казахстан	**Кыргызстан**	**Таджикистан**	**Узбекистан**
Share of area in the basin	12.7	55.3	11.0	13.5
Share of population living in the basin	20.0	56.6	28.6	51.4
Share of surface water resources in the basin*	13.3	24.1	6.7	36.5
Share of agricultural land in the basin	61.66	44.64	38.85	51.14
Share of hydropower produced in the basin area	3.34	98.56	3.09	87.62
Share of thermal power produced in the basin area	9.03	0.00	0.00	87.14

*Data derived from FAO, 2012;[29] World Bank,2013;[30] ICWC, 2014a;[31] ADB, 2012.[32] * an assessment of groundwater would require more data*

Every sector uses resources.[33] The demands for, pressures on and availability of resources may differ yearly, seasonally, even daily. In the case of the Syr Darya, important inter-annual variations in the demand-supply balance have been observed as resulting from changing climatic conditions or external factors such as market shocks. Different sectors have different seasonal demands with regard to water releases: irrigated agriculture needs water released in spring-summer while the demand of hydropower and thus water releases peaks in winter. Water ecosystems are adapted to the natural water flow with highest water flow in spring-summer, but it is also important that water reaches the delta of the river as well as the Northern Aral Sea. Further, daily variations are important and evident in households using energy. Household demand normally peaks in the afternoon-evening. Table 4 gives an overview of the respective sector and its relationship (either directly or indirectly) with water as a resource.

[29] Karen Franken, ed. "Irrigation in Central Asia in Figures. AQUASTAT Survey 2012", in *FAO Water Reports 39*. (Rome, FAO, 2012b) Available from http://www.fao.org/docrep/018/i3289e/i3289e.pdf.

[30] World Bank, World Development Indicators (2013) Available from http://wdi.worldbank.org/tables

[31] GWP CACENA, Presentation at the 2nd Nexus TF Meeting in Geneva, (ICWC, September 2014a) Available from http://www.unece.org/fileadmin/DAM/env/documents/2014/WAT/09Sept_8-9_Geneva/presentations/9_Nexus_issues_in_the_Syr_Darya_Basin_Mr._Vadim_Sokolov_.pdf.

[32] ADB, Master Plan for Central Asia (2012) Available from http://www.adb.org/sites/default/files/project-document/74195/43549-012-reg-annexes1-3.3.2.pdf.

[33] In this work we consider all users of resources as sectors, including the consumptive sectors of households and commercial buildings and, by extension, the demands coming from the environment (e.g., environmental flows or clean water and soil).

Table 4. Overview of economic sectors and ecosystems, and their relationship (either directly or indirectly) with water.

Sector	Use of resources (demand and impact)
Agriculture	Arable land (often irrigated, equipped with complex drainage infrastructure) is the most economically valuable land resource for all countries. Agriculture is the largest water consumptive user in the basin in all countries, constituting the 77% of withdrawals from the basin in Kyrgyzstan, 88.62% in Kazakhstan and 93.8% in Uzbekistan.[34] Groundwater is not widely used for irrigated agriculture but traditionally used for livestock and its importance for crop production is growing with water scarcity and droughts.[35] **Crop production, irrigation and drainage:** Peak demand for irrigation is in the growing season (spring-summer). Infrastructure is degraded and inefficient. Losses in the irrigation systems (conveyance and distribution) result in an overall efficiency of 55% in Kyrgyzstan, 27-46% in Tajikistan, on average 63% (and in the newly built networks 75-78%) in Uzbekistan.[36] Surface irrigation dominates. More water efficient technologies for irrigation are very weakly developed: Uzbekistan has only 0.11% of localised irrigation, Kyrgyzstan 0.04% of sprinkler irrigation and Kazakhstan 2.5% of sprinkler and 0.9% of localised irrigation.[37] Soil salinization is aggravated by poor irrigation and drainage practices and poorly functioning infrastructure. Salinization of soils is a serious problem across the basin, together with waterlogging, contamination and mineralization of groundwater, and downstream water quality degradation[38,39] Soil erosion is a frequent problem and is aggravated by poor management; irrigation network degradation, and also by the cutting of wood and biomass by households for energy purposes.[40,41] High demand of power is experienced in irrigated areas during the growing season (mainly concentrated in Uzbekistan and Tajikistan). In Kyrgyzstan, the underground water for irrigation is used only insufficiently. In Tajikistan, for example, electric pumping in July and August 2009 was the second highest sectoral demand in the country[42] one has to

[34] UNECE, "Second Assessment of Transboundary Rivers, Lakes and Groundwaters". (New York and Geneva, 2011a) Available from http://www.unece.org/fileadmin/DAM/env/water/publications/assessment/English/ECE_Second_Assessment_En.pdf.

[35] Karen Franken, ed. "Irrigation in Central Asia in Figures. AQUASTAT Survey 2012", in *FAO Water Reports 39*. (Rome, FAO, 2012b) Available from http://www.fao.org/docrep/018/i3289e/i3289e.pdf.

[36] Ibid.

[37] Ibid.

[38] UNESCO, Groundwater Cooperation in Central Asia. National presentations from Kazakhstan, Kyrgyzstan and Tajikistan (UNESCO, 2014) Available from http://groundwatercop.iwlearn.net/gefgwportfolio/syrdarya

[39] Karen Franken, ed. "Irrigation in Central Asia in Figures. AQUASTAT Survey 2012", in *FAO Water Reports 39*. (Rome, FAO, 2012b) Available from http://www.fao.org/docrep/018/i3289e/i3289e.pdf.

[40] Ibid.

[41] ECE, "Second Environmental Performance Review of Uzbekistan", in *Environmental Report Series No.29* (New York and Geneva, ECE, 2010) Available from http://www.unece.org/fileadmin/DAM/env/epr/epr_studies/uzbekistan%20II%20e.pdf

[42] Daryl Fields and others, "Tajikistan's Winter Energy Crisis: Electricity Supply and Demand Alternatives", (World Bank, 2012) Available from

	note that the winter generation from hydro-power, reduces water availability in summer, which results in high irrigation and pumping demands for electricity to overcome summer water shortages. **Livestock production:** The main livestocks are cows, horses, sheep and goats. Production in all countries include intensive farming for meat and milk production and require pasture.[43] There are negative effects on soil and water quality. These include over-grazing and over-stocking. This aggravates erosion, soil degradation and contributing to diffuse pollution of nutrients and microrganisms. For example, in Kyrgyzstan, 50% heavily used pastures are degraded (UNECE, 2009. Second Environmental Performance Review of Kyrgyzstan). **Fisheries:** This sector is of secondary priority in all countries. The fisheries sector in all countries of Central Asia declined heavily in output over the period 1989–2006.[44] It is likely to have been partly influenced by water management (including flow regulation) as well as by institutional changes. However, fish production is currently developing in the Northern Aral Sea, as well as in Aydar-Arnasay lakes system.
Electricity production	Electricity produced in the basin is not only valuable for domestic use, but also for export. For example, the Toktogul Dam can produce in summer more electricity than is used in Kyrgyzstan. If there are no opportunities for export during summer, to other countries in Central Asia for example, the water may need to be released along spillways without generating electricity.[45] Export of electricity produced in Central Asia to the south is being discussed. There are plans to connect China and South Asia (i.e. Afghanistan, Pakistan and India) to the region with high voltage transmission lines. The production and transmission of electricity and heat is also inefficient. Heat production accounts for 40-50% of all primary energy consumption in Kazakhstan. Of the transmission facilities: in Kazakhstan some 60% require a complete overhaul or replacement; in Kyrgyzstan a large portion of them is unsuitable for further use; and in 2011 losses in the grid amounted to more than 20%.[46] **Hydropower:** Hydropower is an important non-consumptive water use in the basin, with production in all countries.[47] The highest potential and dependency on hydropower in the Syr Darya is

http://documents.worldbank.org/curated/en/2013/01/18042383/tajikistans-winter-energy-crisis-electricity-supply-demand-alternatives.

43 Karen Franken, ed. "Irrigation in Central Asia in Figures. AQUASTAT Survey 2012", in *FAO Water Reports 39*. (Rome, FAO, 2012b) Available from http://www.fao.org/docrep/018/i3289e/i3289e.pdf.

44 Andy Thorpe and Raymon van Anrooy, Inland fisheries livelihoods in Central Asia, policy interventions and opportunities. (Rome, FAO, 2009) Available from ftp://ftp.fao.org/docrep/fao/011/i0870e/i0870e02.pdf.

45 USAID, "Central Asia Natural Resources Management Program", in *Transboundary Water and Energy Project. Final Report*. (Kazakhstan and Washington D.C., USAID, 2005) Available from http://pdf.usaid.gov/pdf_docs/PDACF627.pdf.

46 TECHECONOMMODEL, "Study on the application of energy efficiency and renewable energy advanced technologies in Central Asian Countries". A report for the United Nations Office at Geneva. (Kraainem, Belgium, 2013).

47 ECE, "Second Assessment of Transboundary Rivers, Lakes and Groundwaters". (New York and

	in Kyrgyzstan. (Tajikistan is also dependent on hydropower, but its main hydropower installations and potential are found in another basin, the Amu Darya.) Peak electricity demand of Kyrgyzstan is in winter. To meet this demand, upstream hydropower facilities have shifted to winter production. As irrigation water is needed downstream in summer, the shift has resulted in upstream dams such as Toktogul affecting water availability in the growing season for agriculture downstream. In addition, it should be noted the sharp fluctuations of the water level in the head main irrigation channels in the Fergana Valley created by the regime in the last hydroelectric Naryn cascade - Uchkurgan HPP, caused by the daily schedule of frequency stabilization of electrical systems. These fluctuations lead to a deterioration of the technical condition of infrastructure, the collapse of river banks, and the acceleration of wear to metal and concrete parts of hydraulic structures. This further increases the challenges in the management of water supply channels. **Fossil fuel plants:** Fossil fuel plants in the region are mainly located in Uzbekistan and Kazakhstan, while in Kazakhstan only water recycling is applied. (ADB, 2012) Water is required for cooling in thermal energy production. As standard water intensive (as opposed to 'dry') cooling technology is used, the production of electricity is put at risk by water shortages. Further, in thermal power plants with open-loop technology, thermal pollution from discharges of high temperature water can negatively affect riverine ecosystems.[48] **Others:** Apart from hydropower, renewables are in early stages of development in the basin and are currently not of importance. There are existing and planned small hydropower installations in Kyrgyzstan (ADB, 2012) as well as in Tajikistan.
Municipal use	**Drinking water:** Groundwater used for drinking purposes in all countries. Its importance varies according to its availability. In Kyrgyzstan for example, 90% of all centrally distributed drinking water comes from groundwater reserves.[49] In many settlements downstream of polluting discharges (i.e. in South Kazakhstan), groundwater is the only safe water source for drinking.[50] **Wastewater:** Untreated wastewater negatively affects surface water quality, and all the riparian

Geneva, 2011a) Available from http://www.unece.org/fileadmin/DAM/env/water/publications/assessment/English/ECE_Second_Assessment_En.pdf.

[48] UN, "World Water Assessment Program (WWAP) of the United Nations", in *World Water Development Report*, (UN, 2014) Available from http://www.unesco.org/new/en/natural-sciences/environment/water/wwap/wwdr/.

[49] Karen Franken, ed. "Irrigation in Central Asia in Figures. AQUASTAT Survey 2012", in *FAO Water Reports 39*. (Rome, FAO, 2012b) Available from http://www.fao.org/docrep/018/i3289e/i3289e.pdf.

[50] UNESCO, Groundwater Cooperation in Central Asia. National presentations from Kazakhstan, Kyrgyzstan and Tajikistan (UNESCO, 2014) Available from http://groundwatercop.iwlearn.net/gefgwportfolio/syrdarya

	countries face challenges with shortcomings in wastewater collection and treatment, degraded infrastructure and gaps of financing construction, renovation, operation and maintenance. Information available about the national level situation suggests that In **Tajikistan** more than 80% of wastewater treatment facilities are worn out and need renovation; some 40% of treatment plants not functioning properly, and flow in many locations exceeding design capacity leads to under-treatment. Illegal wastewater discharges, sometimes misusing communal irrigation systems, are also problematic. Industrial wastewater is largely discharged into public sewage treatment plants. It is estimated that in 2006 that in **Kyrgyzstan** only 20% of the total wastewater received some kind of treatment before discharging into water bodies, and in most cases was only mechanically treated. In **Kazakhstan**, although notable efforts are made through state water and water supply programmes as well as with international funding, urban water supply and wastewater infrastructure is in a poor state in a number of oblast main cities. Developing wastewater infrastructure has been secondary to improving water supply. Regarding the Syr Darya, the water quality is strongly influenced primarily by return waters from drainage collector systems; pressure is still exerted by wastewaters of the cities Shymkent and Kyzyl-Orda. This, despite an upgrade of treatment facilities and putting into operation a biological treatment plant, respectively. According to the Kazakh side, wastewater is not discharged into Syr Darya at the KZ part at all In **Uzbekistan**, wastewater treatment is generally available in cities but commonly does not extend to village settlements. In-stream disposal of public utility wastewater has been decreasing, but the low operating efficiency of wastewater treatment plants (50-70% against rated capacity) leads into concentration of pollutants in water bodies. The share of industrial water recycling has been increasing. The main source of deterioration of water quality in the Syr Darya river is water runoff from agricultural use, namely irrigation. Most of the runoff flows into the river, part of this is re-used, the other part is discharged into the peripheral slide. Depending on the water availability of the year, only a small portion (between 1.1 and 2.5 km3) is used for irrigation within the system without proper justification suitability of their quality. Currently, in the Republic of Uzbekistan over 10 km3 of drainage waters is formed, of the water used for irrigation only 7.4% of the total runoff is used, discharge into the river is 45.4%, and 47.2% is allocated to the limits of irrigated land. **Energy demand:** In Kyrgyzstan and Tajikistan high levels of electricity use, notably for heating, are prevalent in urban areas. The share of urban houses using electricity for heating is around 35% in Kyrgyzstan[51] and 85% in Tajikistan.[52] Rural settlements, on the other hand, have intermittent access to electricity. Frequent power cuts limit households' access to water (restricting pumping and supplies), and expose water supply systems to inflow of polluted groundwater or wastewater. Peak demand in winter heightens the energy focused operation regime of the river to that time.

