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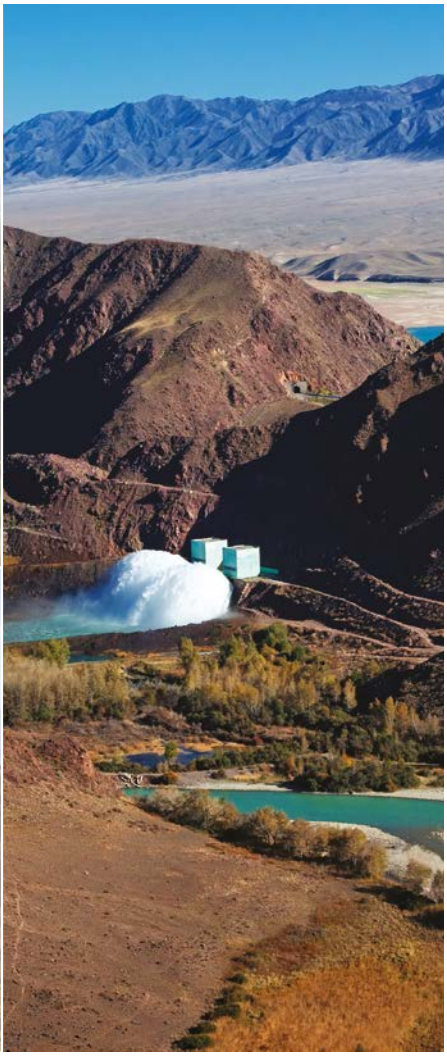
Reconciling resource uses in transboundary basins: assessment of the water-food-energy-ecosystems nexus in the Syr Darya River Basin

(shared by Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan)



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UNITED NATIONS ECONOMIC COMMISSION FOR EUROPE

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New York and Geneva, 2017

ACKNOWLEDGEMENTS

This nexus assessment could not have been prepared without the help and input of many individuals and organizations. The UNECE secretariat would like to thank the following persons who contributed to the process, including to the work at the meetings of the Task Force on the Water-Food-Energy-Ecosystems Nexus, the basin workshops and consultations, for their help in preparing the assessment. All those whom we have inadvertently forgotten, please accept our sincere apologies along with our thanks.

Mansur Abduraimov
Aigul Absametova
Dilshodbeg Ahmadov
Abbos Akhadov
Ittifok Akhmedov
Natalia Alexeeva
Shahlo Azizbayov
Joldoshbek Bajyzbekov
Tolkyn Balpikov
Ines Beernaerts
Iskander Beglov
Ruslan Devyatkulov
Nurzhamal Dosova
Abdybai Dzailoobaev
Sagit Ibatullin
Rope Imanaliev
Furkat Irmatov
Tilek Isabekov
Rahman Jalilov
Ramiz Kalbiyev
Adilkhan Karlikhanov
Daler Kholmatov
Lyudmila Kiktenko
Sharif Kuchkarov
Bekbolot Mamatairov
Maruf Mulloev
Kasiet Musabayev
Kholmakhmad Nazarov
Lydia Nikiforova
Alexander Nikolayenko
Karim Nuraliev
Teymur Osmanov
Igor Petrakov
Oleg Podolny
Tulegen Sarsembekov
Ilyashbek Sarybaev
Nurmahamad Sheraliev
Svetlana Shivareva
Almas Stamaliev
Ekaterina Strikileva
Tatyana Suchkova
Akylbek Sulaimanov
Bedoriev Sunatulo
Gulbanu Tyngyshbayeva
Jalaladdin Valiyev
Anvari Vajsiddin
Rauf Yuldashev
Dinara Ziganshina
Muslim Zhiyenbaev

Local experts who supported the assessment in the Syr Darya Basin

Serik Akhmetov, Erkin Orolbaev, Yarash Pulatov and Vadim Sokolov.

International experts

Seppo Rekolainen for charing the Task Force on the Water-Food-Energy-Ecosystems Nexus.

Mark Howells and Lucia de Strasser for their support in the development of the methodology and throughout the process.

Christian Bréthaut, Nickolai Denisov, Sebastian Hermann, Rishabh Jain, Barbara Janusz-Pawletta, Roberto Martin-Hurtado, Dimitris Mentis, Ulla Mörtberg, Farzona Mukhitdinova, Lesya Nikolayeva, Viktor Novikov, Sara Odelius, Lucie Pluschke, Eunice Ramos, Holger Rogner, Otto Simonett, Vignesh Sridharan, Stephen Stec, Constantinos Taliotis, Vladimir Volosskiy and Manuel Welsch for specific methodological and/or analytical inputs.

Design and graphics

Nick Jackson, North Creative (design and layout), Matthias Beilstein, Emmanuelle Bournay, Carolyne Daniel

Photos: Viktor Novikov, Shutterstock, ThinkstockPhotos, Fotolia

UNECE

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UNECE Environment Division and other divisions:

Mario Apostolov, Tea Aulavuo, Viktor Badaker, Marco Keiner, Vahan Kotanjyan, Bo Libert, Sergiusz Ludwiczak, Alisher Mamadzhanov, Antoine Nunes, Gianluca Sambucini, Iulia Trombitcaia, Lukasz Wyrowski.

Donors and partners

UNECE would like to thank also the following partners for their generous contribution to the nexus assessment series:

Swiss Agency for Development and Cooperation and the Swiss Federal Office for the Environment

German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety

Food and Agriculture Organization of the United Nations

Royal Institute of Technology, Stockholm

Finnish Environment Institute

Global Water Partnership

The preparation of the nexus assessment for the Syr Darya Basin was supported by the Ministry of Foreign Affairs of Finland

LIST OF COUNTRY CODES

KG	Kyrgyzstan
KZ	Kazakhstan
TJ	Tajikistan
UZ	Uzbekistan

ACRONYMS AND ABBREVIATIONS

ADB	Asian Development Bank
ALRI	Agency for Land Reclamation and Irrigation (Tajikistan)
BWO	Water Basin Organization
CAPS	Central Asian Power System
CDC	Coordinating Dispatch Centre
CEP	Committee for Environmental Protection
CIS	Commonwealth of Independent States
EBRD	European Bank for Reconstruction and Development
EC-IFAS	Executive Committee of the International Fund for Saving the Aral Sea
FAO	Food and Agriculture Organization of the United Nations
GEF	Global Environmental Facility
GWP	Global Water Partnership
INDC	Intended Nationally Determined Contributions
ICSD	Interstate Commission for Sustainable Development
IWRM	Integrated Water Resources Management
MEWR	Ministry of Energy and Water Resources (Tajikistan)
MRWR	Ministry of Land Reclamation and Water Resources
NUMP	National Utilities Modernization Programme
NWC	National Water Council (Kyrgyzstan)
NWEC	National Water and Energy Council (Tajikistan)
SDG	Sustainable Development Goal
SIC ICWC	Scientific-Information Center of the Interstate Commission for Water Coordination of Central Asia
SPECA	United Nations Special Programme for the Economies of Central Asia
UNDP	United Nations Development Programme
UNECE	United Nations Economic Commission for Europe
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
WEC	Water-Energy Council
WUA	Water Users Associations

TABLE OF CONTENTS

SUMMARY

The Syr Darya Basin, shared by Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan, represents a classic example for exploring the interlinked and often competing inter-sectoral and cross-border claims to common resources. Such claims often create sources of real or likely tensions, but also, at the same time, opportunities for optimizing the shared use of water, energy and food resources in the basin and – in a wider context – the whole of Central Asia. Centralized Soviet planning, which was predicated on the interests of the entire union – and not specifically the interests of Central Asia or its constituent countries – prioritised agricultural production, and in particular the strategic growing of cotton on newly irrigated lands. At the same time, Central Asia as a whole contained sufficient fossil fuel resources to cater for the energy needs of the republics. With independence came new challenges, and fuel and energy quickly became commodities less willingly traded for water. The changed use of upstream hydropower had consequences for water access of irrigated agriculture, the importance of which grew even further as regional trade slumped and the countries had to rely more on their own production.

The increasing inter-sectoral and upstream-downstream challenges that have developed over the past 25 years also indicate that significant benefits can be reaped from a strengthened cooperation among the different sectors and countries. The 21st century offers technological solutions such as more efficient irrigation, laser levelling of crop fields and local-scale water-efficient management, which save water so that more fibre and food can be produced with less water. Increasing overall energy efficiency in the countries and using cost-efficient alternative or complementary technology for energy production may make upstream countries less dependent on hydropower with improved access to water for agriculture downstream as a consequence. Potentially this may also improve economic performance as excess electricity could be exported to South Asia neighbours. Lowering regional barriers to food trade makes it possible to produce food where the conditions are more favourable, thus lowering pressure on agriculture in water-deficit areas – hence saving water and reducing energy use for pumping it. All this increasingly matters in the context of changes in the global climate that will undeniably put greater pressure on these sectors not only globally, but also in Central Asia and in the basin of its Syr Darya River.

The specifics of understanding and exploiting synergies in the "water-food-energy-ecosystems" nexus in the Syr Darya Basin of Central Asia are the essence of this report, which is a result of a participatory assessment process following a methodology developed under the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention). The assessment's main objectives were to foster transboundary cooperation by joint identification of inter-sectoral synergies and measures to reduce tensions; and assisting countries in their resource use optimization with an improved knowledge base and capacity. The assessment process for the Syr Darya Basin, which included a workshop for the identification of the main inter-sectoral issues and possible solutions, was detailed by a subsequent analysis that was followed by consultations with the various sectoral authorities concerned.

The report offers specific recommendations for how actions in the water, food production and energy sectors and across the state border can mutually reinforce each other – and how water, energy and agricultural practitioners, and the environment, can benefit from them by seeking trade-offs among various sectoral and country needs by seizing existing and future opportunities.

The report specifically suggests:

- improving energy efficiency, reducing dependency on water for energy (diversification of sources), and rationalizing water use (esp. in agriculture);
- developing a regional energy market and exploring opportunities for energy-water exchanges, the development of alternative energy sources and improving overall energy efficiency;
- lowering barriers to trading food and agricultural goods, thus promoting their more cost-, water- and energy-efficient production and exchange within the region;
- developing mechanisms to incorporate wider impacts in sector-based policy development, and improving inter-sectoral coordination at the basin level by increasing representation of and consultation with the relevant ministries;
- improving basin-wide monitoring, data verification and exchange, and knowledge-sharing, including joint monitoring (e.g. of water flows and quality) and joint forecasting.

Adoption of the nexus approach has the potential to improve resource use efficiency and security in the riparian countries. In contrast to national approaches presently employed, cooperation involving all the countries and sectors has significant potential to optimize the use of resources in the basin. Applying certain solutions at the country level – including, among others, improvement of efficiency in water and energy use, as well as well-targeted economic and policy instruments – can gradually build more favourable conditions for transboundary cooperation.

We hope that the assessment will be an inspiration for all those who from their sectoral perspective want to better understand and broaden the impact and benefits of their policies across sectoral boundaries and to eventually contribute to a better management of the common river basin across the borders of the Syr Darya countries. Functioning transboundary, and inter-sectoral cooperation, is a prerequisite for the efficient management of existing infrastructure and optimization of new investments and trade opportunities.

BACKGROUND TO THE NEXUS ASSESSMENT

Objectives and scope of the assessment

The Nexus Assessment of the Syr Darya River Basin aims to support policy and technical reforms, improve transboundary dialogue and cooperation among the Syr Darya countries – Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan[1] – and contribute to the sound management of water and energy resources, sustainable food production and ecosystems conservation.

The assessment is part of a broader UNECE process[2], which covers a number of international river basins with the aim of:

(a) fostering transboundary cooperation by identifying intersectoral synergies that could be further explored and utilized, and by determining policy measures and actions that could alleviate tensions or conflict related to the multiple uses of and needs for common resources;

(b) assisting countries in optimizing their use of resources, to increase efficiency and to ensure greater policy coherence and co-management;

(c) building capacity to assess and address intersectoral impacts.

The specific objectives of the assessment of the Syr Darya Basin are:

(a) to paint a picture of the status and trends of resource needs and the environmental impact of the main economic activities in the basin;

(b) 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;

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

The assessment follows on from and builds on the study *Strengthening Cooperation for Rational and Efficient Use of Water and Energy Resources in Central Asia* developed within the framework of the United Nations Special Programme for the Economies of Central Asia (SPECA) in 2004 and other studies and publications by the World Bank, the Asian Development Bank (ADB) and the United Nations Development Programme (UNDP).[3]

The scope of this Nexus Assessment is limited to providing a preliminary overview of the relevant issues, while exploring some potential solutions. This largely qualitative analysis can serve as the basis for more detailed and quantitative assessments.

Assessment process

This assessment follows the methodology developed under the UNECE Water Convention,[4] in terms of resource base, socio-economy, governance and policy directions:

(a) a desk study to review and analyse relevant documentation (resource base and resource uses, the socio-economic situation, governance and policy framework);

(b) a participatory workshop jointly organized in Almaty (Kazakhstan) on 2–4 December 2014 by UNECE and the Global Water Partnership (GWP), in close cooperation with the Food and Agriculture Organization of the United Nations (FAO). Representatives of various ministries (Natural Resources, Agriculture, Energy, Environment) from Kazakhstan, Kyrgyzstan and Tajikistan, regional organizations based in Uzbekistan, as well as NGOs and academia participated;

(c) drafting the assessment based on the findings of the desk study and the workshop, complemented with an analysis of the jointly identified issues; and

(d) consideration of inputs from local experts and officials of the Syr Darya countries provided in the framework of the meeting of the Task Force on the Water-Food-Energy-Ecosystems Nexus (Geneva, 28–29 April 2015) and the Working Group on Integrated Water Resources Management (Geneva, 24-25 June 2015), as well as consultations held in 2015 with Kazakhstan, Kyrgyzstan and Tajikistan, linked to the EU's Water Initiative National Policy Dialogues.