[51] World Bank, Keeping Warm: Urban Heating Options for the Kyrgyz Republic. (2015) Available from http://www.worldbank.org/en/news/feature/2015/02/25/urban-heating-options-for-the-kyrgyz-republic

[52] Daryl Fields and others, "Tajikistan's Winter Energy Crisis: Electricity Supply and Demand Alternatives", (World Bank, 2012) Available from http://documents.worldbank.org/curated/en/2013/01/18042383/tajikistans-winter-energy-crisis-electricity-supply-demand-alternatives.

	Use of wood and biomass because of unavailable or unaffordable alternative fuels in rural settlements is causing localized deforestation, loss of forest-related ecosystems, and increased erosion.[53]
Industry	Industry is a minor water user in the basin in terms of consumption.[54] **Industrial sites:** Industrial areas affecting the water quality of the river and its tributaries include: • Kazakhstan. Uranium extraction in Shiely; oil extraction in Doshansk mining field, near Zhusaly – both on the right bank of Syr Darya.[55] • Kyrgyzstan. Tailing ponds of Maylu-Say, Kara Darya;[56] (Questionnaire, 2014 • Tajikistan. Various types of industry, manufacturing in particular: industrial centers of Hijand, B. Gafurov, Isfara, Istarashvan, Penjikent, Kanibadam and Kayrakkum; (Workshop, 2014) • Uzbekistan. Chirchik and Akhangatan rivers heavily affected by various types of industrial discharges. Types of industry located in this area: iron, non-ferrous metallurgy, chemical and petrochemical, microbiological, mechanical engineering, woodworking and construction. There is also a cotton-cleaning plant, mill, printing industry. Gas industry is also present; it is the only place in Uzbekistan where the gas is extracted using underground pyrolysis methods.[57] Two of the three oil refineries in the country are located in the Ferghana Valley (Ferghana and Altyaryk).[58] The importance of the energy industry cannot be overstated. The basin area is strategic for the development of oil and gas pipeline networks as well as power transmission lines. Especially smaller industries' wastewater gets commonly mixed with urban wastewater, and these systems may not be well set-up to treat. **Impact:** Untreated wastewater negatively affects water quality. Solid discharges and leakages negatively affect soil quality. Pollution comes from both industry and mining sectors (Workshop, 2014).
Ecosystems	**Needs:** Good soil and water quality are essential to support the functioning of ecosystems. Not only animal and plant species depend on it, but also human health and economic activities (e.g. a good soil and water are necessary to support agricultural activities). Degradation of the quantitative and qualitative status of water also undermines its usability downstream

[53] ECE, "Second Environmental Performance Review of Uzbekistan", in *Environmental Report Series No.29* (New York and Geneva, ECE, 2010) Available from http://www.unece.org/fileadmin/DAM/env/epr/epr_studies/uzbekistan%20II%20e.pdf

[54] ECE, "Second Assessment of Transboundary Rivers, Lakes and Groundwaters". (New York and Geneva, 2011a) Available from http://www.unece.org/fileadmin/DAM/env/water/publications/assessment/English/ECE_Second_Assessment_En.pdf.

[55] Questionnarie, 2014. Factual questionnaire prepared for the Nexus Assessment.

[56] Second Environmental Performance Review of Kyrgyzstan, ECE, 2009.

[57] I. Ruziev, "Environmental Status and ways of sustainable development of Chirchik and Akhangaran rivers", in *Rivertwin project on the Chirchik and Akhangaran rivers*. Presentation at the Work meeting on RIVERTWIN project 27 June—2 July 2006 (ICWC, 2007).

[58] EIA, Country profiles (2014).Available from http://www.eia.gov/countries/index.cfm?topL=exp.

for direct uses (e.g. drinking and agricultural use) and adds to the treatment need which in turn requires both chemical and energy inputs. Soil salinization is causing a significant decrease in soil productivity and loss of usable agricultural land. Organic and chemical pollution affects biodiversity in the river and its surroundings.

Main issues:
The establishment of large irrigation schemes along the river has led to a severe reduction of water flows reaching the Aral Sea. With the shift to a winter energy regime focus of the operation of the main Toktogul dam, less water is available for irrigation in the summer while more water released in the winter. This altered flow has changed ecosystems (and habitats) in many areas along the river, and has led to frequent flooding along the river in the winter time, resulting in less water reaching the Northern Aral Sea. As a product of the winter flooding, there are examples of new sites with rich biodiversity such as the Ramsar Site Aydar-Arnasay.[59]

The shrinking of the Aral Sea has changed the whole climate of the surrounding regions with significant consequences on the environment and ecosystems that are (or were) important for the livelihood and health of local populations. The land degradation and salinization, and the increased frequency of sand and dust storm episodes have a negative impact on the health of population and on the productivity of agricultural land.[60]

Surviving, sensitive ecosystems:
The rare riparian forests (tugai) are decreasing in size and condition. The majority (about 80%) of the riparian forest cover has disappeared and the remaining is decreasing in size and degrading. At the same time, woody and shrubby plants are now appearing around water bodies.[61]

Due to the changes in extent and location of water resources, natural nesting grounds in the northern part of the Aral Sea and the region have decreased in size. However, this has, to some extent, been compensated by the establishment of artificial nesting grounds in the southern part of the region.[62]

The remarkable diversity of the fish fauna the Aral Basin includes several endemic species that have been put under pressure due to changes in the water regime of the region and some are on the brink of extinction.[63]

[59] ECE, “Second Assessment of Transboundary Rivers, Lakes and Groundwaters”. (New York and Geneva, 2011a) Available from http://www.unece.org/fileadmin/DAM/env/water/publications/assessment/English/ECE_Second_Assessment_En.pdf.

[60] UNEP, “The future of the Aral Sea lies in transboundary co–operation”, (UNEP, January 2014) Available from http://na.unep.net/geas/getUNEPPageWithArticleIDScript.php?article_id=108

[61] Ramsar Convention, 2012. Л. Янг, Э. Алдерслей, С.Л. Скляренко, А. Солоха, Е. Крейцберг-Мухина и М. Бромбахера. Руководство Рамсарской Конвенции по водно-болотным угодьям Центральной Азии. – Берлин, 2012. – 112 с. (Ramsar Convention Guidelines for wetlands in Central Asia)

[62] Ibid.

[63] Ibid

VI. Interlinkages across sectors and countries

Sectoral activities influence each other by limiting the supply, demand and/or affecting the quality of common resources. The issues discussed during the workshop have been grouped below into the two main themes relating to water quantity (in particular the seasonal supply variations and needs) and water quality. Given the nature of the draft assessment, this is obviously a time constrained and limited snapshot view.

Figure 1 is a simplified flow diagram, indicating that securing national energy in winter in upstream countries reduces water quantities in summer. This places constraints on summer irrigation and curtails water entering the Aral Sea ecosystem.

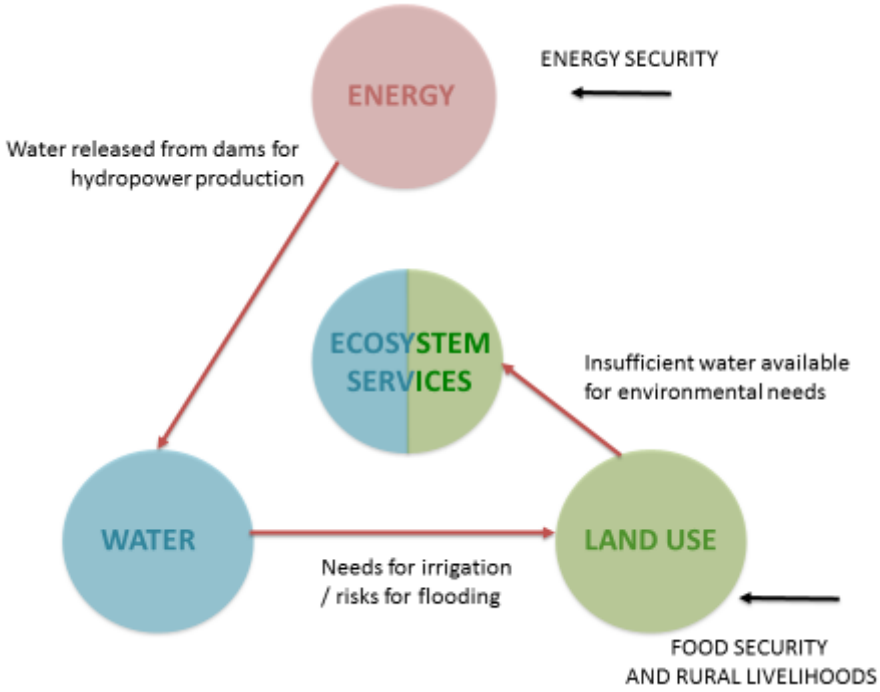


Figure 1 Interlinkages related to water quantity

A. Water quantity

Energy security is a serious concern especially in Kyrgyzstan and Tajikistan where national alternatives to hydropower are presently not available or are significantly more expensive. Since hydropower is the main resource available for both countries, the upstream reservoirs are being operated predominantly according to a national power production regime.[64] The electricity produced is to a large degree used for heating, thus the peak demand is in the winter season. Water discharges from upstream dams are therefore higher in winter months, which limit access to water for irrigation during the growing season (spring/summer). Energy and irrigation needs can nevertheless be covered during wet years with mild winters, but during dry years and cold winters both sectors may suffer.

[64] As previously stated, the main hydropower production and potential of Tajikistan is outside the Syr Darya basin and the main hydropower production upstream, here discussed, takes place in Kyrgyzstan.

For illustration, Figure 2 shows the monthly discharges of the Toktogul dam plotted against the needs for irrigation in the Ferghana Valley downstream. Note that during the summer months of June, July and August, there is insufficient water flow for irrigation but, in winter months when hydropower is needed, there is excess water flow.

Food security and rural livelihoods are also strong drivers of decisions at the national level. Water needs for irrigation remain a priority even if the river flow during the growing season is minimal. This results in significant pressures on providing flows needed to maintain downstream ecosystems. They invariably receive insufficient water flow – especially in spring and summer – for their sustenance and functioning.

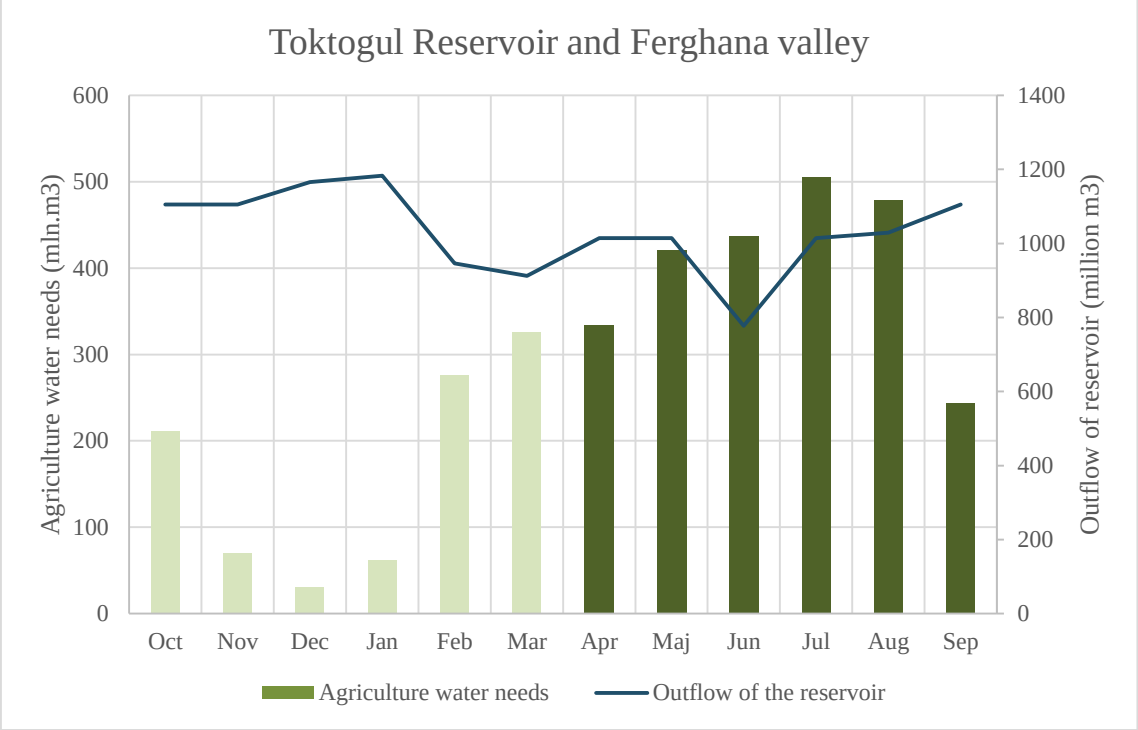


Figure 2 Toktogul discharges and Ferghana valley needs by month (data from year 2011) (Source Central Asia Water Info database (ICWC-SIC).

It can be seen in Figure 3, with simplified indications of the effect of industrial effluent, that poor wastewater treatment and agricultural practice negatively affect ecosystems. The damaged ecosystems, in turn, have a direct effect on water and land quality.

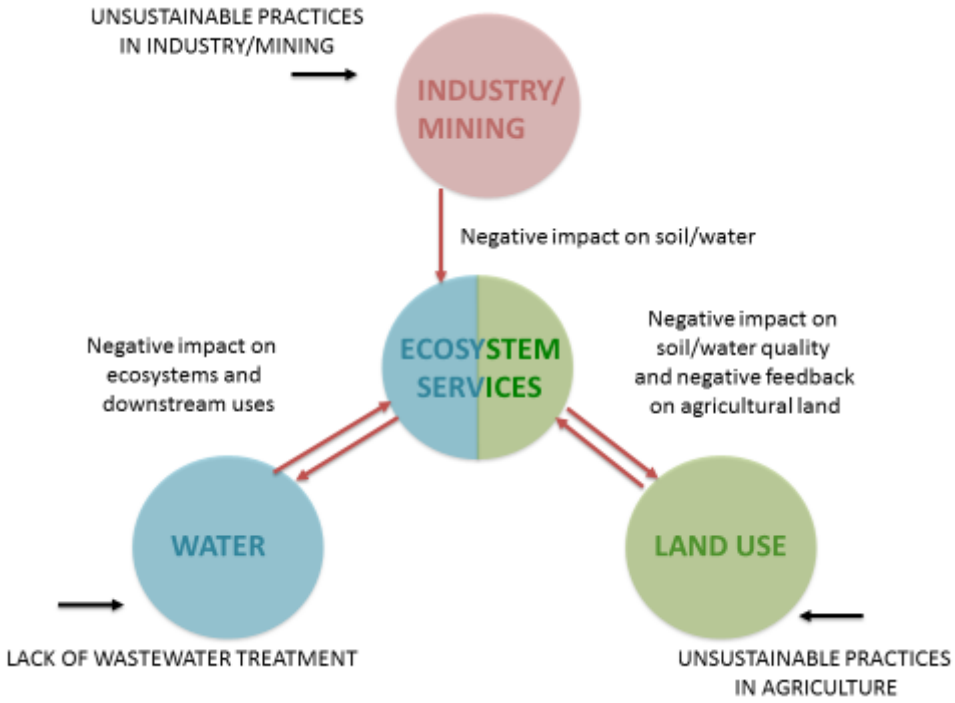


Figure 3 Interlinkages related to water quality

B. Water quality

Most economic activities using water and land resources contribute to pollution with negative impacts for downstream uses and ecosystems.

In particular, various industrial activities (mining, construction, manufacturing, petrochemicals, etc.) take place in all countries and affect water and soil quality. Further, historical activities create concerns due to their prolonged and insufficiently controlled impact on the environment (for example, uranium extraction in Kyrgyzstan and Tajikistan).

Insufficient wastewater treatment is also an issue in the basin. Untreated municipal discharges may lead to the spreading of water-related diseases and pose a risk to ecosystems and water resources used downstream (reflected by the double arrow on the LHS of figure 3).

Agriculture also contributes to water pollution because of the generally high levels of agricultural inputs (fertilizers and pesticides in particular). Currently, the level of fertilizer use (nitrogen, phosphorus and potassium) has decreased significantly compared to the Soviet times because of their high cost. Pesticides are used rarely and mostly as a means of pest control for crops. In Kyrgyzstan, pesticides are still used, including herbicides, fungicides and insecticides.[65] Unsustainable practices in irrigation and drainage cause degradation of soil and water, compromising the long-term usability of these resources for agriculture itself (reflected by the double arrow on the RHS of figure 3).

[65] Second Environmental Performance Review of Kyrgyzstan ECE, 2009.

C. Summary on sectors and resources

In summary, uses and changes of water regimes can have severe impacts downstream. For example, the timing of water releases for hydropower production affects water availability for irrigation; agricultural and industrial activities upstream affect water quality. Not only does this affect water users within the respective countries, these activities also affect neighbouring countries sharing the same basin.

International trade, relations and regulation can heavily affect the patterns of the above water uses. Examples of drivers include regional food and energy markets. As important quantities of electricity and fossil fuels could be traded across borders, energy policies have potential to mitigate or aggravate friction related to water use. Trust, information sharing and coordinated planning are important in gaining these benefits. Countering or embracing these principles can direct national policies towards self-sufficiency or international cooperation.

Irrespective of ratification of international legal instruments, all countries are obliged by customary international law to prevent, limit and control significant transboundary impacts as well as to use shared waters in an equitable and reasonable manner.

VII. Trends and drivers of change

During the Almaty workshop (December 2014), participants were invited to discuss potential future, in a short *scenario thinking exercise.* This involved applying selected elements of a related effort employed in the region previously by FAO **[the reference to be added]**). Although limited time did not allow for an exhaustive categorization of all certainties and uncertainties, nor a concrete discussion of "what if?" scenarios, a few facts were clear after the exercise. The current situation is characterised by a number of realities heavily impacting on development in the riparian countries and the basin.

Examples of issues that will likely affect the interlinkages with regard to water quality and water quantity are: the lack of a functioning energy market; the fact that water is not seen as having an economic value; priorities of development are different between countries; that there is neither effective pollution control nor functioning incentives for improving resource efficiency. Important trends are population growth with increased demand for food, water and energy, and increased pressure on natural resources and the environment. Key uncertainties that will affect the impact of these trends are the development of regional co-operation, geopolitics, population movement[66] and climate change impacts (such as more frequent dry years).

A. Regional climatic trends

According to reports from the IPCC, freshwater availability in Central Asia, particularly in the large river basins, is projected to decrease due to climate change.[67] The melting of

[66] Farmers and employees in the agricultural sector are ageing as a group, and there is a tendency that young people look for opportunities in other sectors. The agricultural sector is increasingly characterized by lack of specialists. Low salaries further intensify the migration from the countryside. The expected return of guest-workers from the Russia Federation back to Central Asia, as a result of the current economic recession, has put pressure on the countries to find acceptable solutions for their employment.

[67] IPCC, Fifth Assessment Report (AR5)(2014). Available from http://www.ipcc.ch/.

glaciers will slowly cause a decrease in water stocked at the source. Understanding these dynamics in addition to improving monitoring, is of great importance to forecast future water availability and the risks of natural hazards such as floods, droughts and landslides. Compounding these, Kyrgyzstan and Tajikistan in particular have to deal with high hydrogeological and seismic risks compromising, among others, dam safety in mountain areas and erosion on the slopes of the mountains. Additional risks include damage to poorly protected storage sites of poly-metallic and radioactive ore waste, which are numerous in this region.

B. Regional socioeconomic trends

Annual freshwater withdrawal in Central Asia is, overall, decreasing, while the share of direct use of treated wastewater is increasing. In Kazakhstan, desalination as a means to provide drinking water to municipalities is starting to develop (FAO 2012b). However, the demand for water can be expected to expand with population growth as well as the continuation of agricultural activities. For example, groundwater may become increasingly important for agricultural needs.[68] This would mean higher energy demand for pumping. Groundwater quality may thus be increasingly threatened by infiltration of agricultural, industrial and municipal discharges and which will require improved monitoring.

All countries are oriented towards crop diversification and in particular towards a shift in production from cotton to less water intensive crops (input from FAO and Workshop, 2014).

The evolution of large hydropower in the Syr Darya is not easy to foresee. Within the Kambarata 1 project, the Naryn dam in Kyrgyzstan is under construction but its completion is delayed. This dam would have a much smaller water capacity than the Toktogul (370 million cubic meters), but would have a higher electrical capacity (around 2,000 megawatts (MW)). No other new hydropower projects of comparable size are planned on the Syr Darya. Kambarata 1 could further decrease access to irrigation water downstream, but may also allow for the Toktogul to return to an irrigation-focused regime in the interest of the downstream countries.

Construction of the Upper Naryn cascade is planned in 4 successive stages: Akbulunskaya hydropower plant (HPP) and Naryn HPPs -1, 2 and 3. The cascade will be located on a 45-kilometre stretch upstream on the Naryn River from the regional centre of the same name. Naryn City is located 180 kilometres south of the railway station Fishing (Balykchy) and 186 kilomtres from the border with China. The installed capacity of hydroelectric Akbulunskaya will be 85.33 MW, Naryn-1 HPP - 47.14 MW, Naryn2 HPP - 46.84 MW and Naryn-3 - 55.42 MW. The construction period is expected to last six years.

Energy trade will play a major role in the development of the energy sector of all countries. Currently, the basin and the region of Central Asia in general are becoming increasingly important for energy production and export. Oil and gas pipelines and electricity grids are being expanded to supply large external markets such as China and South Asia. Examples include:

[68] Karen Franken, ed. “Irrigation in Central Asia in Figures. AQUASTAT Survey 2012”, in *FAO Water Reports 39*. (Rome, FAO, 2012b) Available from http://www.fao.org/docrep/018/i3289e/i3289e.pdf.

(a) The construction of high voltage transmission lines (CASA 1000 Project of the World Bank[69]) aimed at providing hydro-electricity produced in Tajikistan and Kyrgyzstan to Afghanistan and Pakistan;

(b) The planned ultra-high voltage transmission lines to connect Central Asia with China;

(c) Oil and coal export from Kazakhstan to other riparian countries as well as countries outside the region (e.g., the Russian Federation and China). Minor export of oil from Uzbekistan[70]to the Russian Federation via Kazakhstan (existing);

(d) The recently extended natural gas pipeline from Turkmenistan and Uzbekistan to the Russian Federation (via Kazakhstan) and China (via Uzbekistan, Tajikistan and Kyrgyzstan).

The extent of future trade between riparian countries is not easy to predict. The development of pipelines and grids suggest that the countries will be increasingly interconnected. To a certain extent, countries could avoid this interdependency by choosing less direct routes in the development of networks, bypassing each other.

The lack of economic cooperation and trade results in the countries prioritizing self-sufficiency over cooperation. National level, un-coordinated solutions increase pressure on the shared water resources, which have negative transboundary effects. On the other hand, prospects of improved trade (energy and food in particular) are concrete (See Opportunities).

Future trade of resources will largely depend on the directions that national policies will take - in terms of self-sufficiency or cooperation. The development of a regional market for agricultural products has a high potential to positively influence economic growth of the countries in the region as well as their choice of which crops to produce. Kazakhstan and Uzbekistan are already leading wheat exporters[71] and there is a potential to expand the market of fruit and vegetables.[72]

C. National Policies

1. Kazakhstan

The primary goal of Kazakhstan's policy is a "transition to a green economy" as included in the following state programmes: Kazakhstan-2050 and the Concept of Transition of the Republic of Kazakhstan to Green Economy[73] (2014). According to estimates, the actions planned within the Green Economy programme will increase GDP by 3% and create more than 500,000 new jobs. Kazakhstan is exploring safety nets for the poor by offering, for example, preferential credits and social payments to lower the impacts of tariff increases on the most vulnerable groups (e.g., electricity companies offering discounts to users will be compensated by the State) (Workshop, 2014).

[69] Article of the Prime-Minister of Kyrgyzstan http://www.gov.kg/?p=41665

[70] Minor production in the basin area

[71] FAO, "Food Outlook. Biannual report on Global Food Market". (FAO, 2014) Available from http://www.fao.org/3/a-i4136e.pdf.

[72] UNECE, "Regulatory and procedural barriers to trade in Kazakhstan". (UNECE, 2014) Available from http://www.unece.org/tradewelcome/studies-on-procedural-and-regulatory-barriers-to-trade.html.

[73] Government of Kazakhstan. Presidential Decree signed 20 May 2014. Transition to Green Economy. Strategy Kazakhstan 2050. Astana, Ministry of Environmental Protection. (2014)

Water

The national legislation of Kazakhstan is progressing in the implementation of IWRM principles. This can be seen in the adoption of a ir basin approach to water management through the creation of basin councils as well as the promotion of efficient use of water resources. Kazakhstan' s goal is to resolve all issues related to drinking water supply by 2020 and all issues related to agricultural water supply by 2040. Additional and more detailed targets are included in the "State Program of Water Resources Management" (2014) and in the sectoral program "Ak-Bulak". These targets include reaching 100% of the urban population and 80% of the rural population with access to safe drinking water by 2020. Specific Syr Darya basin-related objectives in Kazakhstan are developed in the framework of the "Syr Darya Control and Northern Aral Sea Project", which is in the final process of consultations between Kazakhstan and the World Bank and is expected to be adopted in September 2015. Another special programme, scheduled for 2011–2020, is devoted to provide drinking water to South Kazakhstan and to collect macro-biological indicators.

Energy

Kazakhstan has ambitious energy sector goals as described in the Concept for Transition to a Green Economy, 2014. For example, the share of alternative energy, namely solar and wind, must comprise not less than 3 per cent by 2020, 30 per cent by 2030, and 50 per cent by 2050. Modernization of equipment is expected to allow for an increase in energy efficiency by 15–40 per cent. Kazakhstan also plans on decreasing the energy intensity of GDP by 25 per cent by 2020, as compared to the 2008 baseline. A National Utilities Modernization Programme calls for modernization of significant stretches of heat, electricity and gas distribution networks to be completed by 2020. Kazakhstan has also adopted a law in support of renewable energy sources in 2009 and a law on energy saving and energy efficiency.[74]

Agriculture

According to the State's policy, the agricultural land productivity will be increased by 1.5 times by 2020. The State's policy also foresees land reclamation. According to the strategy of transition to a Green Economy, by 2030 20–30 per cent of the areas of rice and cotton cultivation will be gradually replaced with the less water intensive crops. Similarly by 2030, on 15 per cent of the cultivated land, drip irrigation and other new state-of-the-art water saving technologies must be implemented. Kazakhstan is also currently investing in organic farming (input from FAO) and in restoring fishery (Workshop, 2014). Guidance on the protection and use of fishery resources are stipulated in the Strategic Plan of the Ministry of Agriculture of Kazakhstan.

Environment

With regards to the environment, the Concept for Transition to a Green Economy specifies that the environmental flow into Syr Darya and the North Aral Sea must not be less than 5 km^3 annually, and that the area of protected territories should increase by 2.5% in the short term, and by 5% in the long term. Water treatment facilities of Shymkent, Kyzylorda, Turkestan, Shardara, Saryagash and Baykonur are currently being renovated.

[74] TECHECONOMMODEL, "Study on the application of energy efficiency and renewable energy advanced technologies in Central Asian Countries". A report for the United Nations Office at Geneva. (Kraainem, Belgium, 2013).

2. Kyrgyzstan

The sustainable development policy goal is reflected in the National Sustainable Development Strategy of the Kyrgyz Republic for the period of 2013-2017, which focuses on environmental protection and rational use of natural resources for sustainable development, including priorities of energy sector development.

Water

Non-consumptive users of water (e.g. electricity generation) do not pay for water use in Kyrgyzstan. The country has progressed more with the implementation of IWRM principles, including the concept of environmental flow, provisions for basin management and recognition of the need for creation of basin councils. The Concept of Environmental Safety of Kyrgyzstan until 2020 (as adopted in 2007) reflects the main directions of state policy in the field of environmental protection and conservation.