Assessment results[5] featured at the Seventh Meeting of the Parties to the UNECE Water Convention in November 2015.

This report takes stock of the result of the assessment process and of comments received as well as additional contributions, and further includes additional information collected in the course of 2016 in order to fill identified gaps and demonstrate the possible effects of some of the measures.

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[1] It should be noted that Uzbekistan does not associate itself with the nexus assessment of the Syr Darya.

[2] Available from: http://www.unece.org/env/water/nexus.

[3] World Bank, *Water and Energy Nexus in Central Asia, Improving Regional Cooperation in the Syr Darya Basin*, (Washington D.C., World Bank, 2004).
United States Agency for International Development, Central Asia Natural Resources Management Program, in *Transboundary Water and Energy Project. Final Report*, (Washington D.C., USAID, 2005).
Asian Development Bank project *Improvement of Shared Water Resources Management in Central Asia* (RETA 6163).
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, 2011).

[4] United Nations Economic Commission for Europe. *Methodology for assessing the water-food-energy-ecosystems nexus in transboundary basins*. Document ECE/MP.WAT/WG.1/2015/8, (Geneva, UNECE, 2015).

[5] United Nations Economic Commission for Europe. *Reconciling resource uses in transboundary basins: assessment of the water-food-energy-ecosystems nexus*. (New York and Geneva, United Nations, 2015).

CHAPTER 1

Introduction

The Syr Darya Basin is an example of a river basin in which 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 SPECA approach on strengthening cooperation for the rational and efficient use of water and energy resources in Central Asia,[6] the efforts of the World Bank and the United States Agency for International Development in studying the Energy-Water Nexus in Central Asia,[7 8] as well as the work of the ADB,[9] FAO and UNDP on food and energy security in the region.[10] Previous cooperative solutions among riparian countries have also involved multi-sectoral cooperation, for example the Framework Agreement of 1998, which focused on energy exchanges and the regulation of water discharges.

The aim of the nexus assessment of the Syr Darya is to identify 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. By means of 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. Those opportunities identified and selected for further analysis would automatically benefit more than one sector and country and can therefore contribute to increased cooperation and coordination.

6 United Nations Economic Commission for Europe and United Nations Economic and Social Commission for Asia and the Pacific, *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, United Nations, 2004).

7 World Bank, *Water and Energy Nexus in Central Asia, Improving Regional Cooperation in the Syr Darya Basin*. (Washington D.C., World Bank, 2004).

8 United States Agency for International Development, Central Asia Natural Resources Management Program, in *Transboundary Water and Energy Project. Final Report*, (Washington D.C., USAID, 2005).

9 Asian Development Bank project *Improvement of Shared Water Resources Management in Central Asia* (RETA 6163).

10 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, 2011).

CHAPTER 2

Basin description and resource base

2.1. Geography

The Syr Darya is not only the longest river in Central Asia (3,019 km from the headwaters of the Naryn) but also the second largest (after the Amu Darya) in terms of water quantity, with an annual average runoff 36.57 km^3.[11] 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 sources of the river lie high in the glacier and snow-capped Tien Shan Mountains of Kyrgyzstan, where most of the run-off is generated.

The basin of the Syr Darya is often divided into geographically distinct parts: 1) the upper reaches, consisting of the Naryn and the Kara Darya tributaries and the Fergana Valley; 2) the middle part; 3) the sub-basins of the Chirchik, Ahangarana and Keles; and 4) the lower part, delta and the Northern Aral Sea fed by the Syr Darya.[12]

TABLE 1
The resource base in the Syr Darya Basin and the riparian countries' dependency on it: [a]

	Kazakhstan	Kyrgyzstan	Tajikistan[f]	Uzbekistan
Country areas in the basin (as the percentage of total country areas)[b]	12.7	55.3	11.0	13.5
Country areas in the basin of total country area (sq. km)	345,000 of 2,724,900	110,570 of 199,950	15,680 of 142,550	60,040 of 447,400
Population living in the basin (as the percentage of the total national population)[c]	20.0	56.6	21.2	51.4
Population living in the basin of total national population (million inhabitants)	3.4 of 17.0	3.2 of 5.7	1.7 of 8.2	15.5 of 30.2
Surface water resources in the basin (as the percentage of total resources at country level)[d]	13.3	24.1	6.7	36.5
Total (actual) Surface Water Resources (RSWR) (km^3/year): within the Syr Darya Basin of the national total	13.3 of 99.6	5.1 of 21.2	1.3 of 18.9	15.4 of 42.1
Irrigated land in the basin (as the percentage of total irrigated land at the country level)[e]	59.3	37.3	39.3	54.4
Irrigated land in the basin of total irrigated land at the country level (thousand hectares)	750 of 1,265	381 of 1,021	265 of 674	2,012 of 3,700

a The calculations of shares have been made using more precise values of the parameters. Due to the rounding of figures shown, minor deviations may occur.

b Karen Franken, ed., Irrigation in Central Asia in Figures. AQUASTAT Survey 2012. In *FAO Water Reports 39*. (Rome, FAO, 2012). The estimated total area of the basin does however vary in different sources, from between 200,000 to 400,000 sq. km.

c World Bank. World Development Indicators database, available from http://wdi.worldbank.org/tables; Scientific Information Centre of the Interstate Commission for Water Coordination. CAWATER Info database, available from www.cawater-info.net

d Karen Franken, ed. (2012). Total actual renewable water resources are calculated as the sum of internal renewable resources and external renewable resources, taking into consideration the quantity of flow reserved to upstream and downstream countries through formal or informal agreements or treaties.

e Calculated as: [Irrigated land] / [Area equipped with irrigation actually irrigated (country)]. Sources: Area equipped with irrigation actually irrigated (country). Karen Frenken (ed.) (2012); and Irrigated land – Oblast (Kazakhstan) and national level statistics offices of the riparian countries (2012), quoted by SIC-ICWC

f In 2015, Tajikistan submitted alternative figures that differ somewhat from those in the table based on international sources:
- country area in the basin 12,672 sq. km or 8.89% of total country area;
- population living in the basin 2,084,000 or 25% of total national population;
- irrigated land in the basin 259,000 ha or 34.6% of total irrigated land at the country level;

11 Food and Agriculture Organization of the United Nations, Aral Sea Basin in AQUASTAT database, 2012. Available from: www.fao.org/nr/water/aquastat/basins/aral-sea/index.stm.

12 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 the Syr Darya. For this reason, the Chu and Talas basins are not taken into account in this assessment.

2.2. Socio-economic dynamics

In 2015 the population of the basin exceeded 24,000,000 people. Its distribution by country and provinces is presented in table 1. More than half of the population is concentrated in the Fergana Valley, the most important agricultural and most densely populated area in the basin.[13] Large parts of the population are either working in the agricultural sector or are dependent on subsistence agriculture. Despite significant economic growth and diversification improvement in the region in the past 15 years, poverty is still widespread in Kyrgyzstan and Tajikistan.[14] Both countries are relying on remittances from migrants, and the economic turbulence in Russia and Kazakhstan in 2014-2015 – the main recipient countries for migrants – has adversely affected the flow of remittances, local businesses and sources of family income.

Tajikistan is the least urbanized nation of the four, followed by Kyrgyzstan, Uzbekistan and Kazakhstan. The Syr Darya Basin has been populated since ancient times and several cities – for example Tashkent and Khujand – have a vibrant history stretching for two millennia. All areas of the river basin exhibit population growth. Given that the population in the arid and most densely populated part of the basin is growing, adequate and secure provision and production of food, as well as the employment prospects of the rural population, both depend on the availability and productivity of the irrigated land.

However, there are marked differences between urban and rural living standards, availability of services and dependence on natural resources. The rural population tends to be the poorest in these areas and may have more limited access to safe piped water resources, sanitation facilities, constant clean, regular and secure energy supplies as well as food supplies. Severe power cuts and high food prices in the period 2007-2010 and 2015 brought entire communities to a state of emergency (particularly in Kyrgyzstan and Tajikistan) because of a combination of low water levels in the rivers and reservoirs (which generate the bulk of electricity), harsh winters, volatile food prices and the various episodes of the global economic crisis.[15] The impact of extreme weather events on food production in the basin can be severe. In 2008, the Sogd province of Tajikistan, suffered a huge loss of cattle, sheep and goats - 50% of the national figure – because of the harsh winter. The complicated border relations in the Ferghana Valley area add constraints to local trade, water sharing, land use and the transportation of people and goods.

2.3. Water resources

The flow of the river is supplied by melting water from glaciers, snow and rainfall and is variable both seasonally and between years. The extremes include dry years characterized by droughts and high-flow years characterized by floods,[16] with both extremes damaging to the economy in the basin.[17]

The operation schedule of the reservoirs on the Naryn river (a major tributary located in Kyrgyzstan and Uzbekistan), and in particular the Toktogul reservoir in Kyrgyzstan, is crucial both for the provision of water to the large irrigation schemes for cotton and – to a smaller extent – food production in the Fergana Valley as well as downstream in Uzbekistan and Kazakhstan. It is also vital for power production upstream, mainly in Kyrgyzstan. 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 primarily for irrigation, and flood control though some of them produce electricity. About 90% of the Syr Darya's mean annual flow is regulated by reservoirs.

2.4. Ecosystems

The Syr Darya Basin features a high diversity of ecosystems. These include the glacier and snow-capped mountains of Kyrgyzstan – the habitats of the snow leopard and mountain sheep – as well as the flat and harsh deserts and lowlands of the lower Syr Darya in Kazakhstan, with saiga antelope ranges. The agricultural developments over millennia transformed the Ferghana Valley into a massive man-made oasis. The Western Tien Shan Mountains host many endemic and endangered species. The growing network of nature reserves and the Ramsar sites protects them and supports nature conservation efforts. Wild fruit and nut forests around the Ferghana Valley support rich biodiversity and are used by local population.

However, the environment of the Syr Darya Basin has been continuously under pressure since the advent of industrialization and large-scale irrigation. The seasonal changes in water flow due to dam capacity growth and operation have had an impact on ecosystems in many areas along the river. Water diversion for irrigated agriculture and land use changes created equally significant challenges for the ecosystems. The rare riparian forest cover is under stress.[18] Some flagship species, such as the Syr Darya Shovelnose Sturgeon, the Syr Darya endemic fish found in the middle and lower reaches, has not been recorded since the 1960s. It is suspected that the species is on the verge of extinction.

While dam operations had implications for agriculture and winter flooding downstream, they also led to the appearance of new sites with a rich biodiversity and fishery such as the Aydar-Arnasay Lakes in Uzbekistan. Construction of another dam, the Kok-Aral in 2005 in Kazakhstan, has raised and stabilized the water level in the troubled Northern Aral Sea and led to the revival of the fishing industry there.[19]

[13] Environment and Security Initiative, *Environment and Security: Transforming risks into cooperation - Central Asia – Ferghana / Osh / Khujand area*, (Geneva, UNEP, 2005).

[14] World Development Indicators of the World Bank: about 35% of the population in both countries live in poverty.

[15] United Nations Development Programme, *Central Asia Regional Risk Assessment: Responding to Water, Energy, and Food Insecurity*, (New York, UNDP, Regional Bureau for Europe and CIS, 2009).

[16] The most flood-prone area of the basin in Kazakhstan is now better protected by the recently built Koksarai dam.

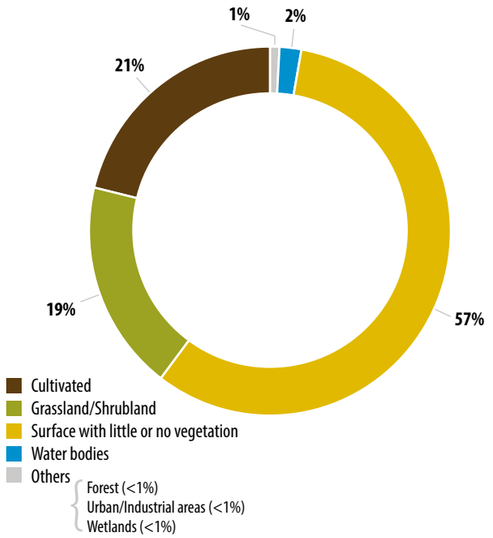
[17] United Nations Economic Commission for Europe, *Strengthening Water Management and Transboundary Water Cooperation in Central Asia: the role of UNECE Environmental conventions*, (New York and Geneva, United Nations, 2011).

[18] Ramsar Convention, *Ramsar Convention Guidelines for wetlands in Central Asia*, (Gland, Ramsar Convention Secretariat, 2012 [in Russian]).

[19] United Nations Economic Commission for Europe. *Second Assessment of Transboundary Rivers, Lakes and Groundwaters*, (New York and Geneva, United Nations, 2011). Kazakhstan plans to continue from 2015 to 2020 in the first phase of the North Aral Sea project carried out in cooperation with the World Bank.

2.5. Landscape features and land resources

FIGURE 1
Land resources in the Syr Darya Basin



The basin is characterized by mountains in the east and flat areas with decreasing altitudes in the west. Its main geographic features are the mountain ranges of Tien Shan (over 5,000m high, mainly in Kyrgyzstan), the Fergana Valley (a depression at an altitude of 250-500m shared by Kyrgyzstan, Tajikistan and Uzbekistan), the lowlands of Gooday Steppe in Uzbekistan, and the Kyzyl-Kum desert in Kazakhstan.[20]

Half of the agricultural land is found in naturally drained oases while the other half is the result of reclamation projects – that is, drainage, land levelling and improvements to the soil structure – largely completed in the Soviet era, which can be expensive in terms of construction and maintenance. Kazakhstan has a healthy availability of agricultural land, while Kyrgyzstan and Tajikistan, and parts of Uzbekistan, have less ample land resources suitable for agriculture.[21]

In addition to agricultural lands, rangelands and forestlands in the upper mountain part of the basin, especially in Kyrgyzstan, are essential resources for food production and livelihoods. Soil degradation is significant in some parts of the basin (Uzbekistan Geographic Atlas 2010, Kazakhstan National Atlas 2012).