Energy

In terms of energy policy, the development of hydro-energy is a priority for Kyrgyzstan, including the construction of Kambarata-1 Hydropower station, the Upper Naryn cascade and the planned second hydro aggregate of Kambarata- 2 Hydropower station. Agreements have been signed with the Russian Federation.[75] In Kyrgyzstan, small hydropower is also increasingly garnering interest. The Ministry of Energy of Kyrgyzstan suggests compensating the electricity deficit of Kyrgyzstan with small hydropower. Enterprises are already aware of the opportunities in this field and the association of small HPPs has applied for registration. From 2016 the country will attempt to build rapidly several small HPPs to increase production.[76]

Land Use/Agriculture

Kyrgyzstan is focusing on issues of land reclamation. The National Council on Sustainable Development was established in 2012.

Environment

In Kyrgyzstan, the Agenda for XXI Century (Action Programme to 2010) made direct reference to rational use of land resources, improvement of soil fertility, regulation of land relationships and as a result ensuring food independence and food security under the conditions of serious scarcity of land resources. The Agenda also recognizes the significance of forests and their contribution to sustainable formation and preservation of fresh water resources, reduction of landslide and mudflow risks and preservation of biodiversity of mountain territories. The State Programme on Forest envisages an increase in afforestation of the country from 4.25 percent in 2000 to six percent in 2025.

[75] See: Agreement between the Government of the Russian Federation and the Government of the Kyrgyz Republic about the Construction and Exploitation of the Upper Cascade Hydropower Station http://www.mid.ru/bdomp/spd_md.nsf/0/BECD1CF77DC631A643257E270042DDFA and Agreement between the Government of the Russian Federation and the Government of the Kyrgyz Republic about the Construction and Exploitation of the Kambarata-1 HPP http://www.mid.ru/bdomp/spd_md.nsf/0/92226763A2F633F943257E270042E153

[76] Regnum.ru, 2015. Kyrgyzstan's Ministry of Energy and Industry proposes to compensate for the electricity by small hydropower stations.(in Russian) [Минэнергопром Киргизии предлагает компенсировать дефицит электроэнергии за счет малых ГЭС. (Regnum information agency, Bishkek, 17 February 2015) http://www.regnum.ru/news/polit/1896306.html

The policy of adaptation to climate change in the Kyrgyz Republic until 2017 is included in relevant policy documents such as "Set of measures to ensure environmental security in the Kyrgyz for 2011-2015". Climate change is reflected in all major strategic documents on country development, which provide for relevant measures on the key sectors: water resources, agriculture, public health, climate emergencies, forest resources and biodiversity. The Coordinating Commission on Climate Change functions as the national authority on climate change and coordinates activities like the development of programs for adaptation to climate change by relevant ministries and agencies. The National Report for 2011-2015 is currently under preparation.

3. Tajikistan

Tajikistan's National Development Strategy for the period of 2006–2015 provides for the management of natural resources including an emphasis on prevention of natural disasters. The Poverty Reduction Strategy Paper for 2010–2012 has acknowledged poverty as the main reason for and consequence of environmental degradation, emphasizing the need to tackle these two problems together.

Energy

Policy actions related to the energy sector have been defined in the 'Long-term Program for Construction of Small Hydropower Plants in the period 2007–2020'. These policies aim to support the integration of renewable energy sources. In Tajikistan, HPP modernization projects include increasing the existing capacity of the aggregates by up to 10 per cent. This applies, primarily, to the HPPs of the Vaksh cascade, the Kaurakkum HPP and the Varzobskie HPPs. According to the Programme of Construction of Small HPPs for 2009–2020, it is planned to build small HPPs (up to 3 MW) on Syr Darya. Tajikistan is not planning to construct any large HPPs on the Syr Darya (Workshop, 2014).

Water

In Tajikistan, the Law on Water Users Association of 2002 was revised in 2013, with updates to the regulatory framework and implementation of new water sector reforms (e.g., to move towards basin and sub-basin water resource management and to improve technical and capacity). The payments for non-consumptive use of water (e.g., electricity generation) are low. Tajikistan's transition towards implementing of IWRM principles is in its early stages, though the country has already introduced some provisions for basin management. The reform of the water sector, as defined in Government's Resolution of 2009, foresees transition towards IWRM and a river basin approach.

A Governmental Decree of 2008 provides the regulatory framework for the 'Agrarian Policy Concept of the Republic Tajikistan'. Its focus lies in the development of a land reform, improving the forms of management of crops and livestock. According to the Programme for reforming the Agriculture Sector of the Republic of Tajikistan for 2012–2020, several principles are to be implemented. These include securing land and water rights, ensuring farmers' freedom to farm and ensuring market regulations and fair and steady supply of agriculture goods and services. The principal focus in Tajikistan is addressing the issues of land reclamation. In particular for the Sogdiiskaya oblast, the overall production of all crops (except for wheat) is expected to grow. Currently, the priority is to increase the share of vegetable and fruit production, as well as to increase cultivating and processing raw cotton. Because these products are currently exported there is room for ramping up production (Workshop, 2014).

Environment

Relevant strategy documents in the field of natural protection include the 'National Environmental Action Plan (2006)' and the 'National Strategy and Action Plan on the Conservation and Sustainable Use of Biodiversity'. These documents focus on solving the major environmental problems in Tajikistan, including: (i) natural disasters (ii) land degradation (iii) deforestation and desertification (iv) limited availability of clean drinking water (v) low levels of water treatment and (vi) deterioration of wildlife and protected areas.

These topics have also been covered in the Agriculture Reform Program of the Republic of Tajikistan for 2012-2020, approved in 2012. The Poverty Reduction Strategy Paper for 2010-2012 draws attention to soil degradation, desertification, deforestation, deterioration of mountain ecosystems and loss of agricultural land fertility both due to climate change and man-made factors. The holistic policy approach to integration of economic, environmental and social concerns was introduced in the framework of the Concept for Transition to Sustainable Development of the Republic of Tajikistan as adopted in 2007.

4. Uzbekistan

In 2010, Uzbekistan implemented the Strategy for Welfare Improvement of Uzbekistan, which aims to ensure an effective, functioning and innovative welfare system by 2020.

Water

Uzbekistan is implementing, together with a number of donors, several projects to improve safe water and sanitation as well as wastewater treatment.[77] The Program on Integrated Development and Modernization of Water Supply and Sanitation (until 2020) focuses on the new concepts of integrated development and modernization of water supply systems and sanitation.

Energy

Simultaneous with economic security, the industrial policy focuses on, among others, the maintaining of energy independence. In terms of renewable energy, Uzbekistan is planning the implementation of large-scale solar energy production. The construction of the first large solar power station[78] in Uzbekistan will start in 2015 in Samarkandskaya oblast (out of the Syr Darya basin). Some installations of renewables are also starting to supply remote areas. As an example, a solar power station of 130 kW is being installed in the region of Namangan (north of Ferghana valley) to serve isolated the district of Kandigon.[79]

Land Use/Agriculture

Food security remains of strategic importance. Restructuring the agricultural sector, which is the main consumer of water, focuses mainly on changing crop patterns, investing in irrigation-water supply and water-saving technologies, creation of farmer institutions and improving the efficiency of water management. In Uzbekistan in 2007 a 'Fund for Irrigated

[77] Karen Franken, ed. "Irrigation in Central Asia in Figures. AQUASTAT Survey 2012", in *FAO Water Reports 39*. (Rome, FAO, 2012b) Available from http://www.fao.org/docrep/018/i3289e/i3289e.pdf.

[78] In accordance with the Decree of the President of the Republic of Uzbekistan № PP-2183 from 04.06.2014g "On measures to implement the investment project" "Construction of a solar photovoltaic power plant 100 MW in the Samarkand region" work on the project is started.

[79] Gazeta.uz, (2014) First solar power plant launched (in Russian) [Запущена первая солнечная электростанция]. Available from http://www.gazeta.uz/2014/12/29/solar/.

Land Reclamation' at the Ministry of Finance was established. The new programme for agricultural development in 2015–2019 is under consideration to provide, among others, the optimization of cotton area. Gradual reduction of cotton area is already taking place, with cereals, vegetables, melons, potatoes, and fodder crops being produced instead. Implementation of these policies has reduced rising prices for food products at the national level, even in times of the global financial crisis.

To improve the fertility of irrigated land, the 'Programme of Measures for Land Reclamation for 2014–2017' will be continued, providing for the construction and reconstruction of irrigation systems and the introduction of modern water-saving technologies. The Ministry of Agriculture and Water Resources (MAWR) of Uzbekistan is currently promoting water-saving technologies in the agricultural sector in order to minimize the sector's dependence on external water resources and to ensure water supply stability for irrigated land. In particular, the Government is implementing a programme on drip irrigation, installing this technology in some 3,710 hectares. Uzbekistan's implementation of IWRM is in its early stages. Provisions for basin management are only gradually being upgraded and the need for creation of basin councils has not yet been legally recognized. Improvement of soil reclamation lies within the focus of the 'State Programme of Comprehensive Measures to Improve the Irrigated Land and Water Resources', which was adopted for the period from 2013 to 2017.

Environment

Concerning ecological aspects there were a number of other governmental strategies adopted: the 'National Environmental Action Plan' (1998, being updated every 5 years); the 'State Programme for Environmental Protection and the Rational Use of Natural Resources' (2001, adopted on May 27, 2013 for the period 2013 -2017); and the 'National Action Programme to Combat Desertification' (2003, with draft under discussion for the period 2015-2025). These strategies provide for (i) the development of integrated land, water and salinity management, (ii) promoting a watershed management approach on a pilot basis, (iii) combating desertification, (iv) developing and implementing a strategy of regional water resource management for the Aral Sea basin, (v) increasing land productivity, and (vi) improving the economic mechanism of environmental protection and use of natural resources.

VIII. Solutions

It is clear that there is an inefficiency of cooperation on management of water resources in and between the basin countries. This constrains the countries' ability to meet their needs for sufficient water quality or quantity and adequately protect the resource. Improving the effectiveness of cooperation is possible through linking water to food, energy and ecosystems.

Solutions are grouped into:

(a) Solutions that focus on national development with unintended co-benefits;

(b) Solutions that focus on broader sustainable development and national policy coherence;

(c) Solutions that accelerate national development by furthering cooperation.

A. Solutions focusing on national development with unintended co-benefits

There are many actions that countries in the region could take to improve national security while not aggravating - and potentially improving - transboundary impacts. These actions focus on improving efficiency in both electricity use and water use in irrigation, increasing the penetration of wind based electricity generation, and reducing electricity and water transport losses. These solutions will contribute to economic competitiveness while helping to alleviate poverty. Because they are 'standard policies', support is generally available for capacity building and financing implementation. Execution of these solutions will require institutional, human capacity, and policy development.

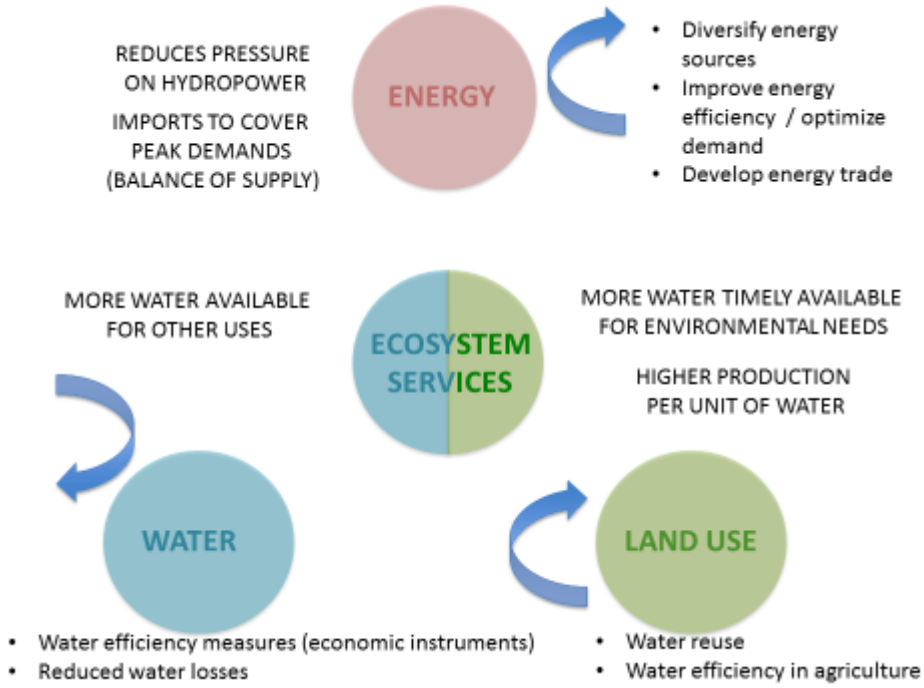


Figure 4 Possible actions to reduce trade-offs related to water quantity

1. Improving energy efficiency and reducing dependency on water for energy production

To improve energy security, support economic development and, for upstream countries, improve resilience to climate change and low flow (dry) years, the following policies should be prioritized: diversify energy sources; improve energy efficiency; reduce transport losses; and develop off-grid energy supply options for remote areas.

National benefits would include:

- Financial savings from lower energy use
- Increased resilience to water shortages in dry years (particularly important if considering climate change)
- Reduced running costs
- Increased export potential/reduced import requirements
- Potential for international finance and support.

A transboundary benefit would be:

- Reduced pressure on shared water resources and hence more water available for different uses, including by ecosystems

These policies improve national development goals and have already been adopted by leading economies. By indirectly releasing constraints on water requirements for hydro generation in winter, water is freed up for use or release in summer. While the 'unintended benefits' are most pronounced from actions in upstream countries, national benefits remain for downstream countries as well.

Possible effect of energy efficiency measures and diversification of energy sources on hydropower generation
With an aggressive but achievableincrease in the efficiency of energy use,[80] a reduction in demand for hydro generation between 10%-20% is possible in the short term, and in excess of 30% in the long term (UNECE 2004). A 20% reduction of hydro-electric production in winter months would allow for irrigation deficits (see figure 2) to be met with no additional intervention. This would be achieved at a net economic saving to upstream countries, given that efficiency measures are usually less expensive than increasing domestic generation or importing electricity. Further, cutting energy losses in the grid has been highlighted by USAID (2005) as a priority action for countries in the region. A 10% reduction in losses would be directly translated into a reduction in hydro-power demand during peak production times. In total, winter hydro generation in upstream countries could be reduced by up to 40%.

A wide array of Policies and Measures (PAMs) are available to improve energy efficiency. Underpinning these is the need for data, monitoring and verification, and institutional and human capacity. Typically improved energy efficiency reduces the need for new capital expenditure and imports, simultaneously reducing fuel costs and freeing up potential exports. This savings can can be used for other productive purposes and boost growth. The PAMs can range from simple pricing signals to the creation of energy efficient building and equipment standards.

Pricing signals improve reduce energy consumption for heating
A recent example of economic instruments leading to decreased energy consumption can be seen with the increase in electricity tariffs of 2014-2015 in Kyrgyzstan. This policy was linked to the expense of importing energy to meet the demand above and beyond that which was produced inside the country. Previously the electricity price in Kyrgyzstan for 1 kWh was less than 1 som.[81] While prior attempts to raise the price led to popular unrest, in this case the government applied a diversified tariff set by threshold of consumption. The basic price increased to 1 som/kWh and if a household uses more than 700 kWh per month the price was set to 5 som/kWh. Energy consumption during the winter 2014-2015 was actually less than average. It is true that this winter was mild, but no protests took place and the goal of reducing energy consumption was achieved. Pricing electricity to better reflect its market cost is one of several policies and measures (PAMs) that are accessible to policy makers to improve the attractiveness of energy efficiency.

Apart from improved end use efficiency, reducing transmission losses and promoting greater generating efficiency are perspective to pursue[82,83].

[80] At least 20% of the demand for electricity in upstream countries is for heating. This implies a demand of around twice this number during winter months. A range of measures could be employed including improving insulation, using heat-pumps and fuel switching. Adding to this other electrical efficiency measures, reduction in upstream hydro generation would be significant.

[81] 63 som = 1 USD (April 2015)

[82] For example, benefits of the construction (completed in 2012) and commissioning of a modern, combined cycle plant at Navoi thermal power plant include significant savings of natural gas, reduced harmful emissions and a supply of heat to the district heating system. *Source*: Abdusalamov D, "Enhancing synergies of national programs of the CIS countries on energy efficiency and

Regarding the diversification of energy production, other non-hydro renewable energy sources are good alternatives to fossil fuels. Renewable energy sources (including micro hydro) have historically played an important role in improving access to modern energy in remote and poor areas.

Opportunities of wind power

According to the UNECE's Sustainable Energy Division, concrete opportunities exist to develop wind technologies in combination with hydropower in Tajikistan. Although the cost of electricity from wind turbines is higher than from hydropower, wind power could be used to ease deficits during dry years while diversifying energy production. Without the diversification of energy resources, Kyrgyzstan and Tajikistan will continue to depend on thermal power plants of neighbouring countries in the winter while simultaneously enduring conflicts over water use.

The benefits for water management would be significant if installed wind energy capacity can reach 500 to 1000 MW. HPPS with high dams are excellent support for wind turbines, which are subject to pauses in the absence of wind. According to wind resource assessment made by the European Bank for Reconstruction and Development (EBRD), the wind potential is higher in the winter months, which coincides with the higher electricity demand. It is estimated that a medium term target of 400 MW wind turbines by 2030 in Tajikistan, which accounts for less than 15% of the current total installed capacity of the country, could provide approximately 1.2 km^3 of water savings per year (10% of the working storage of the Nurek HPPs reservoir). Similarly, a medium term target of 500 MW wind turbines in Kyrgyzstan by 2030, which is less than 15% of currently installed power capacity, would provide ca 1.4 km^3 of water savings per year (about 10% of the active storage capacity of Toktogul).

Thermal power production is dependent on water from the river for cooling. With regards to cooling technologies, the optimal choice is site specific. For example, 'once through' open-loop technologies require significant water intake (and thereafter outlets), but they are not consumptive. Closed-loops technologies, reusing the same water, do not require constant water intake, but their consumption is higher. Dry cooling technology is less efficient, but has become ideal for dry climates. Moving from thermal stations, some generation technologies simply require less water than others. Wind, for example, is the least water demanding technology per unit of energy produced while coal technologies normally require more water than natural gas.[84] The potential need for dry cooling in the Syr Darya basin should be the focus of future study if water constraints persist and new thermal power plants are built.

The Concept for Transition to a Green Economy of Kazakhstan, 2014 contains numerous effective policies and measures to support new investments and energy efficiency. These measures are feasible and strongly in the national interest, but require political will to create an enabling environment. Looking at such policies through a nexus lens, they have the potential to result in cross-sector, transboundary impacts that benefit the region.

2. Rationalizing water use (in particular in the agricultural sector)

Reducing pressure on water resources by improving efficiency in water use and reducing water losses is another urgent objective that is undoubtedly in the national interest:

conservation to enhance their energy security", in National report on the Republic of Uzbekistan: Made in the framework of the project of the UN Economic Commission for Europe (2013).

[83] TECHECONOMMODEL, "Study on the application of energy efficiency and renewable energy advanced technologies in Central Asian Countries". A report for the United Nations Office at Geneva. (Kraainem, Belgium, 2013).

[84] UN, "World Water Assessment Program (WWAP) of the United Nations", in *World Water Development Report*, (UN, 2014) Available from http://www.unesco.org/new/en/natural-sciences/environment/water/wwap/wwdr/.

National benefits include:

- Increased resilience to water shortages in dry years
- Reduced dependency of cross-border flows
- Improved agricultural production and sustainability of agricultural practices
- Reduced land degradation

Transboundary benefits include:

- Increased water availability downstream including for environmental needs

Water efficiency measures in the agricultural sector are crucial to improve the sustained availability of water resources. However, as water efficiency is site, scale and purpose-specific (Lankford 2006), detailed investigations are required before decisions can be made about investments to improve the efficiency of water use. Other issues to consider when developing irrigation efficiency improvements include the irrigation design, operation and management, equity in access, energy savings and levels of waterlogging and salinization (Bos et al., 2005; Faurès et al 2007).

Nevertheless, using less water for the same output[85] ensures that during times of water stress, water demand has already been reduced, and at other times, environmental flows are sustained. It is of importance that the current efforts of Kazakhstan and Uzbekistan will be extended, and that Tajikistan and Kyrgyzstan will take concrete action in this direction as well. Investments in repair to existing infrastructure, modern infrastructure and appropriate technology are needed.

An enabling environment is needed for the successful implementation of improved water efficiency activities. Technical solutions need to be accompanied by reward systems, awareness among the users[86] (not only farmers), and socio-economic analysis of their introduction in the agricultural supply chain. From a recent study in Morocco based on a number of case studies where drip irrigation was promoted in dry agricultural areas, it was concluded that without appropriate consideration of social factors and appropriate legislation, water saving technologies can not only fail in reducing water consumption but even increase inequality.[87] In addition, special attention should be placed on reclaiming salinized agricultural land and reducing current land degradation by gradual improvement of irrigation technology and practice.

From a purely technical perspective, new technologies for irrigation could help increase yields, save water and limit soil degradation and erosion. Many studies indicate that productivity can increase with the introduction of measures such as drip irrigation. Rehabilitation and modernisation of existing systems, through irrigation management

[85] In a later section we discuss impacts of changing output.

[86] Important reforms of the national legal basis and distribution of responsibilities in resource management have been initiated in the past 15 years in all the Syr Darya countries. Practically all the countries are moving towards a greater role for resource users. The public participation in the water governance, reflected in the gradual establishment of basin councils in case of Kazakhstan, Kyrgyzstan and Tajikistan, needs further strengthening. Notably, land reforms and decentralization have gradually given a more important role in agriculture to farmers through e.g. user associations. However, if has not been accompanied by sufficient resources or powers to mobilize the necessary resources, it will continue to be difficult to arrive at more sustainable practices in water use. The regulations should encourage such practices and one means that for the time being has been little used is economic incentives.

[87] Jobbins and others, “To what end? Drip irrigation and the water-energy-food nexus in Morocco”, in *the International Journal of Water Resources Development* (October 2014).

reform may also have advantages, as multi-purpose water supply systems can have increased benefits over irrigation alone (CA, 2007; Meinzen-Dick, 1997a). The different options for a particular location should be carefully evaluated to identify the most suitable solution.

Advantages of drip irrigation and constraints to its application

In drip irrigation, water is applied to each plant separately in small, frequent, precise quantities through dripper emitters. The water is delivered continuously in drops at the same point and moves into the soil. This wets the root zone vertically by gravity and laterally by capillary action.

Drip irrigation can help to increase yields up to two or three times depending on the crop and the soil type. Drip irrigation can also help limit fertilizer use to the actual needs of the plant.[88] As compared to traditional means or irrigation (floods, channels) drip irrigation significantly helps in avoiding soil erosion. With drip irrigation, low soil moisture tensions in the root zone can be maintained continuously with frequent applications. The dissolved salts accumulate at the periphery of the wetted soil mass, and the plants can easily obtain the moisture needed. This enables the use of saline water, which would be unsuitable for use with other irrigation methods.

Cost increases with the complexity of machinery (drip irrigation being the most expensive) but the resulting cash flow and profitability is also potentially much higher, assuming that there is an established market to trade the crops produced. The initial costs for the provision of equipment and training on how to use it are high. Good irrigation management is essential for skilled system operation and maintenance. According to FAO, use requires clean water free of suspended matter like sediment and algae as well as from precipitating substances which may block the small waterways.[89]

In Kazakhstan in the second half of 2015 there is a planned launch of the Project to Improve Irrigation and Drainage systems (PUIID-2) funded by the Government and the World Bank.[90]

Source: Information provided by FAO

In addition, there are opportunities to reuse treated municipal wastewater to exploit the additional nutrients it contains. Safe use of recycled water would require adequate water quality surveillance and control, though, in accordance to international guidelines.

Planning for the use of collector and drainage water for irrigation requires a set of measures for assessing the main indicators of use as well as conditions of the formation of drainage water. Depending on the conditions of formation, technological measures and methods of use of drainage water for irrigation can be appointed.

Conditions of formation of collector and drainage water in different lithological, hydrogeological and water-economic conditions differ in volume of water, salinity of drainage water, power and pressure of groundwater, state of the irrigated lands. The Syr Darya River Basin has three different areas in terms of the formation of collector and drainage water. Each zone has its own characteristics, which determine the conditions of use of such water for irrigation:

- In the area of thinning and dispersion of groundwater of intermountain valleys and depressions (Fergana valley, Pritashkentskaya depression) irrigation-groundwater filling of drainage waters is developed. The volume of drainage water, taking into account the return water into the vegetation amounts up to 1000 m^3 / ha per month, water salinity in the range of 1.5-2.5 g/l.

[88] FAO. *Crops and Drops – Making the best use of water for agriculture*. Rome, Food and Agriculture Organization of the United Nations, 2002.

[89] Andreas Phocaides. *Handbook on Pressurized Irrigation Techniques*. Rome, Food and Agriculture Organization of the United Nations, 2007.

[90] World Bank to Help Kazakhstan Modernize Irrigation System. Press Release (29 April 2014, Astana). Washington, D.C., World Bank, 2014. Available at http://www.worldbank.org/en/news/press-release/2014/04/29/world-bank-to-help-kazakhstan-modernize-irrigation-system

- In the steppe zone Sogdiiskaya, Syrdaryinskaya, Jizzakhskaya and, South Kazakhstan oblasts filling of drainage water through irrigation is developed. The monthly rate of drainage waters in the area during the vegetation season does not exceed 500-800 m^3/ha. Drainage water salinity is 2.5-5 g/l and more.
- In the area of interceptor drains and sewers, horizontal drainage system is filled from the pressured groundwater. Such zones are mainly piedmont plains of the Ferghana Valley. The mineralization of these waters is identical to the salinity of groundwater, and does not exceed 0.8-1.0 g / l. The lands are nonsaline with high natural drainage conditions.

The main directions for the use of this water in irrigation can be decided by taking into account the conditions of formation together with the volume and quality of collector and drainage water, its intra-distribution during the year, mechanical composition of soils, meliorative state of lands and natural drainage conditions.

For areas with irrigation and underground filling, the most realistic use of drainage water for irrigation is in the place of their formation. Allowable salinity of irrigation water for these areas, taking into account soil conditions, the composition of salts in the soil and drainage water, ensured drainage and crop composition (the main crops being cotton and wheat) is found from the experimental data to be in the range of 2-3 g/l.

In the areas with irrigation and river filling, which includes irrigated land located in the middle and lower reaches of the Syr Darya River, the use of irrigation drainage water at the place of formation is not possible because of the high salinity of this water. Allowable salinity of the irrigation water in these zones is also lower, in the range of 1.5 to 2.0 g/l. This is because of the area in which collector and drainage water is formed having high concentrations of chloride and sodium salts in its composition, which in turn has a depressing effect on the plants and soil salinization processes.

Potential of using drainage waters

In areas with low salinity and non-saline irrigated land, light-textured soils and secure drainage, the drainage water supply could be partially secured by the use in the place of formation. The majority of drainage waters should be transferred and used outside of the zone of formation. The use of drainage water is possible in pure form on light or sandy soils for growing salt-tolerant forage crops or for use in irrigation and fisheries after purification in a bioplato (biopond).

Collector-drainage water of 1.5-2.0 g/l are suitable for irrigation. This water accounts for 7-8% of the total and is mainly concentrated in Sogdiiskaya, Jizzakhskaya, Syrdaryinskaya and South Kazakhstan oblasts.

In the area of intercepting drains and sewers - in the Ferghana Valley and Dalverzinsoky steppe, where most fresh water drainage is formed, it is possible to be directly used for irrigation in the place of formation, especially when pumped from drainage wells. A characteristic feature of reclamation in these areas is the highly pressurized groundwater which wedges out to the surface. To release the pressure in these zones, a large number of drainage wells from a single well flow rate of 60 to 100 l/s is constructed. Pumped water does not exceed 1 g/l and the composition of the salts is quite suitable for irrigation. The most pronounced in this regard is the Ferghana Valley. In this region in the areas with wedging out water, an intensive abstraction of fresh water for improvement of state of land can be observed. Across from the wedge-out zone of the Ferghana Valley, at the moment, there are about 1000 vertical drainage wells with a production rate of 60 to 100 l/s; each borehole pumps from 0.1 to 0.3 million m^3 of drainage water with salinity not exceeding 1.0 g/l. In general, all the wells of the wedge-out area the volume of pumped water is from 171 to 300 million m^3 per year. Considering that around 5.5 billion m^3 of collector and drainage water is formed in the Ferghana Valley, drainage water in the wedge-out area is around 5% of the volume that can be used without any additional costs for irrigation.