2.6. Energy and mineral resources

Relatively large oil, coal, and natural gas resources, as well as uranium deposits, are found in Kazakhstan and Uzbekistan and exploited by the extractive industries of both countries. Existing and planned pipelines and power line cross the basin and deliver fossil fuels and power to the neighbouring Russian Federation, China and South Asia. Hydropower contributes to the energy mix in all basin countries, but it is most important for the economies of Kyrgyzstan and Tajikistan. Thermal power plants running on coal and gas constitute the main power production capacities of Uzbekistan and Kazakhstan.

The regional electricity grid, the Central Asian Power System (CAPS), connects all the countries in the basin, but at present is fragmented and not fully functional.[22] High voltage transmission lines are being planned or built for the export of power produced in Kyrgyzstan and Tajikistan to Afghanistan, Pakistan and China.[23] These new connections will allow for the sale of surplus energy outside the region in summer, when demand both for South Asia, and power generation for Syr Darya itself, is at its highest.

The Syr Darya Basin is rich in mineral resources – gold, silver, mercury, antimony, copper, coal amongst others – which have been extracted and produced in the basin since ancient times. The largest gold mining sites are Chuuk in the central part of Uzbekistan's Kyzylkum desert , Kumtor in Kyrgyzstan, and in the headwaters of the Naryn river in the glacier zone. Kazakhstan's major in-situ uranium leaching operations are located in the lower part of the Syr Darya Basin. In Kyrgyzstan and Tajikistan, a significant number of uranium mines and tailing ponds are located upstream of the Ferghana valley[24]. The Soviet-era mining practices, improper mining waste storage and the neglected uranium and other mining tailings, led to industrial pollution hotspots that pose an ecological risk to the ecosystems and the river basin and need to be properly monitored and addressed. Work is underway to ensure the monitoring and safety of the ecosystems and river basins and to develop plans for their rehabilitation.

[20] O. Savoskul et al. 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*. (Amsterdam, Institute of Environmental Studies, 2003).

[21] Food and Agriculture Organization of the United Nations. *The Status and Challenges of Food Security in Central Asia*, (Budapest, FAO Regional Office for Europe and Central Asia, 2011).

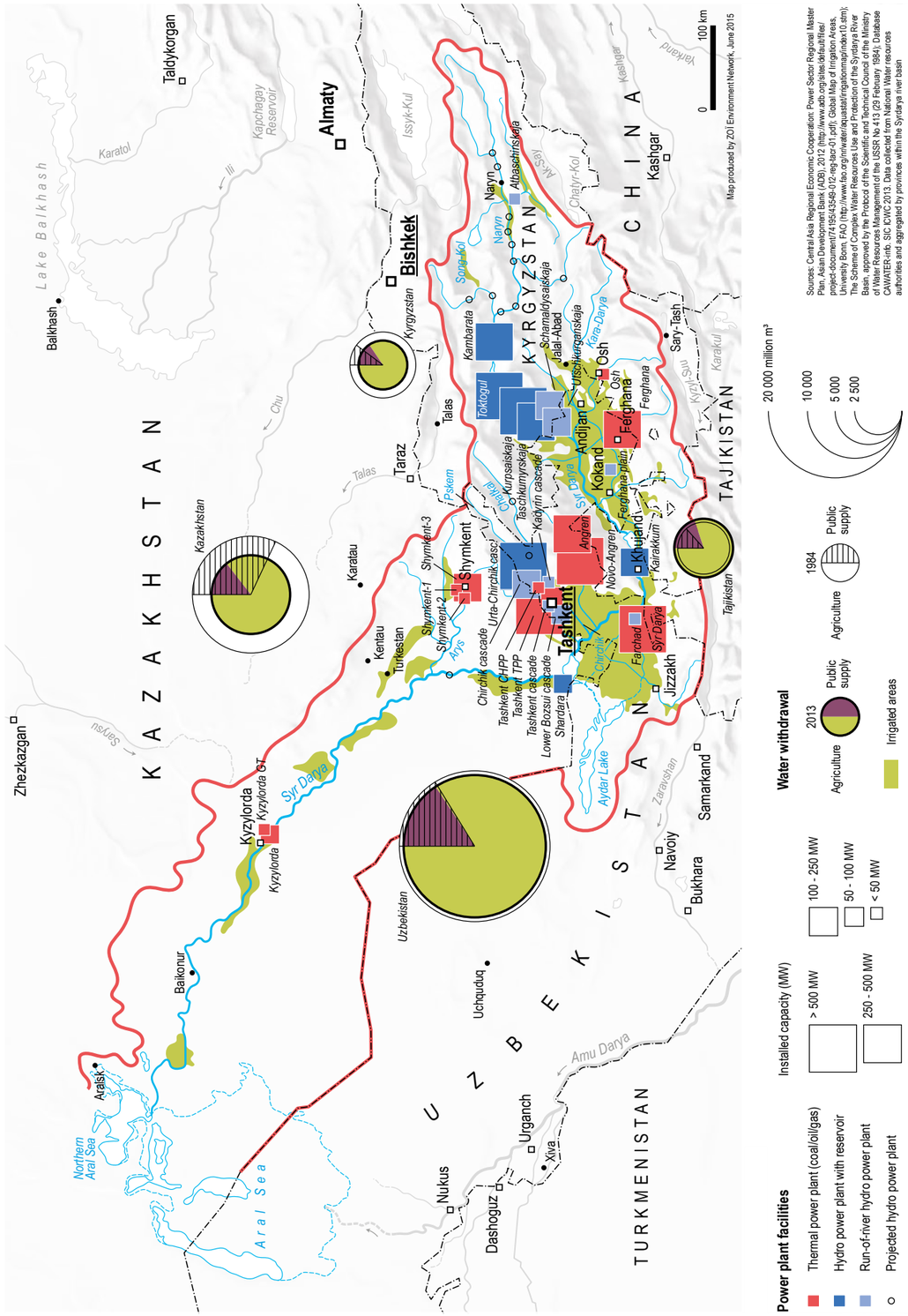
[22] Energy Charter Secretariat, *In-Depth Energy Efficiency Review: Tajikistan*. (Brussels, Energy Charter Secretariat, 2013). Due to Uzbekistan's withdrawal from the CAPS network, Tajikistan can no longer import electricity from Uzbekistan or Turkmenistan that transits through Uzbekistan.).

[23] Chen Yang and Liang Fei, Regional Grid Connection Planned. In *Global Times*, 2014.

[24] Environment and Security Initiative, *Environment and Security: Transforming risks into cooperation - Central Asia* – Ferghana / Osh / Khujand area, (Geneva, UNEP, 2005).

FIGURE 2
NEXUS ELEMENTS IN THE SYR DARYA BASIN

Distribution of selected elements relevant to the nexus: water bodies, irrigated areas, power plants; water withdrawals for agriculture; and water supply.



CHAPTER 3
Governance and water resources management

3.1. Regional and basin level governance

Water resources

In the Soviet era, the Syr Darya Basin was managed as an integrated economic unit with agricultural production given higher priority over hydropower generation. The 'Syr Darya basin organisation' was created in 1986 to manage all water facilities on the major canals on the main stream of the river, and to develop – in partnership with the riparian republics – flow regulation plans. Compensation and exchange schemes centrally planned and managed by the Soviet government ensured a compromise between the riparian states in the development of the agriculture, energy and other sectors and competition for water resources between them was consequently minimized or avoided altogether.[25] It is important to note that the Soviet State Planning Committee prioritized distribution of water resources for large-scale agricultural production, especially cotton, whilst hydropower generation was a lower priority. Mismanagement and overuse of water led to environmental degradation and the crippling Aral Sea crisis.

Following the independence of the former republics, each country began to review and revise its own economic priorities. It soon became clear, particularly to hydropower-dependent states, that the Soviet-era system of water use in terms of both quantities and timing, was increasingly suboptimal in a rapidly changing geo-political and local economic context in satisfying their needs for economic development and poverty alleviation.

Initially, as reflected in the 1992 Agreement on cooperation in the joint management of use and protection of transboundary water resources, at basin level, the Aral Sea countries decided to continue the use of water management principles inherited from the Soviet era and pledged to comply with the agreed procedures. But energy realities and pricing policies beyond national borders soon changed in line with market forces. Shortly after independence, therefore, the former system of water management in the Syr Darya started to change as large dams and associated hydropower stations began to serve national needs and energy security interests, rather than regional agricultural priorities. In contrast, water pricing, and new market approaches to water resource allocation and use became more sensitive both domestically – since water pricing remained tightly linked with food production and rural wellbeing – and internationally, between the upstream and downstream countries over the costs of water regulation and provision. While energy price adjustments and other market reforms have continued, adequate water pricing remains a sensitive issue in the basin.

After independence, new institutions were established, particularly the Inter State Commission for Water Coordination (ICWC) under the International Fund for Saving the Aral Sea (IFAS). In 1999, following the signing of the so-called Ashgabat Declaration, the four nations, as well as Turkmenistan, agreed to the following distribution of responsibilities among the basin organizations, that:

(a) The IFAS Board is the highest level body for decision-making.

(b) The Executive Committee of IFAS (EC-IFAS) implements the decisions taken by the IFAS Board through the national branches of IFAS, including through donor financed projects.

(c) ICWC is responsible for the management of transboundary water resources in terms of the allocation and approval of national quotas for water use.

(d) The basin water organizations, the Scientific-Information Centre of the ICWC, and the ICWC Secretariat are the executive bodies of the ICWC.

There are concerns that this governance system is not working as well as it should be (in terms of clarity of roles, division of responsibilities and coordination) and that – as a consequence – regional water resources are not managed effectively.[26]

Ideally the regional level institutions should help to balance the countries' divergent interests and coordinate plans that may not be fully compatible at all times. Concerned about suboptimal efficiency in the cooperation within the IFAS framework, the heads of states – at their meeting in 2009 – expressed their intention to improve the organizational structure and legal framework of IFAS, noting especially the need to develop a mutually acceptable mechanism for the integrated management of water resources and environmental protection in the Aral Sea Basin.[27] The fact that the energy authorities are only marginally involved in inter-sectoral and inter-state coordination of water management in the Syr Darya Basin has remained a shortcoming since the Soviet period.

As clear evidence of this complexity, Kyrgyz authorities declared in May 2016[28] that the country was to suspend its participation in the IFAS processes. They stated that the current frameworks were not sufficiently in line with Kyrgyzstan's national priorities, in particular the interests of the hydropower sector and certain aspects that are not considered in the regional water management.

The mandate of the Syr Darya Water Basin Organization (BWO Syr Darya) includes:

1. preparing and coordinating with ICWC the water use quotas for all major users in the Syr Darya River Basin;
2. developing plans for the main water intake structures and modes of operation of cascades of reservoirs;
3. measuring water flows at the border hydrometric stations jointly with national hydro-meteorological services;
4. providing a water supply to users in compliance with the quotas established by ICWC.

[25] United Nations Economic Commission for Europe and the United Nations Economic and Social Commission for Asia and the Pacific. *Strengthening cooperation for rational and efficient use of water and energy resources in Central Asia, United Nations Special Programme for the Economies of Central Asia* (SPECA), (New York, United Nations, 2004).

[26] Sergei Vinogradov and Vance P.E. Langford (2001). 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, pp. 345–362; Strengthening the Institutional and Legal Frameworks of the International Fund for Saving the Aral Sea: Review and Proposals. Discussion paper dated 31 January 2010.

[27] idem

[28] *Kyrgyzstan "Freezes" its Participation in Saving the Aral*. Sputnik news, Bishkek, May 20, 2016 [in Russian].

With the exception of salinity (mineralization), the mandate does not include water quality management and monitoring. Because of a lack of direct access to governments, BWO Syr Darya is not in a position to effectively carry out its mandate. As a result, it cannot serve as a platform for cross-sectoral coordination (except for solving operational problems with the Coordinating Dispatch Centre "Energy" – see below). In effect, BWO Syr Darya currently only covers the part of the basin within the territory of Uzbekistan.

At present, while there is no formal bilateral cooperation between basin countries on the management of the Syr Darya, de facto bilateral discussions of water issues do take place. Draft bilateral agreements for the regulation of relations on small rivers in the Syr Darya River Basin, such as the Isfara and Khodjabakirgan rivers between Kyrgyzstan and Tajikistan, were under consideration at the time of the report's completion.

Energy resources

Several frameworks allow for the Central Asian states to cooperate on energy policy and practice.[29] [30]

In 1991 the heads of electric power systems of the region signed in Ashkhabad an agreement on parallel operation of the electric power systems. In 2000 the electric power systems of Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan were connected with the electric power system of Kazakhstan for synchronous parallel operation. In 2004 the Central Asian states established the Coordinating Electric Power Council of Central Asia as a consultative body bringing together national electric power systems operators: KEGOC from Kazakhstan, NESK from Kyrgyzstan, Barki Tojik from Tajikistan, Kuvvat from Turkmenistan and Uzbekenergo from Uzbekistan. This replaced the earier existing Council of the Central Asian Unified Power System. The creation in 2006 of the Coordination Dispatch Centre "Energy" located in Tashkent, ensures the redistribution of the electrical load in the system during excessive loads or faults in the network. The centre is not engaged in the planning of production and consumption of electrical power and does not provide for intergovernmental coordination or adoption of strategic policy decisions, but it can provide recommendations to governments.

Within the framework of the Commonwealth of Independent States (CIS), and as part of the Agreement on Coordination of Intergovernmental Relations in the Electric-Power Sector of the CIS, the CIS Electric Power Council was established in 1992 to coordinate strategic policy decisions, includng the formation of the common power market. However, of the Central Asian states, only Kazakhstan, Kyrgyzstan and Tajikistan signed the CIS 2007 agreement to establish the common electric power market.