There are many opportunities for capacity development to improve the efficiency of water use in agriculture, with demonstrated advantages[91]

Source: Information provided by ICWC-SIC

It is important to search for solutions to improve the efficiency of irrigation water use for crops. These solutions should involve careful planning and management of the water resources at the farm level. However, an evaluation of the feasibility of using more sophisticated methods of irrigation is needed, such as drip, sprinkler and subsurface irrigation. These methods should be assessed for their feasibility in the natural and economic conditions and with the compositions of crops where the effect of water saving can be expressed most significantly.

Water use issues that should be addressed:

- Need for a reasonable system of planning water distribution and use at the WUA level - the farmer
- Need to clarify the hydromodule zoning and agricultural water consumption norms by the crops
- Optimization of reclamation regimes on the background of the real state of drainage and irrigation techniques
- Development of agricultural practices that enhance soil fertility
- Introduction of advanced irrigation methods
- Improvement of the water users economic incentives to save water - transition from a per hectare payment for water services to services paid for on the basis of the volume of water supplied.

It is necessary to consider that water saving is not only a technological process, but largely institutional, inextricably linked with the further spread of the principles of IWRM.

The application of tariffs and collection of fees can provide adequate funds to invest in the construction and repair of water supply infrastructure. All Syr Darya countries struggle with water infrastructure that is generally in bad condition. There are various costs related to water supply and sanitation infrastructure that the utilities need to cover including operation, maintenance, repair, capital costs and network extension. With proper planning, fees and tariffs could directly contribute to covering these costs. For instance, collected fees could be reinvested in wastewater collection and treatment infrastructure.

Opportunities exist to implement water tariff reforms that ensure water utilities can collect funds to cover the costs of repairs and maintenance, at the same time ensuring the water needs of the poorest communities are met. While this is an important aspect in terms of providing safe drinking water to the population as well as making sure that this water is treated after use, it may be even more important from a nexus perspective to initiate or increase payment for water in irrigation. In this sense, Kazakhstan is a good example of advancing this balanced nexus perspective with the implementation of volumetric tariffs and differentiation of tariffs in different oblasts according to water scarcity levels.

[91] The advantages are shown, for example, in the “Implementation Plan of the main directions of strengthening of ICWC activity" - paragraph 1.2 (ICWC meeting protocol No 63 from 18.04.2014) - "Systematizing the conservation practices based on the experience of countries and previous design studies" (SIC ICWC).

Economic instruments for Kyrgyzstan's water sector by the OECD

Key recommendations of a water sector reform proposed by the OECD in Kyrgyzstan consist of a gradual introduction or improvement of surface water abstraction charges (including for non-consumptive uses) and environmental pollution fees and tariffs for irrigation water and urban water supply. These interventions should be implemented with care and consideration of social implications. Water use reforms are essentially directed towards a separation of fixed fees (such as a connection fee) and variable fees (such as volumetric) to allow the water supply utilities to cover not only operation and maintenance costs but also structural ones. Although the suggested reforms would be gradual, it can be recommended that the first steps towards their implementation should take place soon.[92] Further, developing incentives for water users to economise water is crucial. For example, by metering systems, users are informed about how much water they are actually using, empowering them to make an effort to reduce consumption to reduce the water bill.[93]

As with energy efficiency, there are a large array of effective policies and measures to support efficient supply and use of water. These are feasible, strongly in national interest and require political will to create the needed enabling environment. Looking at such policies through a nexus lens, they inadvertently result in cross-sector, transboundary impacts that benefit the region. Efficient water management reduces energy demand for pumping and conveyance as well as the impacts on the environment. Ultimately, improving water efficiency and reducing losses allows the governments to allocate more water to uses that have higher value for the economy as well as to ecosystems.

Finally, it should be noted that energy and water efficiency are tightly interrelated. Often, investing in improving one of the two positively affects the other. For example, reducing water use can reduce the need of energy for pumping; reducing energy demand then decreases the need for hydropower production, resulting in water savings in winter that can be utilized later for summer uses.

The potential for application and extension of sustainable land management practices which integrate land, water, biodiversity, and environmental concerns is important to explore. Such practices include conservation agriculture, certified organic farming, water conservation and runoff control, salinity control, nutrient management, restoration of rangelands, grazing management and livestock protection. **[Information from national experts and administrations about examples from the basin or information about the extent to which these are used currently would be welcome.]**

Summary

There are strong indications that improving economics and productivity at a purely national level would alleviate energy-water-agriculture-ecosystem stress. For this reason it is important that the right policies are embraced. By improving energy efficiency, transmission losses and the deployment of renewables upstream 30-40% of winter generation requirements could be reduced in upstream countries. Added to this, potential summer irrigation savings in downstream could conservatively reach 20%. Even if these actions are uncoordinated, both have the potential to ensure that summer irrigation demand is met and winter hydro-generation is reduced, with potential overflows available for ecosystems. All of the suggested possible actions result in clear national gain. In the case of energy and water efficiency, more is produced with lower inputs. In the case of increased RET deployment, potential GHG emissions are mitigated. Additionally, in all of these cases there is the potential to access international financing.

[92] OECD, Facilitating the reform of economic instruments for water resources management on Kyrgyzstan (2014).(NOT YET AVAILABLE ONLINE)

[93] Europe Aid, Water Governance in Central Asia. Annex 3 to the Draft Final Technical Report. (2010).

To reach this potential enabling environments are required that allow for effective deployment of appropriate policies and measures (PAMs).

These are required at least at five levels:

- Building national planning capacity and strength of implementing institutions
- Developing sound data, metering and monitoring capacity
- Instituting efficient and appropriate cost recovery measures, while allowing support for pro-poor tariffs
- Providing incentives for improved end-user efficiency
- Providing an enabling and investor friendly environment for domestic and international investment.

In many ways, strong national capacity will help lay the foundation for mutually beneficial cooperation that ensures equitable outcomes that can be achieved.

These nationally focused actions will improve domestic control, economics and productivity and reduce water demand during critical times (for generation in winter and irrigation in summer). **Regional cooperation holds the potential to accelerate growth throughout the region.**

B. Solutions that focus on broader sustainable development and national policy coherence

The next set of opportunities would support more forward looking development at the national level while having stronger development co-benefits in riparian countries. They revolve around implementing consistent environmental legislation, cross-sector coherence of national policies, as well as climate proofing development. The net effect is more resilient national development, with greater efficiencies and greater ‘overflows’ to service ecosystems. As with the first set of policies these are primarily inward focused, supporting national growth with little explicit consideration for the development of co-riparians.

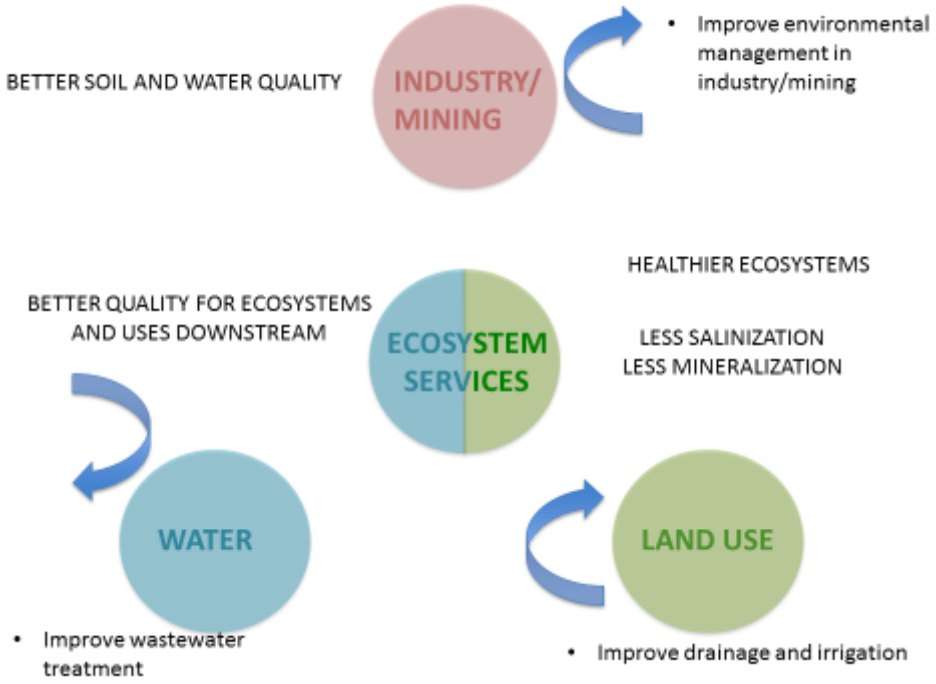


Figure 5 Possible actions to reduce trade-offs related to water quality

1. Reinforcing environmental legislation and integrating environmental considerations into sectoral policies and management practices

In the industrial sector, legislation is needed to limit pollution of water and soil, and to find solutions to the containment of old mining sites. In the water (communal) sector, improving wastewater treatment will mean better quality of water discharged as well as, as previously mentioned, an opportunity to reuse the runoff in agriculture. Finally, legislation is needed in agriculture, to enforce the improvement of irrigation and drainage systems, thus reducing salinization with clear benefits for the agricultural sector itself.

A national benefit would be:

- Increase sustainability and long-term profitability of economic activities by relying on clean water and soil (e.g. agriculture, fishery, tourism, etc.).

A transboundary benefit would be:

- Increase quality of water downstream allowing for direct uses and restoration of ecosystems.

Due to their mandates covering different economic sectors in addition to their duties related to environmental protection, the local authorities would be in a prime position to integrate the work of different sectors. However, an overview and general direction in resource management needs to be provided from higher levels of administration, with consistent oversight and direction from the national policy level.

Modernising legislation and policies to better integrate environmental considerations as well as promoting investments in environmental protection would help to move towards more sustainable economic development. Limiting pollution has direct public health benefits because it reduces the risks associated to contaminated water. For the utilities, limiting pollution from the users reduces the need of wastewater treatment and indirectly the need to treat water from the source for water supply. In terms of economic value, it also

increases the value of the environmental assets. Private properties, agriculture and tourism are examples of sectors that would directly benefit from a cleaner environment. Better water quality can reduce problems when using water in irrigation, especially when using more sophisticated systems like drip irrigation, which requires good quality water. Finally, limiting pollution would reduce negative transboundary effects leading to less water-related health impact downstream, decreased environmental degradation (e.g. soil and water quality), and long term benefits for agricultural production, fisheries and other water intensive industries.

Combating salinization of soil and water – currently a major threat to agricultural sustainability in the basin – will be challenging because it will require investing in the modernization of existing large scale drainage and irrigation infrastructure, as well as the restoration of salinized soils. During the workshop, the participants highlighted concerns related to funding opportunities for such large investments from international banks, because governments with tight budgets are reluctant to engage in long term loans and local users may run into difficulties in pay-back. International aid, foreign investments, public private partnerships as well as newly designed loan schemes could play a positive role. In this respect, the experience of Uzbekistan is remarkable. In accordance with the decree of the President of the Republic of Uzbekistan in 2007 the Fund for reclamation of the irrigated lands was created at the Ministry of Finance. The state program was implemented in 2008 - 2014 with a total budget of USD 672 million. For its realization state leasing company "Uzmeliomashlizing" and 49 State unitary enterprises were created.

Resource efficiency and environmental protection should be better integrated into sectoral policies. Even though benefits of such activities may not be felt in the short term, degrading natural environment and ecosystem services compromise their long term availability and usability, and the costs of inaction could be significant. The clearest example of long term economic and social impact of environmental degradation is given by the Aral Sea catastrophe itself. This disaster has led to the destruction of entire livelihoods and local economies with resulting social and health issues on the top of the list of the national security issues for Kazakhstan in the Syr Darya basin.

Before independence, autonomy in the development of rules of national water law of the republics of Central Asia - in the Syr Darya basin was possible under the relevant legislation of the USSR. Thus, according to the "Fundamentals of Water Legislation of the USSR and Union Republics" (1971), Developed in the early 1970s the Water Codes (of the Kazakh SSR, the Kirghiz SSR, Tajik SSR, Uzbek SSR) were virtually identical in format and content standards and were in force in parts not contradicting the legislation of the newly independent Central Asian republics, before taking national legislative acts in the field of water relations[94]

In the countries of Central Asia during the 1993–2005 the following were adopted:

(a) The Water Code of the Republic of Kazakhstan (1993, 2003);

(b) The Water Code of the Republic of Tajikistan (1993, 2000);

[94] Основы водного законодательства Союза ССР и союзных республик. Приняты Верховным Советом СССР 10 дек. 1970 ***Principles of water legislation of USSR and the Republics*** ("Ведомости Верховного Совета СССР", 1970, № 50, ст. 566), введён в действие с 1 сент. 1971. Изменения и дополнения - 7 янв. 1980 ("Ведомости Верховного Совета СССР", 1980, № 3, ст. 43) - Сельскохозяйственный энциклопедический словарь - М.: Советская энциклопедия, 1989 Гл. редактор: Месяц В.К. / Словари и эн-циклопедии на Академике // http://agricultural_dictionary.academic.ru/3741/ОСНОВЫ_ВОДНОГО_ЗАКОНОДАТЕЛЬСТВА_СОЮЗА_ССР_И_СОЮЗНЫХ_РЕСПУБЛИК

(c) Law of the Kyrgyz Republic "On Water" (1994, 2005);

(d) The law of the Republic of Uzbekistan "On Water and Water Use" (1993).

2. Increasing policy coherence and coordination across sectors

Coordination across sectors, as opposed to isolated sectoral planning, can result in far more efficient policy. Actions in one sector effect actions in another. By harmonising actions, the benefit-to-cost ratio can be greatly improved.

National benefits would include:

- Lower development 'cost'
- Greater development 'impacts'
- Greater direct and indirect resource (water, energy, environmental) management.

A transboundary benefit would be:

- Higher water and energy efficiency frees up excesses for trade, or other uses such as for ecosystems.

The degree to which intersectional coordination is reflected in sectoral regulation is relatively low in all riparian states of Syr Darya. Institutional coherence could be improved on all levels of management: central, basin and local levels, as well as in main aspects of management, like separation of regulatory and operational functions, control over water quantity and quality, management of surface and ground waters, etc. In recent years, several intersectoral bodies have been established for coordination related to cross-cutting themes, for example in Kyrgyzstan, the National Council on Sustainable Development (2012) and the Coordinating Commission on Climate Change. In Kyrgyzstan the National Water Council chaired by the Prime Minister could be a potentially important mechanism to coordinate water policy development and implementation across sectors. While such effort to coordinate policy between ministries is laudable, establishing and making high-level structures operating regularly has turned out challenging.