Created in 2014, the Eurasian Economic Union, which from Central Asia includes Kazakhstan and Kyrgyzstan, formally adopted the concept of the common electric power market, with a view to it being established in 2019.

Ecosystems

The Interstate Commission for Sustainable Development (ICSD), mandated under the auspices of IFAS, leads on regional sustainable development initiatives. ICSD lists land degradation and desertification, as well as mountain ecosystems conservation, among its priority work areas. Several suggestions were made within the framework of regional projects about how the network of protected areas could optimize the connectedness of nature's elements to preserve the invaluable biodiversity of the basin. There have been major efforts by both the countries, and a donor focus, on the maintenance and growth of the protected areas in the Syr Darya Basin. Among the noteworthy examples of national actions that improve both the local environment and create regional benefits are the rehabilitation of fisheries in the Northern Aral Sea in Kazakhstan, the political priority given to preserve the Aydan-Arnasay Lakes in Uzbekistan, the rehabilitation and monitoring of the hazardous waste sites in the mountainous parts of the basin, and the Western Tien Shan conservation efforts. In June 2016, for example, after intense, collective and coordinated efforts by both nature conservation groups and the environmental authorities of Kazakhstan, Kyrgyzstan and Uzbekistan, the Western Tien-Shan Mountains were officially endorsed as a UNESCO world heritage site.[31]

Located in Tashkent, the IFAS agency for the implementation of the Aral Sea basin and Global Environmental Facility projects (IFAS GEF Agency), is another institution, in practice its efforts and main focus are on Aral Sea environmental and social issues in Uzbekistan.

However, there is no regional institutional or other formal regional coordination on the conservation of the Syr Darya ecosystems. While IFAS deals with the Aral Sea crisis and strives to minimize its impact, including through ecosystem recovery or stabilisation, in general ecosystem conservation efforts remain nationally planned and funded. Regional ecosystem needs and priorities are not widely known to policy-makers and are not well integrated into water, land use and energy planning in the Syr Darya Basin.

[29] World Bank, *Load Dispatch and System Operation Study for Central Asian Power System*, (Washington D.C., World Bank, 2010).

[30] Vladimir Volosskiy, *Electricity Cooperation and Sustainable Development of the Central Asia States*. Unpublished paper for UNECE, 2016.

[31] Please see http://whc.unesco.org/en/list/1490.

TABLE 2
Governance structures and institutions in the Syr Darya Basin

Regional level	Near Aral Sea communities and environmental rehabilitation efforts	International Fund for Saving the Aral Sea			
	Surface water allocation and management	Interstate Commission for Water Coordination (including the Syr Darya Water Basin Organization and SIC ICWC)			
	Sustainable Development and Environment	Interstate Commission for Sustainable Development (incl. regional centres)			
	Power	Coordinating Electric Power Council of Central Asia, Coordination Dispatch Centre "Energy"			
	Renewable energy	Regional Centre for Renewable Energies			
	Hydrometeorology (climate and water monitoring and forecasts)	Regional Centre for Hydrology			
	Mountains	Regional Mountain Centre			
		KAZAKHSTAN	KYRGYZSTAN	TAJIKISTAN	UZBEKISTAN
		Presidents and Cabinets of Ministers			
Ministries and members of the Government	Transboundary water issues	Ministry of Foreign Affairs	Ministry of Foreign Affairs	Ministry of Foreign Affairs	Ministry of Foreign Affairs
	Transboundary and domestic water management and infrastructure	Ministry of Agriculture, Water Committee	Department of Water Resources and Melioration of the Ministry of Agriculture, Melioration and Food Industry	Ministry of Energy and Water Resources, Ministry of economic development and trade	Ministry of Agriculture and Water Resources
	Regional and domestic energy management and infrastructure	Ministry of Energy	State Committee on Industry, Energy and Mining, National Energy Holding	Ministry of Energy and Water Resources	Ministry of Economy and the National Energy Company
	Food and agriculture	Ministry of Agriculture	Ministry of Agriculture, Melioration and Food Industry	Ministry of Agriculture, Ministry of economic development and trade	Ministry of Agriculture and Water Resources
	Health issues	Ministry of Healthcare and Social Development	Ministry of Healthcare	Ministry of Healthcare and Social Protection	Ministry of Healthcare
	Education and awareness raising	Ministry of Education and Science	Ministry of Education and Science	Ministry of Education and Science	Ministry of Public Education
	Floods, droughts and safety	Ministry of Internal Affairs, Committee for Emergency Measures and National Hydrometeorological Service	Ministry of Emergencies and National Hydrometeorological Service	Committee of Emergencies and National Hydrometeorological Service	Ministry of Emergencies and National Hydrometeorological Service

		KAZAKHSTAN	KYRGYZSTAN	TAJIKISTAN	UZBEKISTAN
		Presidents and Cabinets of Ministers			
Committees and agencies	**Environmental aspects of water Management**	Water Committee of the Ministry of Agriculture	State Agency for Environmental Protection and Forestry	Committee of Environmental Protection	State Committee of Nature Protection
	Groundwater management	Committee of Geology and Subsoil of Ministry of Investment and Development	State Committee on Industry, Energy and Mining	Main Administration on Geology	State Committee of Geology and Mineral Resources
	Surface water resources monitoring	National hydrometeorological service	National hydrometeorological service	National hydrometeorological service	Centre of Hydrometeorology
	Land resources monitoring and environmental aspects of land use	Committee for Construction, Housing and Communal Services and Land Resource Management of the Ministry of National Economy	State Institute of Land Use Planning under the Ministry of Agriculture, Melioration and Food Industry	Agency for Land Reclamation and Irrigation	Ministry of Agriculture and Water Resources, State Committee of Nature Protection, State Committee on Land Resources, Geodesy, Cartography and Land Cadastre
	Ecosystems monitoring and protection, forest rehabilitation	Committee of Forestry and Hunting, Ministry of Agriculture, Department of environmental monitoring and information of the Ministry of Energy	State Agency for Environmental Protection and Forestry	Committee of Environmental Protection and Forest Agency	State Committee of Nature Protection, Ministry of Agriculture and Water Resources
	Water resources and energy	Committee of environmental regulation, control and state inspection in oil and gas sector of the Ministry of Energy	State Inspectorate on environmental and industrial safety	Water and Energy Coordination Council under the Government of the Republic of Tajikistan	State Inspectorate for Supervision of the Energy Sector
Intersectoral state bodies	**Water-energy-agriculture-ecosystem interactions and coordination arrangements**	Council under the President on transition to the Green Economy, Council on sustainable development	National Water Council, Climate Change Coordination Council, National Council on Sustainable Development	Water and Energy Coordination Council under the Government, National Development Council under the President	
State enterprises	**Municipal water use**	"Kazakh Water Industry"	"Vodokanal" local branches and Department on drinking water supply of the State Agency of architecture, construction and housing	"KhojagiiManziliuKommunali" State Enterprise and municipal Vodokanals	"Vodokanal" local branches
	Power production, transmission and distribution	"KEGOK" Joint Stock Company	"National Power Network of Kyrgyzstan" State Joint Stock Company	"Barki Tojik" State Joint Stock Company	"Uzbekenergo" State Joint Stock Company

		Parliament			
Basin level at national and sub-national level	**Water distribution and use**	Water Basin Inspections	Basin Water Economy Administrations	Water Basin Councils (the reform is not yet completed and the councils not yet created)	Basin Irrigation System Authorities
		Basin Councils		River Basin Organisation	
Local administration		Maslikhat and Akimat	Kenesh and Mayor	Madjlis and Hukumats (City, Region and District Administrations)	Kengash and Hokimiat
Local level	**Water distribution and use**	Rural water users associations (WUAs)	WUAs	WUAs	WUAs

* Information in the table is accurate as at August 2016.

3.2. Water management at the national level

At the national level, the management of the natural resources of the Syr Darya riparian States and the regulatory and operational functions within the relevant institutions are not always clearly defined. This is partly a feature left over from the Soviet era during which governing bodies were also assigned operational functions.

Effective implementation of national policies on water, agriculture, energy and the environment in the Syr Darya Basin states requires a large degree of coordination between the relevant authorities. Currently, the agricultural and energy agencies and related interests dominate the field of water management, while the protection of ecosystems and maintaining water quality standards, are relatively marginal.

Kazakhstan

In Kazakhstan, the Ministry of Agriculture is responsible for the development and implementation of agricultural policy and water management. The Ministry's Committee on Water Resources conducts and controls the use and protection of water resources via the River Basin Organizations and Republican State Enterprises. With the exception of issuing relatively small water abstraction licences, groundwater remains within the purview of the Ministry for Investment and Development and the Committee of Geology and Subsoil Use.

Environmental aspects of water resource management were assigned to the Ministry of Energy as part of the reforms of late 2014. The Ministry of Energy oversees the policy related to environmental protection and management, as well as 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 and epidemiological control. Emergency situations, including water-related ones (floods and droughts in particular), fall within the competence of the Ministry of Investment and Development.

Kyrgyzstan

In Kyrgyzstan, institutional reform in 2005 of the water sector and related areas, assigned relevant functions to various bodies, although those functions have yet to be assumed. The National Water Council (NWC) was given responsibility for oversight and became the coordinating body for all agencies involved in water resources management. It was, however, only convened 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 held by the Department of Water Economy and Melioration of the Ministry of Agriculture, Melioration and Food Production. The department fulfils both regulatory and operational functions. Competence in environmental quality and environmental health standards was assigned to the State Agency on Environment Protection and Forestry and to the Department of Sanitary and Epidemiological Service of the Health Ministry.

The prevention of water pollution as a whole rests with the State Inspectorate on environmental and industrial safety 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 is located at the State Registration Service, the State Design Institute of Land Management "Kyrgyzgiprozem", and the State cartographic and geodetic service.[32]

[32] A debate is ongoing about the establishment of 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 GDS, the State Registration Service, State Design Institute of Land Management "Kyrgyzgiprozem", and the State Cartographic and Geodetic Service. Currently the development of the National strategy on land management is not a part of the functions of any of these institutions.

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 merged with the Ministry of Energy and Industry to form 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 developing a state policy and regulations for land reclamation and irrigation, the proper use and preservation of water bodies, water supply and water conservation. The Ministry of Agriculture remained the central executive authority for the development and implementation of policy in agriculture.

Urban and rural water supply and sanitation services are provided for public utilities by the 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. CEP sets the annual 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.

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 (MAWR) is responsible for surface water resources, and the 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 to the relevant public administration. State control in the electricity sector is ensured by the State Energy Inspectorate 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".

3.3. Cross-sectoral coordination and integration

The development and coordinated implementation of a national policy on water resources, food production, energy and the environment in the Syr Darya countries requires a large degree of coordination between the relevant authorities and sectors. Each of the basin countries would benefit from strengthened procedures for the consideration of the environmental and social impact of development plans. Mechanisms of inter-sectoral coordination have already been set up in some countries.

For example, in Kyrgyzstan, the Coordination Committee on Climate Change (CCCC) reviews and discusses national commitments and reports under the auspices of the United Nations Framework Convention for Climate Change (UNFCCC) that require cross-sectoral consensus and inputs. The CCCC coordinates climate change adaptation strategies in various sectors. The inter-ministerial National Water Council (NWC) in Kyrgyzstan, formally established in 2005, convened for the first time in 2013.[33] The Water-Energy Council (WEC) under the government of Tajikistan coordinates between ministries and agencies on water and energy issues. National strategies on sustainable development in all countries often have inter-sectoral coordination councils.

Water

After the break-up of the Soviet Union, the Central Asian republics adopted new national water codes (1993-1994), and since the 2000s Kazakhstan, Kyrgyzstan and Tajikistan have also updated their water legislation. Uzbekistan is also assessing the potential for reform. Basin management has been gradually introduced in the Syr Darya riparian countries via legislative reforms that require the creation of basin-based organizations able to develop river basin plans.[34]

Currently, water management is the responsibility of specific ministries, either agriculture (Kazakhstan, Kyrgyzstan and Uzbekistan) or energy (Tajikistan). These ministries, in partnership with the ministries of foreign affairs, also represent the countries in cooperation frameworks on transboundary water resources. Water quality management receives less attention from the authorities than water quantity and there is no agreed framework or set of targets for water quality in Central Asia's major rivers. The agencies for geology are responsible for groundwater.

A number of institutional reforms have been undertaken but sometimes left unfinished. For example, 10 years after Kyrgyzstan's 2005 institutional reform programme was introduced, the State Water Administration has yet to be established. Furthermore, policy development, and regulatory and operational functions are not always clearly separated. In Kyrgyzstan, for example, the Department of Water Economy and Melioration (DWEM) of the Ministry of Agriculture and Melioration (MAM) fulfils both regulatory and operational functions. Tajikistan has recently started the process of separating policymaking, regulation and operational functions. In April 2016 the government endorsed the Water Sector Reform Programme 2016-2025 that will both facilitate the transition to water resources management based on river basin principles and clarify the competencies of national institutions involved in water. It is envisaged that the transition will be accomplished by 2020, while basin management plans for all the basins in the country are currently under development.

[33] United Nations Economic Commission for Europe and the Organisation for Economic Co-Operation and Development, *Integrated Water Resources Management in Eastern Europe, the Caucasus and Central Asia*, (New York and Geneva, United Nations, 2014).

[34] 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 Kyrgyzstan in 2008 (Talas Basin Council), and in Tajikistan the establishment of such structures is in progress.

At present, basin inspections exist in Kazakhstan, where the river basin councils have an advisory role, and in Kyrgyzstan the first basin councils have been created. But despite the legal recognition (with the exception of Uzbekistan) of the need to create basin councils, their practical work suffers from a number of shortcomings. In Kazakhstan only does the state budget contribute to financing the meetings of the basin councils. Many relevant competencies in the countries remain with traditional state administration bodies.

The process of dismantling collective farms gave rise to peasant farms and to the reform of water management and relevant management structures (decentralization and privatization), including the establishment of Water User Associations (WUAs). However, WUAs, which assumed control over irrigation networks, are a weak link in operational water management. They need strengthening to make them more efficient and less dependent on state water management structures. One important challenge is that their financing needs to be improved.

Energy

In addition to being responsible for the energy sector, the energy ministries also oversee other matters: industry and mining (Kyrgyzstan), environmental protection (Kazakhstan) and water resources (Tajikistan). In Uzbekistan, the Ministry of Economy is responsible for fuels and hydropower. The policies in the fossil fuel producing countries (Kazakhstan and Uzbekistan) are more oriented towards the optimization of supply and the modernization of power plants, while those in the countries whose main source is hydropower (Tajikistan and Kyrgyzstan) focus on the modernization and growth of hydropower generation capacities and power transmission. Both mountain countries are increasing investments into coal mining and coal-powered energy capacities.

Land and agriculture

Transformative policies in agricultural land management since the 1990s have mainly affected tenure rights, involving a shift from large collective farms to smallholders. Private ownership of land has been introduced in Kazakhstan and Kyrgyzstan[35]; in Tajikistan land use rights may be the subject of transfer to long-term lease and the right of inheritance and transfer, but land as such remains under state ownership. In Uzbekistan land is under state ownership and not transferable. In addition to private agricultural producers, cooperatives of different types – production, service and consumer cooperatives – sometimes offer support to smallholder farmers by, for example, facilitating access to markets, providing machinery and negotiating favourable credits.[36] Land management authorities maintain land register information, but the link to land use planning and other sectors (mining, energy, conservation) is weak.

Environment

Environmental legislation exists in all the Syr Darya Basin countries and is being constantly updated. The degree of implementation of international instruments and regional environmental action plans remains low. Economic development is prioritized over the protection of the environment despite the efforts of the responsible state agencies. National environmental strategies, programmes and action plans are in place, but often their implementation is difficult because of financial constraints and a lack of affordable technologies. Limited availability of up-to-date and accurate environmental information is also a constraint to development.

[35] United Nations Economic Commission for Europe, *Country profiles on the housing sector: Kyrgyzstan*, (New York and Geneva, United Nations, 2010).

[36] Zoi Lerman. *Structure and Performance of Agriculture in Central Asia*. Discussion paper, (Jerusalem, Hebrew University of Jerusalem, Department of Agricultural Economics and Management, 2013).

CHAPTER 4

Key sectors and economic trends

4.1. The overview of the key sectors

Agriculture, aquaculture and food production

Irrigated agriculture is the largest consumptive water user in the basin, constituting on average 85% of total withdrawals in all countries.[37] Large irrigation schemes along the river have led to a reduction of water reaching the Aral Sea with significant direct consequences for the environment as well as public health, along with secondary effects such as the decline of fisheries and dust storms affecting the Aral region.[38] Groundwater is not widely used for irrigated agriculture, but is traditionally used for livestock, and its importance for crop production is growing with water scarcity and droughts.[39]

Surface irrigation dominates. More water-efficient technologies for irrigation are very poorly developed: Uzbekistan has 0.11% of localised irrigation, Kyrgyzstan 0.04% of sprinkler irrigation and Kazakhstan 2.5% of sprinkler and 0.9% of localised irrigation. Soil salinization is aggravated by poor irrigation and drainage practices and poorly functioning infrastructure.

Irrigation is characterized by inefficient water use due to system losses caused by a significant amount of degraded, ageing infrastructure, as well as poor management. The use of water efficient technologies remains limited (localized or sprinkler irrigation is below 1%), but water efficiency targets and plans set by Kazakhstan, and modernization programmes in Uzbekistan, are gradually improving the situation.[40] Run-off from irrigated agricultural land is the main source of water quality deterioration in the Syr Darya River and contributes to the continued practice of wasteful water use. There is possible scope to re-use agricultural drainage waters with low salinity.

Irrigated agriculture also creates a high energy demand for pumping water during the growing season, notably in Uzbekistan and Tajikistan. Locally, excessive irrigation and improper drainage in some parts of the Ferghana Valley causes water-logging with high groundwater levels damaging crops and property.

Apart from irrigated agriculture, rain-fed crops, tree plantations and forests (pistachios and fruits) along with animal husbandry, are the key sources of food production for the domestic market, family consumption and food exports. Uzbekistan already leads in the basin in diversity and volume of food production for export – a trend likely to become more prominent in the next five to ten years. Additional investments are likely in food processing and transportation, which might increase a demand for water and cause a significant water footprint.

Because of the optimization of the agriculture sector in recent years, Uzbekistan, the most populous of the countries, is now independent and self-sufficient in food production (with the exception of milk and meat production). Furthermore, this optimization resulted in the development of supporting infrastructure, deep processing of all kinds of raw materials, as well as the establishment of a marketing strategy both domestically and abroad. Thus the rate of growth of agriculture production is higher than population growth. There are similar trends in the other countries. As part of its implementation of the Vision 2050 and the transition to a green economy, Kazakhstan, the largest country in the region, invests in organic agriculture as well as zero tillage and water saving technologies.

Local and national food security priorities and regional export prospects define the changing picture of land use, cropping patterns and ultimately water needs in the region. Table 3 gives an overview of food and cotton crop dynamics in selected provinces of the Syr Darya Basin.

[37] Oblast (Kazakhstan) and national level statistics offices of the riparian countries.

[38] United Nations Environment Programme, *The future of the Aral Sea lies in transboundary cooperation* (UNEP, 2014).

Oleg E. Semenov. Dust storms and sandstorms and aerosol long-distance transport. In Freckle, S-W., Wucherer, W., Dimeyeva, L.A., Ogar, N.P. (Eds.) Aralkum – a Man-Made Desert: The Desiccated Floor of the Aral Sea (Central Asia), *Ecological Studies*, 2012 vol. 218. pp. 73–82.

Andy Thorpe and Raymon van Anrooy, *Inland fisheries livelihoods in Central Asia, policy interventions and opportunities*, (Rome, FAO, 2009).

[39] Karen Frenken, ed. Irrigation in Central Asia in Figures. AQUASTAT Survey 2012. In FAO *Water Reports 39*, (Rome, FAO, 2012).

[40] A relevant example is the IWRM-Fergana project, which involved national teams from Kyrgyzstan, Tajikistan and Uzbekistan funded by the Swiss Development Cooperation and implemented with technical assistance from the International Water Management Institute and SIC ICWC. The project managed to reduce water losses (its primary objective) involving multiple levels of governance and employing agreed procedures and methods for equitable and stable water allocation under the control of water users. Source: Global Water Partnership, Integrated water resources management in *Central Asia: The challenges of managing large transboundary rivers*. Technical Focus Paper, (GWP, 2014).

TABLE 3
Areas of selected crops

	Crops	1991	2005	2010	2015
OSH, KYRGYZSTAN					
	Cereals	70	93	93	95
	Cotton	10	13	12	5
	Vegetables	2	6	6	10
JALALABAD, KYRGYZSTAN					
	Cereals	67	61	68	66
	Cotton	15	30	14	9
	Vegetables	3	6	9	12
BATKEN, KYRGYZSTAN					
	Cereals	28	35	40	41
	Cotton	0	1	0.1	0
	Vegetables	1	2	2	3
SOGD, TAJIKISTAN					
	Total, including:			264	270
	Cereals			133	123
	Cotton			54	57
	Vegetables			13	14
SOUTH KAZAKHSTAN					
	Cereals	240	213	255	
	Cotton	204	137	99	
	Vegetables	24	30	36	
KYZYLORDA, KAZAKHSTAN					
	Cereals	85	85	87	
	Cotton	0.1	0	0	
	Vegetables	5	6	3	

* thousand hectares, data for 2015 or the latest available year.
Source: compilation of data from national statistical agencies

While animal husbandry in the Syr Darya relies mainly on natural pastures in the mountains and deserts and locally available water sources, the importance of this sector in all areas of the basin, coupled with the growing need for forage crops, translates into an additional water need. This need, however, remains low compared to the current water use in irrigation. The next table gives an overview of cattle numbers in the selected provinces of the Syr Darya Basin. In general, Kyrgyzstan and Kazakhstan have sufficient meat and milk production levels for local needs. Uzbekistan and Tajikistan are working to achieve self-sufficiency in these products. All countries are developing meat and milk processing capacities and marketing chains.

TABLE 4
Number of cattle

	2015
OSH, KYRGYZSTAN	340
JALALABAD, KYRGYZSTAN	295
BATKEN, KYRGYZSTAN	127
SOGD, TAJIKISTAN	580
SOUTH KAZAKHSTAN	830
KYZYLORDA, KAZAKHSTAN	260

* thousands, data for 2015 or the latest available year.
Source: compilation of data from national statistical agencies

Traditionally, the Aral Sea and the major Syr Darya reservoirs and lakes – such as Kayrakkum – provided the Syr Darya Basin communities and countries with fish. But with the growing Aral Sea crisis, Uzbekistan's fishery has shifted to the Aidar-Arnasay lakes and fish ponds. Since 2009 the country has boosted its fish production from 6-8,000 tonnes to 45-60,000 tonnes due to a boom in fish farming. Kazakhstan has managed to increase its fish production to over 8,000 tonnes in the Northern Aral Sea because of a water level stabilisation project co-funded by the World Bank and support to the fishery sector.[41] Both Tajikistan and Kyrgyzstan are dependent on the Syr Darya river and lakes for fish, but fish catches here are marginal comparing to the countries' needs. Natural fish resources tend to be overused. In addition, water pollution and the pumping of water for irrigation without fish protection measures adversely affected fish stocks in the Syr Darya basin.[42]

Energy production and distribution

The basin area is strategically located for the development of oil and gas pipeline networks as well as power transmission lines. In addition to the present hydropower plants, the basin has the potential for further electricity generation, and there are plans to export electricity produced in the basin to China and South Asia through high voltage lines. These are currently being built. Upstream hydropower facilities have shifted to energy production to meet the winter peak energy demand in Kyrgyzstan, which has reduced water availability in the growing season for agriculture downstream,[43] altered ecosystems along the river, and led to flooding along the river in winter. Efficient electricity transmission and energy use in general could be improved in all the countries to reduce the pressure on the basin's resources. For example in Kyrgyzstan, grid losses reach 16-18% on distribution lines and 5-6% on transmission lines.[44] For energy source diversification and meeting growing needs, Kazakhstan and Uzbekistan are building heat power stations in the Syr Darya Basin as well as investing in solar power and energy efficiency in housing. Tajikistan and Kyrgyzstan have introduced some energy efficiency measures, but low energy prices and returns remain a critical issue for the major upgrading and expansion of electricity production capacities and reduction of losses in distribution network. The regional project CASA-1000, which is designed to export electricity from Kyrgyzstan and Tajikistan to South Asia, is being planned and partly under construction.

Mining and industry

In all the riparian countries, mining and industry is well developed and have the potential for growth. Particularly in Kyrgyzstan's Syr Darya Basin, mining and industry is considered an engine for the national economy, but it is constrained by the lack of energy outputs, which is mainly generated by the Syr Darya hydropower plants. Tajikistan has major mineral reserves, especially silver, copper and uranium within the Syr Darya Basin, which are yet to be explored and mined. Uzbekistan has probably the most developed and diversified industries and mining facilities in the Syr Darya Basin, while Kazakhstan leads in the production of uranium by in-situ leaching. In the past open-cast and near surface uranium mining created a number of tailings around the Ferghana Valley, which still need to be properly rehabilitated and secured.

Household consumption

Many settlements in the basin depend on groundwater for drinking purposes. For example, in Kyrgyzstan 99% of centrally distributed drinking water in cities comes from groundwater resources, while in rural areas the figure is below 30%. Untreated wastewater due to infrastructure shortcomings puts intense pressure on the quality of water resources. In Tajikistan, 80% of wastewater treatment facilities are not fully functioning. Efforts are being made to improve the reliability and efficiency of urban water supply and wastewater treatment in the major cities of the Syr Darya Basin.

Households rely on electricity for heating. This demand peaks in winter and is met through hydropower production.[45] Use of wood and biomass, as a result of unavailable or unaffordable alternative fuels in rural settlements, is causing localized deforestation, loss of forest-related ecosystems and erosion[46] on top of high levels of indoor air pollution.[47]

[41] Stephen M. Bland, *Kazakhstan: Measuring the Northern Aral's Comeback*. Eurasianet.org, January 27, 2015
World Bank. *World Bank and Kazakhstan Plan Further Improvements in the Northern Aral Sea Area*. Press release, July 10, 2014.

[42] Kyrylo Mirsaidov, *Fish Has Become a Delicacy in Tajikistan*. ASIA-PLUS news agency, Dushanbe, February 27, 2014 [in Russian].

[43] World Bank, *Water and Energy Nexus in Central Asia, Improving Regional Cooperation in the Syr Darya Basin*. (Washington D.C., World Bank, 2004).

[44] TECHECONOMMODEL, Ministry of Energy and Industry of Kyrgyzstan, *Study on the application of energy efficiency and renewable energy advanced technologies in Central Asian Countries*. A report for the United Nations Office in Geneva, 2013.

[45] It is worth noting that the total primary energy consumption per capita in Kyrgyzstan and Tajikistan is low compared to Kazakhstan and Uzbekistan, influenced by various factors relevant to energy intensity of a nation's economy: KZ – 150, KG – 44, TJ – 26 and UZ 78 million BTU per person.

[46] United Nations Economic Commission for Europe, *Second Environmental Performance Review of Uzbekistan*, Environmental Report Series No.29, (New York and Geneva, United Nations, 2010).