At the national level in the Syr Darya Basin countries, the fact that water management at ministry level is in the same ministry with either agriculture or energy, in principle opens the possibility to co-optimize and develop synergies in the management of related resources. However, functioning structures or arrangements for effective coordination and consultation with other ministries responsible for other nexus resource uses (land, energy and environment) would be important to ensure.

Concrete opportunities exist for improving performance across sectors. For example, reducing water in agriculture can effect broader changes, freeing up water for other uses. Consider the impact of crop diversification and a shift to less thirsty crops, organic farming and modernized, more efficient irrigation technologies that are already being promoted in the basin (e.g. in Kazakhstan and Uzbekistan). An example (that has shortfalls, but is none the less illustrative)[95] is a shift from cotton towards wheat production. Central Asia is noted to have significantly reduced overall irrigation water requirements. Cotton requires 10 000–12 000 m^3/ha, with virtually all water coming from irrigation. Winter wheat is irrigated four to six times during the growing season (October–June) and consumes approximately 8 000–9 000 m^3/ha. However, only about 60% is delivered by irrigation, with the rest supplied by rainfall.[96,97] However, some areas like the vast steppes of Kazakhstan are well suited for

[95] While this demonstrates the potential for water reductions, it is not necessarily an optimal example. Depending on rainfall, wheat need not be produced on irrigated land and can thus be imported

[96] Hammons Murray-Rust and others," Water Productivity in the Syr-Darya River Basin". (Colombo,

rain-fed wheat production without major infrastructure. Reduced irrigation results in lower energy demands. Reduced water use results in lower dependence and more water available for other purposes. Uzbekistan has implemented large-scale measures to increase production for the saturation of the domestic market of food products. During the years 1990-2013 the area used for vegetable crops increased by more than 140%, potatoes by almost 170%. In the last seven years the volume of fruit and vegetable production doubled.

3. Climate-proofing national development

Development can be stalled by changes in external factors, such as climate change. Drying is predicted for the region, and water threads through development at many levels. Ensuring that development continues through dry periods implies a move toward even greater levels of water efficiency and lowering water dependency. As a result, this would free up strategic volumes of excess water for other purposes during non-dry periods that might be used to re-charge ecosystems during 'normal' or 'wet' years.

National benefits would include:

- Resilience to climate shocks
- Reduced impacts of drought
- Reduced impacts of hydro-power shortages
- Reduced impacts of thermal power shutdowns due to cooling water shortages.

A regional benefit would be:

- Diversification away from water intense usage frees up strategic volumes of excess water available for other uses, including recharging ecosystems.

Climate change is expected to further limit water resources in the basin. Adaptation measures will be needed to reduce negative impacts on the economy and society. These measures will be heavily required in the water and energy sectors.

Not accounting for climate change impacts can result in strong re-enforcements of dangerous cycles. Lower water levels can result in lower hydro-generation and less water for cooling thermal power plants, resulting in less available energy. However, more energy is required as groundwater may need to be pumped to fill irrigation shortfalls. Even lower levels of water availability result in greater environmental impacts and land degradation. For various reasons in the region, food-shortages have led to hunger, and energy shortages to freezing conditions in homes. Such types of events may repeat due to a combination of poor regional cooperation and successive dry years.

In response to these challenges, efforts to reduce dependence on water at the national level can be developed. These efforts need to be analysed and cost-benefits derived. Proposed actions would include, amongst others, the use of measures described previously (greater efficiency, policy coherence etc.). However, they would be implemented at a deeper level. This would result in even greater water efficiency and the creation of limited 'buffer' flows of water. Those flows would in turn potentially be available to re-charge ecosystems.

IWMI, 2003) Available from http://www.iwmi.cgiar.org/Publications/IWMI_Research_Reports/PDF/Pub067/Report67.pdf.

[97] Karen Franken, ed. "Irrigation in Central Asia in Figures. AQUASTAT Survey 2012", in *FAO Water Reports 39*. (Rome, FAO, 2012b) Available from http://www.fao.org/docrep/018/i3289e/i3289e.pdf.

As such actions would be undertaken at the national level, they would involve developing scenarios to simulate the potential behaviour of upstream countries, inter-related sectors and other uncertainties. Such approaches are increasingly being undertaken.

Analytical approaches to climate proof agriculture and energy are available and resulting in actionable policy. For example, in recent work on development in Africa, a World Bank led analysis 'finds that failure to integrate climate change in the planning and design of power and water infrastructure could entail, in scenarios of drying climate conditions, losses of hydropower revenues between 5% and 60% (depending on the basin); and increases in consumer expenditure for energy up to 3 times the corresponding baseline values. In in wet climate scenarios, business-as-usual infrastructure development could lead to foregone revenues in the range of 15% to 130% of the baseline, to the extent that the larger volume of precipitation is not used to expand the production of hydropower.
Despite the large uncertainty on whether drier or wetter conditions will prevail in the future in Africa, the [analysis] finds that by modifying existing investment plans to explicitly handle the risk of large climate swings, can cut in half or more the cost that would accrue by building infrastructure on the basis of the climate of the past.'[98]

Climate change will accelerate the melting of glaciers, bringing an expected impact onf the occurrence of natural disasters such as avalanches and land-slides. The hydro-geological risk needs to be carefully assessed in the mountains of Kyrgyzstan as well as Tajikistan. Due to its encroaching impacts, policy relevant climate related research should be promoted. Examples include capacity building, sub-regional cooperation on dam safety and risk reduction as promoted by various regional and international organisations, such as UNECE, EC-IFAS, UNDP and UNEP.

Various international funding sources for adaptation to climate change can support efforts towards improving water use efficiency. Furthermore, with effective inter-agency/inter-ministry coordination, governments can negotiate support from development institutions and donors for example for energy efficiency projects as Nationally Appropriate Mitigation Actions (NAMAs).

C. Solutions that accelerate national development by furthering cooperation

The above measures help ensure that national development takes place within the potential constraints of limited regional integration. There are strong gains to be made at national and regional level with an increase in cooperation amongst riparian countries. These gains can be appreciated in areas of economic, social and environmental, regional economic integration and peace and security.[99] Cooperation begins with simple data sharing and moves on to facilitating regional trade.

1. Improving communication, information and knowledge sharing as well as joint monitoring

As water resources are shared and impact all riparian countries, all of the aforementioned actions would benefit from better access to shared consistent data. This would help each

[98] Raffaello Cervigni, Enhancing Clim. Resil. Afr. Infrastruct. Power Water Sect. (FEEM, 2015) Available from http://www.feem.it/getpage.aspx?id=7171&sez=Events&padre=82.

[99] ECE, Policy guidance note on identifying, assessing and communicating the benefits of transboundary water cooperation. Document ECE/MP.WAT/WG.1/2015/4 contains a draft of the policy guidance, which will be reviewed by the Working Group on Integrated Water Resources Management at its tenth meeting. The document is available from http://www.unece.org/env/water/10th_wgiwrm_2015.html#/

country understand better the current water availability and to predict future availability for its national planning.

National benefits would include:

- Better forecasting would allow for better planning of water uses
- Better control over shared resources
- More informed governance of water and environmental sectors.

Transboundary benefits would include:

- Better planning within each country means less uncoordinated responses to hazards that would have a transboundary impact (e.g. sudden change in reservoir operation, accidental pollution etc.)
- Established network of human and technical resources to monitor, control, plan transboundary activities.

A good monitoring and forecasting system is necessary to ensure resilience of energy production and agricultural activities. This will include access to weather data with relevant weather and climate predictions at the appropriate levels. In accordance with the decision of the sixty-fourth meeting of ICWC in April 2014, a concept of the formation of a network for information exchange on water issues in Central Asia is being agreed upon. In the preparation of the concept, materials of the working meetings and consultations of plenipotentiary representatives of States and of ICWC and IFAS were used. The concept is a recommendation, based on a statement of available information convergence in Central Asia, and is a system of agreed views on the goals and priorities in the areas of cooperation under the aegis of ICWC and IFAS in the development of inter-state information exchange on water issues and related aspects.

GWP CACENA and the World Bank are promoting a number of tools that are open and accessible, including the AralDIF mathematical modelling tools, ASBmm (ICWC-SIC), and BEAM model (developed by COWI and DHI, and further elaborated with the support of the World Bank), which can be useful for quantifying the effects of changing resource uses and policies to inform integrated, transboundary planning. Such data should not only include information on monthly quantities, but also on quality.

Specific suggestions from the project Water Quality in Central Asia report (UNECE and the Regional Environmental Centre for Central Asia, 2009-2012) suggest the following long-term objectives, which still hold strong traction today:

1. Exchange of information and where possible improvement/harmonization of the systems of water quality management
2. Coordination of monitoring of the water quality of regional transboundary watercourses and the regular exchange of data among the countries
3. Improvement of the legal basis for regional cooperation in water quality regulation, and the establishment of an efficient regional expert body

Sharing experiences and building knowledge on ‘good practices’ of water management can help to improve water management in each of the countries. This could happen both at local level (communities sharing transboundary waters) or at national level (water sector as a whole).[100] Existing similarities between the Syr Darya countries in the legal and institutional basis might be a useful starting point. These are derived partly from the states’

[100] ECE, Counting our gains. Policy guidance note on identifying, assessing and communicating the benefits of transboundary water cooperation. Second draft. (ECE, 2014c).

common legal heritage from the Soviet period. Obviously, success of a particular policy or practice in one country does not guarantee success in another and the specificity of settings requires adaptation.

Knowledge transfer and training could play a major role in disseminating solutions across countries. Central Asia Regional Economic Cooperation (CAREC), SIC-ICWC and other organizations already provide international platforms for energy efficiency, reduction of carbon emission and the cooperation of researchers and teachers. Training future generations in dealing with environmental issues relevant to the Syr Darya Basin would prevent a lack of prepared professionals who will be needed to continue to address future challenges. The same could be said for agricultural training and extension services, especially with regards with water saving technologies and adaptation measures. Sharing knowledge and lessons learned can avoid duplicating failures. Increasing public awareness about resource scarcity could, over time, change behaviours to become more sustainable.

2. Facilitating trade for energy and agricultural products among the Syr Darya riparian countries

National benefits would include:

- New opportunities for economic cooperation and growth
- Economic benefits for import and export countries
- Avoiding high cost production in locations that are sub-optimal
- By reducing the cost of services, economic growth is accelerated
- Greater resilience.

A transboundary benefit would be:

- The potential to move towards optimal allocation of resources, including water energy and environmental assets.

In this section we focus on agriculture and energy.

Following independence, new barriers for the importation and exportation of goods were introduced across the region. These should be addressed.

Recently the UNECE identified important non-tariff barriers (NTBs) in Kazakhstan and Tajikistan. Apart from technical barriers (poor road networks, lack of appropriate storage, limited transmission systems) certain barriers reflect the lack of coordination and harmonization of regulations between agencies within the countries and between trading and transit countries. For example, adequate phyto-sanitary controls are necessary to limit plant diseases. However, if these are not in place in sufficient capacity, fresh food and agricultural product trade is vulnerable, leading to delays in transit.[101] Adherence to international standards and certificate systems together with harmonized regimes facilitate trade, however capacity is limited. Kazakhstan's challenges are a case in point, where such issues as limitations of the validity of conformity certificates, as well as outdated facilities and testing methods of laboratories have emerged. These issues undermine the ability of Kazakhstan to cover requirements related to the framework of the Customs Union.[102]

[101] ECE, "Regulatory and Procedural Barriers to Trade in the Republic of Tajikistan: Needs Assessment". (ECE, 2014) Available from http://www.unece.org/tradewelcome/studies-on-procedural-and-regulatory-barriers-to-trade.html

[102] ECE, "Regulatory and procedural barriers to trade in Kazakhstan". (ECE, 2014) Available from http://www.unece.org/tradewelcome/studies-on-procedural-and-regulatory-barriers-to-trade.html.

Development of trade facilitation or Free Trade Agreements as well as deepening and expanding the basis for trade for agricultural products would benefit all the Syr Darya countries. The first step to promote trade would be removing existing regulatory and procedural barriers. Trade would allow the countries to make the best of their domestic assets. For example, crop selection at country level could be more sensible with regards to climatic conditions and water availability.[103] In Tajikistan this would stimulate an increased production of vegetables, fresh and dried fruits, and non-perishables produce, which enjoy a significant demand from Uzbekistan.[104] Hydropower production in Kyrgyzstan could be optimized avoiding the economic losses of surplus production of electricity in summer and a deficit of energy in the winter.

Agricultural trade also has the potential to reduce negative transboundary impact and help strengthening trust between the countries. Trade facilitation in a broader regional market would stimulate business across countries and in turn regional economic growth, increasing the region's leverage to benefit from trade with external players (e.g. China). Crop selection according to climatic conditions is also, indirectly, a good example to illustrate this benefit because cultivating crops in unsuitable soils often implies using more water and other agricultural inputs, affecting water availability and quality.

Improving food trade and food access could also bring significant benefits to the local population and the economy. Kazakhstan, and recently Uzbekistan, is a leading exporter of cereals in the region, while cereals produced in Kyrgyzstan and Tajikistan are often of too low quality for local consumption.[105] [Are there examples of food production from the Syr Darya countries that has got notable export potential?] For creating jobs and value within the country, developing processing industry based on agricultural production provides advantages, as the opportunity of producing textiles from cotton in the case of Uzbekistan demonstrates.

A whole variety of factors determine access to food, including poverty/income levels, production capacity of agriculture, presence or lack of appropriate infrastructures and international relations. Local populations, especially in the Syr Darya riparian countries, have a restricted access to marketed goods (due to distances from trading routes).[106] Further, poor packaging, conservation and long transport times limit trade (NDP meeting). Access to markets by farmers would be improved by investments in infrastructure and equipment.