[47] World Bank, *Keeping Warm: Urban Heating Options for the Kyrgyz Republic*, (Washington D.C., World Bank, 2015).

4.2. National economic policies

KAZAKHSTAN

The primary goal of Kazakhstan's economic policy is a "transition to a green economy". This goal is to be realized by means of the Kazakhstan-2050 and the *Concept of Transition of the Republic of Kazakhstan to Green Economy*[48] (2014) state programmes. 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 those in poverty by offering, for example, preferential credits and social payments to reduce the impact of tariff increases on the most vulnerable groups. For example, electricity companies offering discounts to users will be compensated by the State. (Workshop, 2014).

Water

The national legislation of Kazakhstan is progressing with the introduction of IWRM principles. This progress is clear from the adoption of a basin approach to water management. Basin councils have been created and efficient use of water resources are promoted. 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 'Kabuli. 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", and is a component of the final round of consultations between Kazakhstan and the World Bank. Another special programme, scheduled for 2011–2020, is devoted to providing drinking water to South Kazakhstan and to collect macro-biological indicators.

Energy

Kazakhstan produces electricity primarily from fossil fuel (coal, oil and natural gas), and the country's economy is relatively energy-intensive. Kazakhstan has ambitious energy sector goals, as described in the Concept for Transition to a Green Economy, 2014. For example, the share of low-carbon energy (solar, wind and nuclear) must be equivalent to no less than 3% of all energy by 2020, 30% by 2030 (including 10% solar and wind), and 50% by 2050. Modernization of equipment is expected to allow for an increase in energy efficiency by 15-40%. Kazakhstan also plans to reduce the energy intensity of its GDP by 25% by 2020, as compared to the 2008 baseline. A National Utilities Modernization Programme (NUMP) calls for the modernization of significant stretches of heat, electricity and gas distribution networks to be completed by 2020. Kazakhstan also adopted two laws in 2009 to support renewable energy sources and energy saving and energy efficiency.[49] In southern Kazakhstan, including the Syr Darya basin, there are plans to develop wind and solar parks and equip remote water wells in pastures with solar-powered pumps.[50] Astana EXPO-2017 "Energy for the future", to be held in Kazakhstan in the summer of 2017, will bring together regional and global players in renewable energy and is likely to boost the prospects for renewable energy in the region.

Agriculture

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

Environment

The Concept for Transition to a Green Economy specifies that the "environmental flow" into the 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 in Chimkent, Kyzylorda, Turkestan, Shardara, Saryagash and Baykonur are currently being renovated.

KYRGYZSTAN

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

Water

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

Energy

Kyrgyzstan has almost no hydrocarbon reserves of its own, and imports almost 100% of the oil and natural gas it needs and up to 50% of coal.[51] Hydropower provides more than 90% of domestic electricity, and Kyrgyzstan plans to further develop its hydropower generation to increase electricity export. Despite the reduction of electricity use in industry and agriculture, the

[48] Government of Kazakhstan. *Presidential Decree signed 20 May 2014: Transition to Green Economy Strategy Kazakhstan* – 2050, (Astana, Ministry of Environment Protection, 2014).

[49] TECHECONOMMODEL, Ministry of Energy and Industry of Kyrgyzstan, *Study on the application of energy efficiency and renewable energy advanced technologies in Central Asian Countries.* A report for the United Nations Office in Geneva, 2013.

[50] See Climate Policy Scorecards, prepared by Zoï Environment Network in cooperation with the European Commission / DG Climate Action at http://www.zoinet.org.

[51] Vladimir Volosskiy, *Specific Aspects of the Energy Systems in Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan*. Unpublished paper for UNECE, 2016.

recent trend of growing consumption in the municipal sector also means that electricity generation needs to be increased overall. This is problematic as much of the electricity generation machinery is no longer fit for purpose. The development of new hydropower facilities remains a priority, including the construction of Kambarata-1 station by 2022, the Upper Naryn cascade by 2019, and the second generator at the Kambarata-2 station due to be launched in 2019. Small hydropower is also increasingly garnering interest, which can partly help to overcome power shortages in some parts of the country. The energy strategy until 2025 includes the further development of renewable energy, up to 4% of its overall potential (currently less than 1% is used).[52]

Land Use/Agriculture

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

Environment

The State Programme "Forest" envisages an increase in the country's afforestation from 4.25% in 2000 to 6% in 2025. The policy on adaptation to climate change in the Kyrgyz Republic covers all key sectors: water resources, agriculture, public health, climate emergencies, forest resources and biodiversity.

TAJIKISTAN

Tajikistan's Development Strategy up to 2030 (in preparation at the time of writing) provides for the sustainable management of natural resources and highlights priorities in the context of the Sustainable Development Goals (SDGs).

Energy

Tajikistan globally ranks eighth in terms of hydropower resources, but only 5% of this potential is currently in use. The country is a net importer of fossil fuel, and suffers from regular power shortages, especially in winter. Meanwhile demand for electricity is growing, - particularly in winter when it is increasingly used for heating houses. New thermal power generation facilities are being developed to cope with winter deficit, while hydropower modernization projects are planned to increase the existing capacity of the generators by up to 10%. This increase in capacity will primarily occur at Kayrakkum and Varzob power plants, the large stations of the Vakhsh River cascade. The new Rogun and Sangtuda hydropower plants will also allow for a larger-scale electricity export.[53] There are no known plans for the construction of large hydropower plants on the Syr Darya river. The Program of Small Hydropower Plants development until 2020 aims to support the integration of small-scale renewable energy sources.

Water

In Tajikistan, the law on Water Users Associations (WUAs) of 2002 was revised in 2013, with updates to the regulatory framework and the implementation of new water sector reforms, for example to move towards basin and sub-basin water resource management and to improve technical capacity. Tajikistan's transition towards IWRM principles is in its early stages, although the country has introduced provisions for basin management.

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 land reform, improving the forms of management of crops and livestock. In line with 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, enshrining the freedom to farm, guaranteeing market regulations, and ensuring a fair and steady supply of agricultural goods and services. The principal focus in Tajikistan is addressing the issue of land reclamation. The overall production of all crops (with the exception of wheat) is expected to grow and in particular in Sogd oblast. Currently, the priority is to increase the share of vegetable and fruit production, as well as to increase the cultivation and processing of cotton(Workshop, 2014).

Environment

Salient strategy documents in the field of natural protection include the National Environmental Programme and the National Strategy and Action Plan on the Conservation and Sustainable Use of Biodiversity. These focus on addressing the major environmental challenges faced by Tajikistan: (i) natural disasters (ii) land degradation (iii) deforestation and desertification (iv) limited availability of safe drinking water (v) low levels of water treatment and (vi) forests, wildlife and protected areas.

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 and was adopted in 2007.

UZBEKISTAN

Uzbekistan began implementing the Strategy for Welfare Improvement in 2010, which aims for an effective, functioning and innovative welfare system by 2020.

Water

Supported by donors, Uzbekistan is implementing several projects to improve sanitation and wastewater treatment.[54] The Program on Integrated Development and Modernization of Water Supply and Sanitation until 2020 focuses on the new concepts of integrated development and the modernization of water supply systems and sanitation.

[52] Vladimir Volosskiy, *Specific Aspects of the Energy Systems in Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan*. Unpublished paper for UNECE, 2016.

[53] idem

[54] Karen Franken, ed. *Irrigation in Central Asia in Figures. AQUASTAT Survey 2012*. FAO Water Reports 39, (Rome, FAO, 2012).

Energy

Uzbekistan's industrial policy focuses on maintaining economic security and energy independence.[55] The country is rich in fossil fuel, ranking the eighth worldwide for natural gas production. Other resources include oil, coal, uranium and hydropower. The country's economy however, is rather energy-intensive. Most power generation and many electricity transmission facilities date back to the Soviet era and require renovation. To address these needs, Uzbekistan continues to reform its power generating and coal-mining sectors, gradually replacing part of the share of natural gas with coal. Uzbekistan has high renewable energy potential, and is planning to implement a large-scale solar energy programme. The construction of the first large solar power plant[56] in Uzbekistan began in 2015 in Samarkand oblast, outside the Syr Darya Basin. Some renewable energy installations are also now beginning to supply remote areas. For example, a solar power plant with 130 kW capacity has been installed in Namangan (in the Ferghana valley) to serve the isolated district of Kandigon[57].

Land Use/Agriculture

Food security remains of strategic importance. Restructuring the agricultural sector, the main consumer of water, focuses primarily on changing crop patterns, investing in irrigation-water supply and water-saving technologies, the creation of farmer institutions and improving the water management efficiency. In Uzbekistan a 'Fund for Irrigated Land Reclamation' was established by the Ministry of Finance in 2007. The new programme for agricultural development in 2015-2019 is currently under consideration, and will provide, among other things, for the optimization of cotton production. A gradual reduction in cotton production is already taking place, with cereals, vegetables, melons, potatoes, and fodder crops being produced instead. The implementation of these policies has lowered the rising cost of food products at the national level, even during 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 the stability of water supply 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 being upgraded, but the creation of basin councils has not yet been legally recognized. Improvement in 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 2013-2017.

Environment

A number of other governmental strategies have been adopted to address ecological challenges These included the State Programme for Environmental Protection and the Rational Use of Natural Resources (adopted on 27 May, 2013 for the period 2013-2017) and the National Action Programmes to Combat Desertification and Biodiversity Conservation (both drafts are under discussion for the period 2020-2025). 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 for regional water resource management for the Aral Sea basin; (v) increasing land productivity; and (vi) improving the economic mechanism for environmental protection and the use of natural resources.

4.3. Regional economic integration and cooperation

The Syr Darya countries have prioritized self-sufficiency in food and energy production over economic cooperation. This has led to the adoption of uncoordinated solutions that increase pressure on shared water resources. Prospects for improved trade, and for energy and food in particular, could mitigate these consequences, with the energy trade potentially playing a major role in the development of the energy sector of all the countries. The necessary technical infrastructure is in place but at present the political situation does not allow for the related benefits to be realized.

The development of a regional market for agricultural products has strong potential to positively influence economic growth in the countries in the region, as well as their choice of crops. Kazakhstan and Uzbekistan are leading wheat producers and exporters[58] and there is potential to expand the fruit and vegetables market.[59]

Detailed analysis of intra-regional trade in agricultural products reveals that trading is predominantly between Kazakhstan, on the one side, and Kyrgyzstan, Tajikistan and Uzbekistan, on the other. The trade between the latter three countries in agricultural goods and foods is small and unstable. In 2011-2012, the turnover of agricultural trade between the three countries was about US$40 million, equivalent to well below 1% of their total trade turnover in agricultural products.

The product structure of this trade is simple. Kazakhstan exports primarily wheat grain and flour, and some prepared foods to the other countries. In turn, they supply Kazakhstan with fruits and vegetables. Trade in other products is lower and unstable and is insignificant at the regional and national levels. However, trade in other products have some local importance; for example, exports of dairy products from northern Kyrgyzstan to southern Kazakhstan. Kazakhstan has a stable positive balance in the trade of its agricultural products with its southern neighbours.

[55] Vladimir Volosskiy, *Specific Aspects of the Energy Systems in Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan*. Unpublished paper for UNECE, 2016.

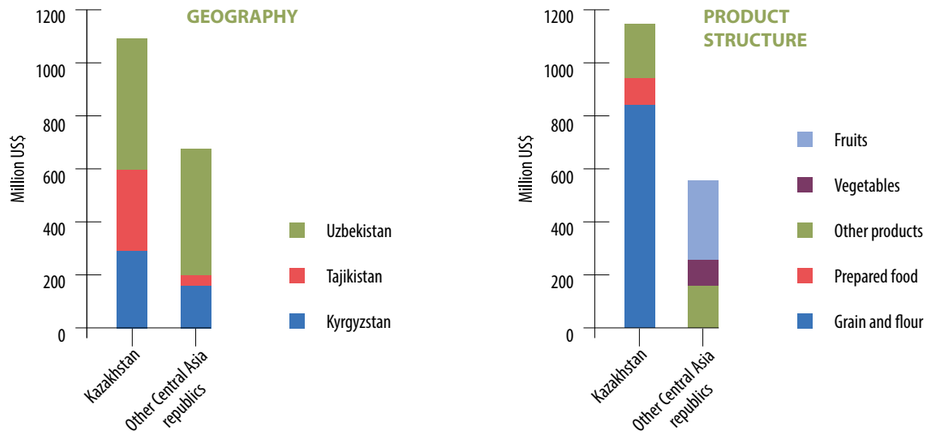
[56] In accordance with the Decree of the President of the Republic of Uzbekistan № PP-2183 from 04.06.2014g "On measures to implement the investment project *Construction of a solar photovoltaic power plant 100 MW in the Samarkand region*", work on the project has started.

[57] *First Solar Power Plant Launched*. Gazeta.uz, Tashkent, December 29, 2014 [in Russian].

[58] Food and Agriculture Organization of the United Nations, *Food Outlook*. Biannual report on Global Food Market, (Rome, FAO, 2014).

[59] United Nations Economic Commission for Europe, *Regulatory and procedural barriers to trade in Kazakhstan*, (New York and Geneva, United Nations, 2014).

FIGURE 3
Trade in agricultural goods between Kazakhstan and other Central Asian republics



* 2012 data from national statistical agencies

FIGURE 4
Product structure of agricultural trade in Central Asia

* 2012 data from national statistical agencies

BOX 1.
Barriers to trade in selected Central Asian countries

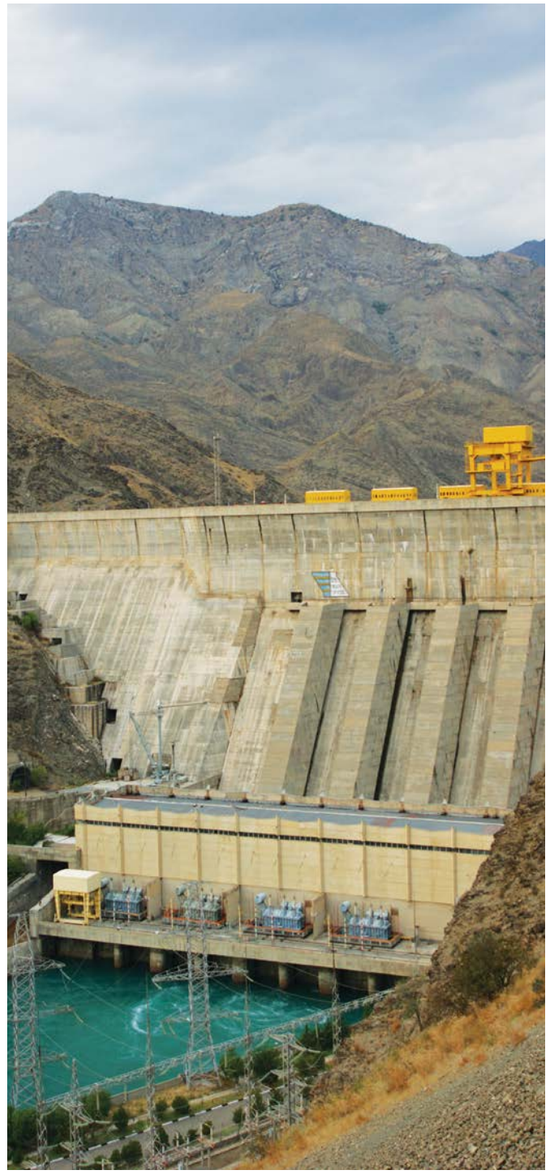
- Lack of adequate legal, technical, physical trade and transport infrastructure
- Lack of adequate facilities and inter-agency coordination at border control
- Weaknesses in standard-setting and implementation
- Weak strategies guiding quality control, food safety and quality assurance
- Weak national laboratory testing and conformity assessment capacity
- Stringent and complex documentary requirements for export and import (time and financial burden for traders)
- Transparency issues (including lack of access to accurate, up-to-date information for traders)

Source: Studies on Regulatory and Procedural Barriers to Trade by the UNECE Trade Programme: http://www.unece.org/tradewelcome/studies-on-regulatory-and-procedural-barriers-to-trade.html

Despite progress in domestic production and strengthening regional cooperation, the countries of Central Asia face a number of barriers and obstacles to trade. Some of these barriers are shared by all four countries, while others are country-specific (see box).

In the electrical power sector, the basic direction of change after independence was the creation of energy infrastructures that ensured power independence for each state. Thus the necessity of preserving cooperative relations in the sphere of electrical power, developed earlier at the Central Asia states, began to vanish. Despite constant acknowledgement by the Central Asia states of the advantages of regional cooperation in this sphere, gradually the tendency towards power independence began to emerge in national power strategies and plans. Ultimately, a transition from the concept of regional energy cooperation to one of national energy self-sufficiency took place. This approach has led to various instances of inefficiency – high power consumption, high carbon intensity, higher cost of deliveries – and has threatened the safety and reliability of the power supply. This is best exemplified by Tajikistan's winter energy crisis of 2008.

Regional power cooperation only began to be considered as a mechanism for realizing export opportunities. Thus the importing of electrical power from neighbouring states in the region is not envisaged and is not planned. In 2014 the volume of electricity trade did not exceed 3.2% of any Central Asian country's domestic consumption. The incomplete liberalisation of the energy market is often seen as the main barrier to a fully functional electricity trade within the CIS. But CIS regulations do not allow for supra-national market control mechanisms that would eventually be required. Such mechanisms are in principle possible under the regulations of the Eurasian Economic Union. Among the CIS countries, Kazakhstan is one of the leaders in liberalising its national energy market[60].



In its 2013 analysis of Uzbekistan's energy sector, the World Bank confirmed the benefits of regional cooperation for the country's energy system. Coordinated and optimised seasonal electricity trade with neighbouring states could convert USD 700 million of investments into 500 MWt of Uzbekistan's own power generation capacities.[61] Recent regional studies commissioned by the World Bank[62] and the ADB[63] also point to numerous tangible benefits of energy trade and cooperation.

[60] Vladimir Volosskiy, *Electricity Cooperation and Sustainable Development of the Central Asia States*. Unpublished paper for UNECE, 2016.

[61] Artur Kochnakyan, Sunil Kumar Khosla, Iskander Buranov, Kathrin Hofer, Denzel Hankinson, Joshua Finn, *Uzbekistan: Energy / Power Sector Issues Note*, (Washington D.C., World Bank, 2013); see also World Bank, *Project Appraisal Document on Proposed Grants for a Central Asia – South Asia Electricity Transmission and Trade Project (CASA-1000)*, (Washington D.C., World Bank, 2014).

[62] *Mercado's – Energy Markets International. Load dispatch and system operation study for Central Asian power system. (Madrid, Mercados – Energy Markets International, 2010).*

[63] Fichtner GmbH & Co. KG, *Central Asia Regional Economic Cooperation: Power Sector Regional Master Plan*. Technical assistance consultant's report for the Asian Development Bank, (Manila, ADB, 2012).

CHAPTER 5

Selected nexus issues and the outlook

Energy, water and land resources are closely linked in the Syr Darya Basin. The diagram below provides an overview of the current nexus linkages. In the Syr Darya Basin water-energy and water-land links are particularly important, as they both affect the state of ecosystems.

FIGURE 5
Nexus interlinkages in the Syr Darya Basin (current status)

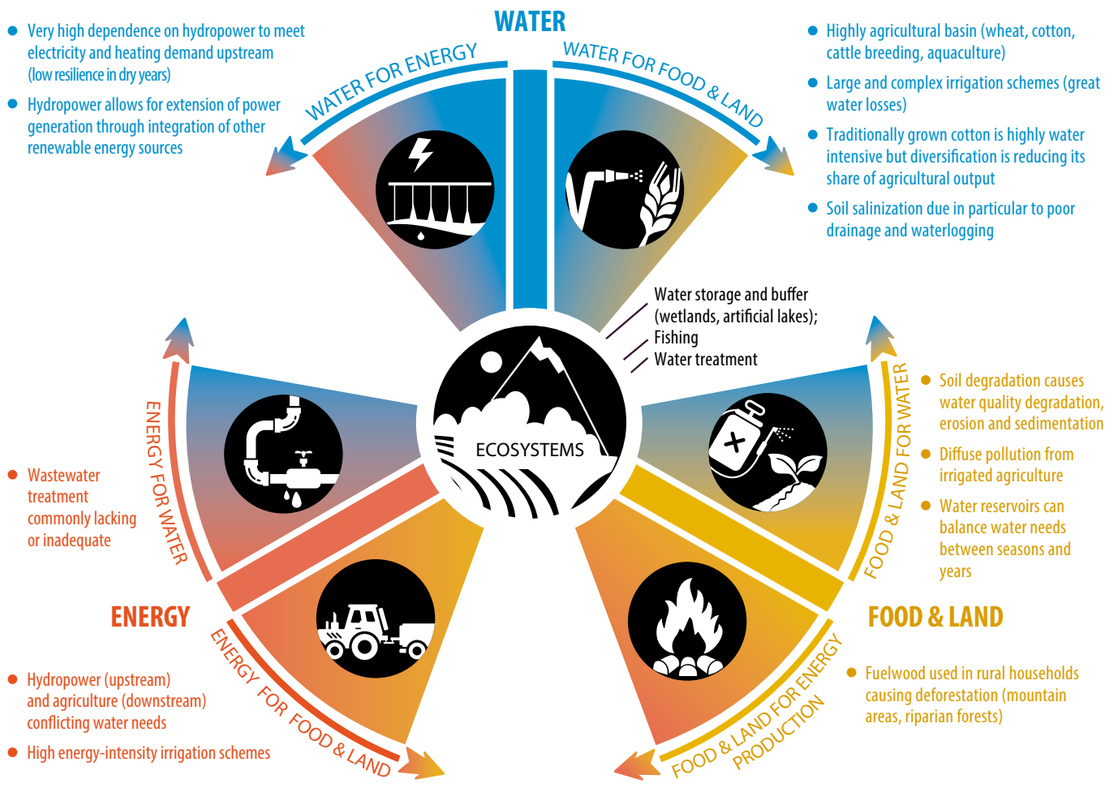
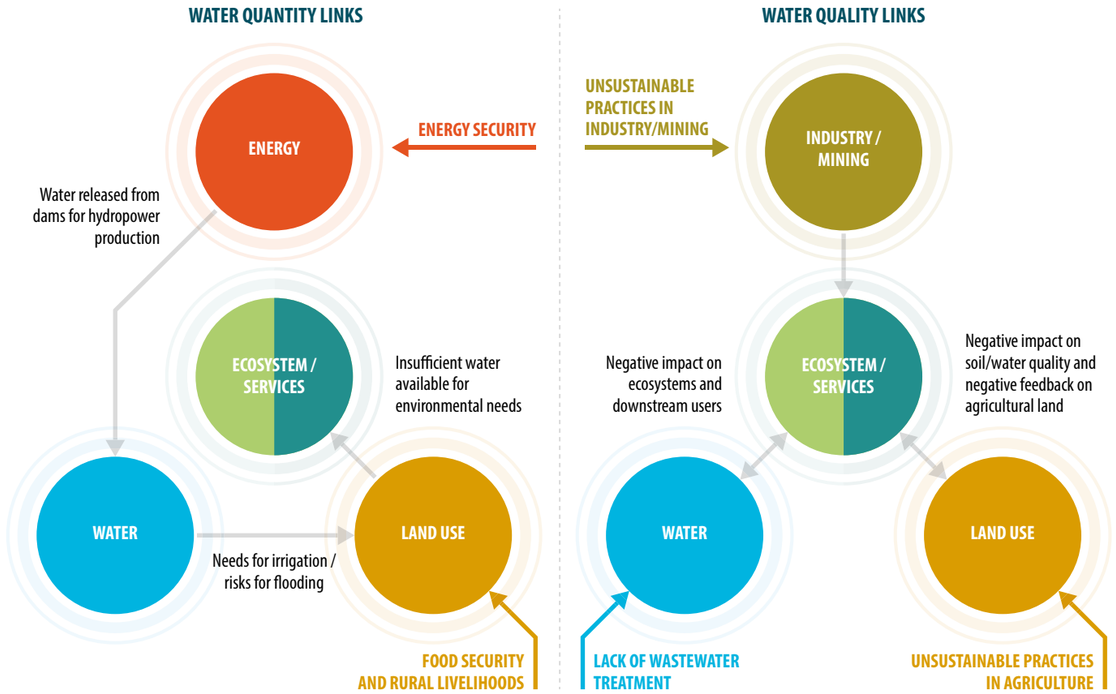


FIGURE 6
Nexus interlinkages in the Syr Darya Basin (water quantity and quality)



5.1. Water, Energy and Food

When compared to the Soviet era, overall annual freshwater withdrawal in Central Asia has decreased. The demand for water, however, is now expected to expand with population growth. A warmer climate may further increase irrigation needs, change the optimal timing for irrigation and cropping, and affect the hydrological cycle. These factors could be counter-balanced by the replacement and modernization of outdated infrastructure with more efficient and better coordinated water-energy policy and trade schemes. In addition, all countries are oriented towards crop diversification and a shift in production from cotton to less water-intensive crops.

The 1998 *Agreement on the Use of Water and Energy Resources in the Syr Darya River Basin*[64] provided a framework for energy exchanges and the regulation of water discharges until the early 2000s. However, the 1998 Agreement was never effectively enforced by the parties, although no formal withdrawal was ever arranged.

Kyrgyzstan and Uzbekistan are the most dependent on the Syr Darya Basin water for power production. Kyrgyzstan is reliant on hydropower, while many of Uzbekistan's thermal power plants and oil refineries use the Syr Darya water for cooling and other energy production needs, and most of the country's hydropower stations are built there. Kyrgyzstan, the upstream mountain nation, where hydropower is the main source of energy, operates reservoirs in a mode adapted to meet a winter peak power demand, resulting from heating needs.[65] In winter, water discharges from upstream dams tend to be higher than natural flow and lower in spring and summer. This limits access to water for irrigation during the growing season. Energy and irrigation needs can be met during wet years with mild winters, but during dry years and cold winters both sectors may suffer. In dry years, demand for irrigation is high, while the water availability, in addition to flow regulation, also depends on the availability of snow and glacial melt. The combination of a dry vegetation season with low meltwater availability followed by a cold winter, is a recipe for a critical situation for both the irrigation and energy sectors. Moreover, there are significant energy requirements for pumping water in the large-scale irrigation and drainage systems. Water shortages in the summer have already been reported to affect thermal power plants in the Syr Darya Basin.

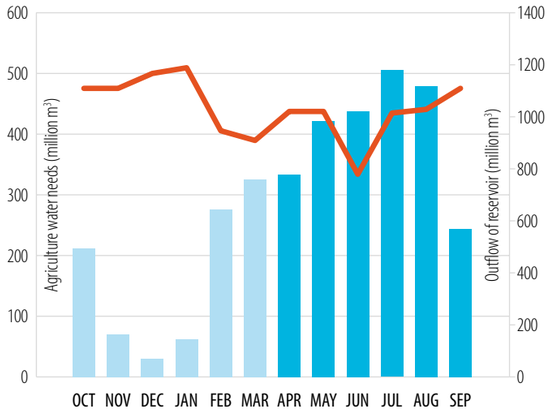
[64] This agreement was concluded between Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan.

[65] As previously stated, the main hydropower production and potential of Tajikistan is outside the Syr Darya Basin, and the main hydropower production upstream, discussed here, takes place in Kyrgyzstan. The shift in operation regime has been gradual from the flow regulation system's initial optimization for agricultural production (cotton at the time).