Energy between countries and throughout the region has great potential for revenue generation and providing an alternative energy source. However at present trade is limited. Internal issues will need to be addressed first, including developing an enabling environment and improving national coverage and efficiency of grids.[107] Next connections and harmonization between riparians are needed if trade is to be supported. Finally

[103] World Bank, "Adapting to Climate Change in Europe and Central Asia", (Washington D.C., 2009) Available from http://www.worldbank.org/eca/climate/ECA_CCA_Full_Report.pdf

[104] ECE, "Regulatory and procedural barriers to trade in Kazakhstan". (ECE, 2014b) Available from http://www.unece.org/tradewelcome/studies-on-procedural-and-regulatory-barriers-to-trade.html.

[105] FAO, National Aquaculture Sector Overview. Uzbekistan. National Aquaculture Sector Overview Fact Sheets. Text by Karimov, B.K. In: *FAO Fisheries and Aquaculture Department* [online]. (Rome, 11 October 2011) Cited 25 March 2015. Available from

[106] FAO, National Aquaculture Sector Overview. Uzbekistan. National Aquaculture Sector Overview Fact Sheets. Text by Karimov, B.K. In: *FAO Fisheries and Aquaculture Department* [online]. (Rome, 11 October 2011) Cited 25 March 2015. Available from http://www.fao.org/fishery/countrysector/naso_uzbekistan/en.

[107] These items are addressed in solution 1.

connections with other regions would facilitate full utilization of energy resources and export revenue potential.

Selected concrete steps to be addressed in the energy sector include, amongst others:

- Investment in transmission and trade related infrastructure
- Addressing high wear and tear of existing equipment
- Development of joint forecasts of trade and growth in the energy sector.

Note that many steps (highlighted in solutions presented earlier) including building an investor friendly enabling environment, rational tariffs, and improved efficiency are strongly supported by the states.

3. Capacity building for the transition to the optimal allocation of resources, including principal water resources, energy and ecology

Building on clear data, efficient integrated resource management, monitoring and measuring, the potential for an array of market based and flexible agreements can be established.

National benefits would include:

- Countries experience freedom to develop
- Lower cost sources of food and energy
- Increased export revenues.

A transboundary benefit would be:

- Movement towards optimized use of resources, lowering impacts of development on resource systems.

At present there are strong but unquantified economic drivers for scheduling hydropower generation in upstream countries in summer. This can result in releases of water when they are needed for irrigation. There are also potential alternatives to using hydropower in winter if low cost energy supplies can be reliably imported at that time, reducing the need for winter generation. Additionally, there is potential for summer sales of hydroelectricity if national demand is limited, but grids allow for electricity trade within the region or beyond.

If the afore-mentioned options are implemented (from data through to transport and market development) there is the potential to evaluate these economic drivers. In turn, this will allow the evaluation of the services brought about by actions such as hydropower rescheduling. Enabling a functioning market to operate would allow for nuanced and flexible solutions to cooperation that maximise the benefits for all.

The value of summer hydro production may increase if export opportunities to regions with high summer demand are facilitated. With information sharing, markets and signals could respond to coming shocks, such as dry years. Each of these would inform a willingness to pay for services and security of supply. By adopting strong market principles that mitigate against the abuse of market power, a creative and efficient set of agreements and infrastructure investments would be facilitated.

Finally, the nexus assessment of the Syr Darya highlighted the need to consider the basin in its whole extension, from the glaciers of Tien-Shan to the Aral Sea. Environmental flows, already dramatically disturbed by human activities, are needed to sustain the livelihoods of entire populations and the habitats of a wide range of important ecosystems.

Matrix of the proposed solutions (opportunities) for the Syr Darya River Basin

Problem	**Target, needing a solution**	**Proposed Solution**	**Benefits**	
			Basin/transboundary	National
The ineffectiveness of cooperation on management of water resources of the basin countries to meet the quantity and quality of water and its protection	To improve the effectiveness of cooperation by linking water to food, energy and ecosystems	**<u>Solutions that focus on national development with unintended co-benefits:</u>** Improving energy efficiency and reducing dependency on water for energy production. Rationalizing water use (in particular in the agricultural sector)	Reduced imbalance of shared water resources and needs , hence more water available for different uses, including by ecosystems Increased stability and evenness of water supply downstream including to ecosystems Improved agricultural production and sustainability of irrigation; Reduced land degradation Higher efficiency of water and energy use releases certain amount for development	Financial savings from lower energy use Increased resilience to water shortages in dry years (particularly important if considering climate change); Reduced running costs; Increased export potential/reduced import requirements and potential for international investments
		<u>Solutions that focus on broader sustainable development and national policy coherence</u>: Reinforcing environmental legislation and integrating environmental considerations into policies and practices of all sectors of the economy Adapting national development to the climate change	Increase quality of water downstream that allow for direct uses and restoration of ecosystems	Increase sustainability and long-term profitability of economic activities relying on clean water (e.g. agriculture, fishery, tourism etc) Less unexpected expenses, bigger effects of development Resilience to climate shocks, reduced impacts of drought, reduced impacts of hydro-power shortages, reduced impacts of shortages

				of water and energy resources
		Solutions that accelerate national development by furthering cooperation: Improving communication, information and knowledge sharing as well as joint monitoring Facilitating trade for energy and agricultural products among the riparian countries Capacity building (human and technical)	Better planning within each country means less uncoordinated responses to hazards that would have a transboundary impact (e.g. sudden change in reservoir operation, accidental pollution etc.); Potential to move towards optimal allocation of resources, including the main water energy and environmental assets Movement towards optimized use of resources, lowering impacts of development on resource systems (green development).	Better forecasting would allow for better planning of water uses, better control over shared resources, more informed governance of water and environmental sectors New opportunities for economic cooperation and growth Economic benefits for import and export countries Avoiding high cost production in locations that are sub-optimal reduced costs of services Greater resilience towards the external factors Countries experience freedom to develop

IX. Preliminary conclusions

The nexus assessment of the Syr Darya basin, including both technical and governance analysis, highlighted a number of challenges related to natural resources and environment degradation. These are related on one hand to energy and food security and socio-economic development, especially in rural areas, on the other they address the need to ensure long-term sustainability and resilience of economic activities to changing climate and other external factors including the global financial crises or energy and food price fluctuations. Poverty levels are still high in Kyrgyzstan and Tajikistan as well as in rural areas of Uzbekistan and Kazakhstan, and energy and food insecurity have recently caused humanitarian emergencies in Kyrgyzstan and Tajikistan. Significant shares of the basin population lack access to affordable energy and food as well as safe water and sanitation. Alarming environmental degradation is ongoing, in particular with regards to the drying up of the Aral Sea Basin and soil salinization in agricultural areas.

Cooperation between countries has decreased since their independence from the Soviet Union in 1991. Initially, the understanding of the benefits of an established water governance structure at basin level and the high levels of trade between the countries lead to a number of efforts to develop cooperation. The establishment of the Interstate Commission for Water Coordination of Central Asia (ICWC), later IFAS and other regional structures are examples of important achievements. However, a series of missed opportunities of cooperative solutions, in particular on energy exchanges and water discharges, led the countries to act independently and without coordination to ensure economic growth and resource security. This not only caused transboundary tensions, but also aggravated the exposure of each country to external shocks.

The aim of the nexus assessment of the basin is to analyse challenges and trade-offs related to the multiple uses of common resources, to uncover opportunities using a holistic (nexus) approach and to propose solutions building on cooperation between sectors and countries. This approach aims to improve mutual understanding between sectors by jointly discussing regional, national and local development and what can be done at sectoral and intersectoral level to reduce negative impacts and achieve positive synergies.

Sectoral activities may influence each other by limiting the availability and/or affecting the quality of common resources. As expected for a river basin, the interlinkages identified can be grouped into water quantity and water quality issues. With regard to water quantity interlinkages and trade-offs between the agricultural sector, the energy-hydropower sector and the environmental protection sector are important. Energy security, food security and rural development are the main drivers that lead to high seasonal difference as to demands of water and to the tension between a demand for energy production upstream in the winter and a demand for irrigation water downstream in the summer. The second group of interlinkages includes the negative impacts of various human activities on water quality and also on soil quality, and their direct and indirect effects on other uses of the polluted resources, such as health issues and reduced agricultural productivity. A weak regulatory framework and a lack of incentives to rationalize uses and limit pollution are the main drivers to environmental degradation and its intersectoral effects.

The analysis of future trends, based largely on national priorities and policy directions, regional trends and climate change, indicates that in the future environmental and social challenges will become increasingly urgent . However, clear complementarities between countries and existing opportunities to achieve a more sustainable resource use and to stimulate growth suggest that by taking appropriate action the future outlook could be greatly improved. As an example, land and soil degradation as well as climate change are expected to reduce agricultural yield but trade of agricultural products including between the countries would make it possible to cover the demand for food and feed products (such as rice and wheat) while taking into account the natural climatic conditions.

Presently, the riparian countries find themselves in a vicious cycle, in which solutions based on self-sufficiency lead to negative effects on co-riparians, additional loss of trust and decreasing opportunities for development of cooperation. Uncoordinated national policies risk pushing countries further away from each other and while undermining opportunities to optimize resource use and maximize benefits. Transboundary relations and confidence in cooperation could and should be developed step by step, paying attention to actions that, while benefitting national economic development, also decrease pressures on shared natural resources, increase efficiency of sectors and strengthen economic ties between the countries.

The opportunities identified during the nexus assessment have been divided into three categories:

- Solutions that focus on national development with unintended co-benefits

- Solutions that focus on broader sustainable development and national policy coherence
- Solutions that accelerate national development by furthering cooperation

An overview of the opportunities and possible related actions is given in the table below.

A. Solutions that focus on national development with unintended co-benefits
1. Improving energy efficiency and reducing dependency on water for energy production.
• Energy efficiency determines: - Technical and economic potential for reductions by end use sector, by use, by technology (i.e. % reduction in electrical household heating by introduction of building standards; exploration of the potential of heat pump introduction; further promotion of combined power and heat generation; gradual fuel switching, e.g. from coal to gas or changing from pulverized coal to coal gasification, where feasible etc. including costs). (Note that sectors include: Generation (improving power plant efficiencies); Transmission and distribution (reducing losses); • Diversifying from dependence on large hydro (winter generation) determine: - Comprehensive mapping of RET and fossil fuel resource potential including costs and import options; Technical and economic potential for integration of alternatives including: RET and fossils (i.e. % winter generation reduction potential - and cost - by deploying large scale wind use; improving energy security upstream by source diversification etc.)
2. Rationalizing water use (in particular in the agricultural sector)
• Rationalizing determines: - Technical and economic potential for reductions by water using activity, by use, by technology (i.e. % reduction in irrigation requirements for cotton growing etc. including costs). (Note that activities include: Ground water pumping; Soil flushing; Water transport; Irrigation technology and practices; extending sustainable land management practices etc.)
Common steps needed for all (A.1 and A.2) Determine: - Full mapping and suitability analysis of potential Policies and Measures PAMs (from equipment standards, to end use charges (higher electricity prices / abstraction charges / pollution fees etc.) - Data, metering, monitoring requirements - Tariff (or tax/expenditure) structure required to fund interventions and support pro-poor policies and build investor confidence - Practical improvement of “user pays”, including reduction of commercial losses in electricity provision - A more favourable climate for attracting internal and international investment into modernizing infrastructure and for improving energy and water efficiency needed by introduction of appropriate policies. Public private partnerships and well as appropriately designed loan schemes could further help to respond to the significant infrastructure upgrading need - Targeting in terms of retrofit and new investment options - Capacity building for: Policy development; Institutional operation; Investors; End-user training and support - including extension services. (i.e. from civil servant, to equipment purveyor, to end user (farmers/households etc)
B. Solutions that focus on broader sustainable development and national policy coherence
3. Reinforcing environmental legislation and integrating environmental considerations into sectoral policies and management practices - Improving wastewater treatment, containment of old mining sites, improving irrigation and drainage (including control of return waters), shifting and diversifying crops
4. Increasing policy coherence and coordination across sectors - At policy level: ensure functioning of inter-ministry structures or arrangements for coordination and consultation; clear mandates and adequate sectoral representation
1. Climate-proofing national development - with effective inter-agency/inter-ministry coordination, Governments can negotiate support from development institutions and donors for example for energy efficiency projects as Nationally Appropriate Mitigation Actions (NAMAs); international funding for adaptation to climate change can support efforts towards water use efficiency

Note that B.3 and B.4 require the following enabling actions: • Extending and strengthening inter-sector integrated planning • Establishing pathways to low water intensity development • Applying risk management techniques • Facilitating buffer water flows during 'non-dry' years • Developing integrated modelling capacity
C. Solutions that accelerate national development by furthering cooperation
6. Improving communication, information and knowledge sharing as well as joint monitoring - Transboundary Institutions: Gradual, step-by-step development of the dialogue and restoring confidence for further transboundary cooperation. Strengthen the role of regional organisations in coordinating between different uses including improving representation of different sectors - Strengthening multi-sectorality, inclusiveness and the status of political and technical cooperation on the basin level; ensure a reliable and accurate provision of flow data; assessment of water quality, proper assessment of groundwater resources etc.
7. Facilitating trade for energy and agricultural products among the Syr Darya riparian countries - Restoring the functioning of CAPS - Infrastructure requirements:; development of road networks and storage facilities; Improve connectivity of transmission lines and fuel transport/conveyance to international markets; Investment in refurbishment and extension of national, regional and inter-regional transmission and energy transport systems - Market development: Removing regulatory and procedural barriers; promote adoption of international standards and certification systems, develop related capacities (human, facilities, testing laboratories etc.); clear pricing signals / transparent pricing mechanisms - Sharing of good practices (e.g. about water management, energy and water efficiency improvements); develop training of users and specialists on topics relevant to resource use efficiency; increasing public awareness; promoting research cooperation
8. Dynamic allocation and solutions to the trans-boundary cross-sector nexus - Assessment of the value of the service that water provides to establish incentives for hydro re-scheduling
Note that these require the following enabling actions: • Providing an enabling environment to support end users changing cropping and technology patterns • Clear costing of energy and water security options for each country • Development and use of new integrated modelling tools to analyse effects of changing resource uses and policies

The suggested solutions are developed in a manner that they allow for the concurrent building of national development and mutual trust. Due to the nexus approach, type A and B actions do not require active cooperation, yet will result in clear gains for the region. Type C solutions will rapidly accelerate regional development, while limiting potential vulnerabilities and increasing potential trade revenues or development costs.