[66] World Bank, *Water and Energy Nexus in Central Asia, Improving Regional Cooperation in the Syr Darya Basin*, (Washington D.C., World Bank, 2004).

FIGURE 7
Trade-off between hydropower and agricultural water needs

Discharges of the Toktogul dam and Fergana valley needs by month in 2011.
The year 2011 was average in terms of water availability.



Source: Central Asia Water Info database (ICWC-SIC).

The Kambarata-1 and 2 dams in Kyrgyzstan would have a smaller water capacity than the Toktogul, but a relatively high generation potential. According to the Kyrgyz authorities, their operation would allow for the Toktogul to return to an irrigation-friendly mode, which would greatly benefit the downstream agricultural areas and avoid harmful emissions into the atmosphere, which would otherwise occur from heat power plants of similar capacity. In order to upgrade and properly maintain the existing power generation system and to make energy projects attractive to investors, Kyrgyzstan began to increase electricity tariffs. There are indications that, when combined with a more careful attitude to energy use, power consumption has decreased by 20%.

Uzbekistan and Kazakhstan remain concerned about hydropower developments upstream. But at the same time, there has been a tendency to build dams and facilities downstream to support irrigation, power co-generation, and the reduction in the impact of floods. The Koksarai dam in Kazakhstan and the Andijan hydropower station-2 are two examples of this, among others.

The future dynamics and interactions between agriculture and energy production and water is somewhat uncertain in the Syr Darya Basin. A scenario exercise at a regional workshop revealed the following uncertainties that may affect these future dynamics: the spirit of regional cooperation and geopolitics, population movement (migration of the rural population and agricultural workers) and climate change.

Water and energy inefficiencies also play out and reinforce each other at the local level, for instance with respect to irrigated agriculture (see box).

BOX 2.
Water and energy challenges in irrigated agriculture

Tajikistan's heavily subsidised irrigation accounts for 90% of water withdrawals in the country and 40% of the total electricity bill during the irrigation season. With more than 80% of the total irrigated area in the Tajik section of the Syr-Darya river relying on pump irrigation, inefficiencies in water and energy use are found to reinforce each other. The generally low water efficiency puts additional pressure on the pump infrastructure and therefore reinforces the losses of the energy sector, while conversely, obsolete pumping equipment, the poor technical conditions of pumps, an unreliable electricity supply and frequent power outages are among the factors that contribute to inefficiency in water use. For example, power outages lead to increased demand for water immediately after the problem is fixed, because of the need to re-establish the flows in the emptied pipelines and irrigation canals. This is particularly true for the Sogd region of Tajikistan, where most of the areas under high lift pump irrigation (up to 300 meters) are located. The choice of crops is also one of the determining factors in the use of water and energy resources. Although the area under cotton production reduced from 24% of total arable land in 2011 to 16% in 2015 in the Sogd region, cotton production is favoured by farmers as it represents the only (relatively) established value chain. At the same time, agriculture productivity remains low, ranging for cotton from 1.4 t/ha in the Asht district to 2.1 t/ha in the Kanibadam district.

Source: FAO (data by FAO, the Agency on Land Reclamation and Irrigation and the Statistical office of Tajikistan, analysis by Farzona Mukhitdinova and Rishabh Jain)

In Uzbekistan, more than 75% of pumping stations used for irrigation have exceeded their operational lifetime and require modernization or replacement[67]. To address local water-energy inefficiencies, Kazakhstan has implemented volumetric water tariffs with differentiated tariffs across provinces according to water scarcity levels.

Inefficiencies in countries' energy systems (see box) also significantly contribute to nexus dynamics.

BOX 3.
Energy losses in Central Asia

Along with other CIS member-states, Central Asian countries rank among the lowest worldwide by energy efficiency per unit of GDP[68]. Their chains for electric power production – from generation to transmission, distribution and sales – have a relatively low operational efficiency. Combined with low efficiency of water and energy use in agriculture this is a serious challenge for the region.

The key efficiency indicator of power generation is the fuel intensity of electrical supply. In Central Asian countries between 2007 and 2014 its value was relatively high, above 300 g per kWh.-hour, regularly exceeding 400 g per kWt-hour in Kyrgyzstan and Uzbekistan. (For comparison, the best value in 2014 across the CIS was reached by Belarus: 246.8 g per kWt-hour.) Losses in the transmission and distribution networks between 2004 and 2014 were between 10 to 20% of generated electricity in Uzbekistan and Tajikistan and up to one third of all energy generation in Kyrgyzstan, which points to the poor technical state of the electricity grid.[69]

[67] Vladimir Volosskiy, *Electricity Cooperation and Sustainable Development of the Central Asia States*. Unpublished paper for UNECE, 2016.

[68] World Bank, *Water and Energy Nexus in Central Asia, Improving Regional Cooperation in the Syr Darya Basin*, (Washington D.C., World Bank, 2004).

[69] According to official data of Kazakhstan's operator KEGOC, in 2014 grid-related losses in Kazakhstan amounted to 2.77% of generated electricity. This is the lowest across Central Asia and the CIS as a whole, however the provided data may only account for losses in transmission as opposed to distribution networks.

[70] Fichtner GmbH & Co. KG, *Central Asia Regional Economic Cooperation: Power Sector Regional Master Plan*. Technical assistance consultant's report for the Asian Development Bank, (Manila, ADB, 2012).

[71] Igor Tomberg, *Power industry of Central Asia: problems and the future*. Website of the Russian International Affairs Council, 2012 http://russiancouncil.ru/inner/?id_4=324#top-content [In Russian].

BOX 4.
Energy losses in Central Asia

FIGURE 8
Fuel intensity of electric supply (g / KW-h)

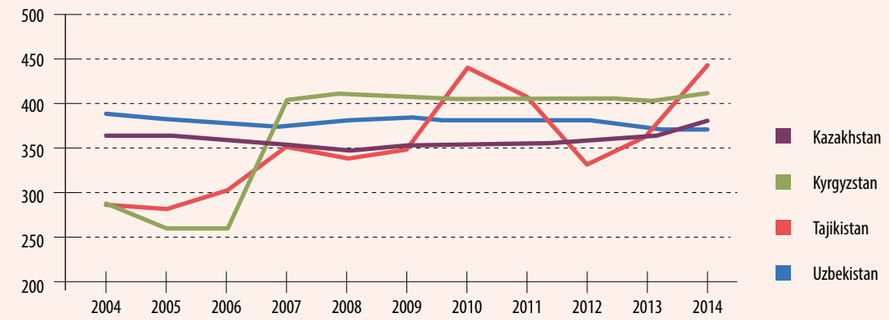


FIGURE 9
Electricity losses in transmission and distribution networks (%)

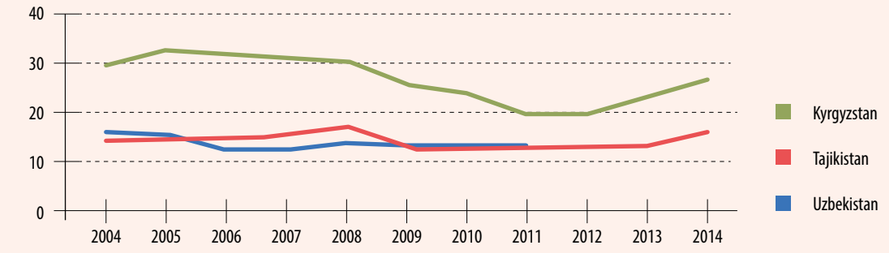
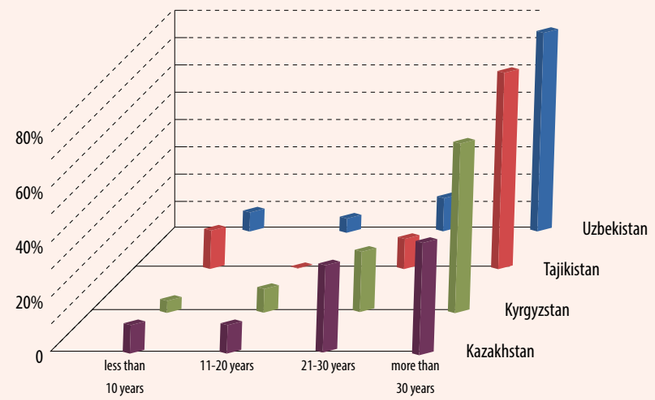


FIGURE 10
Operating age of power facilities



The recent dramatic increase in the use of electricity for house and water heating in Kyrgyzstan has significantly increased pressure on distribution networks. The depreciation of the network infrastructure currently stands at 50%. Only 14% of measuring equipment complies with modern requirements; the rest were manufactured in the 1950s, are prone to serious measurement errors, and are not safeguarded against undue intervention. All this results in the unduly large amount of technological and commercial losses in electricity distribution.

A recent study for the ADB[70] attributes the main challenges of power supply in Central Asia to ageing generation equipment. Dated infrastructure increases the risk of malfunction in the countries' energy systems, reduces the quality of supplied electricity and negatively affects the region's economics and quality of life. Lacking investment in new generation capacity, within the next twenty years some of the countries are likely to face the uncontrolled deterioration of power infrastructure inherited from the Soviet Union[71].

Source: Vladimir Volosskiy, Electricity Cooperation and Sustainable Development of the Central Asia States. Unpublished paper for UNECE, 2016

5.2. Water and Land

As a consequence of the extensive irrigation in the Aral Sea Basin between the 1950s and 1980s the level of the Aral Sea declined and the sea became divided into several water bodies with fluctuating water levels and salinity. However, the Northern Aral Sea fed by Syr Darya has stabilized after the construction of the Kok-Aral Dam build by the joint efforts of Kazakhstan and the World Bank.

Unsustainable former practices of extensive irrigation led to soil salinization and seriously declining soil fertility, even though the practices have been gradually modernized.[72] The upstream part is affected by erosion and a substantial part of the irrigated land downstream is salinized or waterlogged. Land degradation and salinization over decades led to the high use of water to wash away the salts, and the problem remains serious despite ongoing efforts with soils amelioration. Uzbekistan reported having already reduced the extent of saline soils by 60,000 ha in response to a government decree adopted in 2007.

While agriculture contributes to water pollution through contaminated runoff (in the form of fertilizer and pesticide remains), because of costs, the amount of mineral fertilizer used in the Syr Darya Basin has decreased since Soviet times. The flow of salinized drainage waters from agricultural lands to the river also contributes to water quality deterioration.

Reducing the volumes of water deployed for irrigation, optimizing soil reclamation and improving the management and use of drainage waters can reduce soil salinization and water pollution caused by agricultural run-off. Some rehabilitation and modernization of existing irrigation systems, including the introduction of drip irrigation, has been carried out, notably in Kazakhstan and Uzbekistan. According to SIC-ICWC's information, the application of irrigation water has been reduced in Uzbekistan from 18,000 m^3/ha in 1990 to 10,500 m^3/ha in 2008. Uzbekistan has already installed water efficient drip irrigation systems covering more than 15,500 ha of cultivated land, and plans to extend this system up to 25,000 ha by 2017.

The high investment costs, limited access to finance and insufficient knowledge among farmers are some factors complicating the upscaling of water efficient technologies.

5.3. Climate change as an additional stressor

Weather and climate factors play a crucial role in food and hydropower production. They define water flow in the rivers, flood and drought severity and the pattern of seasonal energy and water uses. Water availability in the Syr Darya Basin, especially its glacier sub-basins, is projected to increase or remain stable in the near future due to the intensification of glacier melting and the hydrological cycle.[73] With the continued temperature increase beyond the mid-century, the decline of glaciers and the changing nature of snow cover, (for example earlier snowmelt) the basic hydrology in the mountains will change and may reduce water availability when it is most needed for food production.[74]

Of the four Syr Darya Basin countries, Kazakhstan, Kyrgyzstan and Tajikistan submitted their Intended Nationally Determined Contributions (INDCs) to the UNFCCC in advance of the Paris Climate Change Conference in December 2015.[75] This conference led to the adoption of the new Paris Climate Change Agreement 2015, which entered into force in November 2016 and paves the way for global and national climate change actions beyond 2020. The Paris Agreement was signed by Kazakhstan, Kyrgyzstan and Tajikistan.

The stated climate change goals of Kyrgyzstan and Tajikistan mention both adaptation and mitigation, with an emphasis on loss and damage from extreme weather and disasters and the need for adaptation actions. Both countries have developed strategies and action plans on adaptation in its totality and for specific sectors. Tajikistan, with support of the European Bank for Reconstruction and Development (EBRD) and other international donors is currently rehabilitating the Kayrakkum dam and reservoir on the Syr Darya River.[76] These rehabilitation measures are being undertaken both to help mitigate the impact of climate change and to improve the climate resilience of the facility's hydropower and irrigation capacity. Both countries are members of international strategic climate resilience programmes.[77] Kazakhstan's climate targets include limiting the greenhouse gas emissions and significantly increasing the share of renewable energy production. Other countries are also planning the development of renewable energy (see sectoral trends above). However, when competing goals are taken into consideration, such as achieving maximum power independence and exporting electric power, Central Asian countries also aspire to the prompt creation of additional generating capacities, and therefore, in practice, the development of renewable energy in the region is not yet a priority.[78]

[72] Among such unsustainable agricultural practices in the Syr Darya Basin are, for example, monocropping of cotton, inappropriate use of fertilizers and pesticides, inadequate soil management, and overgrazing of rangelands.

[73] Intergovernmental Panel on Climate Change, *Fifth Assessment Report*, (Geneva, IPCC, 2014).

[74] Andreas J. Dietz, Christopher Conrad, Claudia Kuenzer, Gerhard Gesell and Stefan Dech, Identifying Changing Snow Cover Characteristics in Central Asia between 1986 and 2014 from Remote Sensing Data. In Remote Sensing 2014, 6(12), 12752-12775; doi:10.3390/rs61212752.

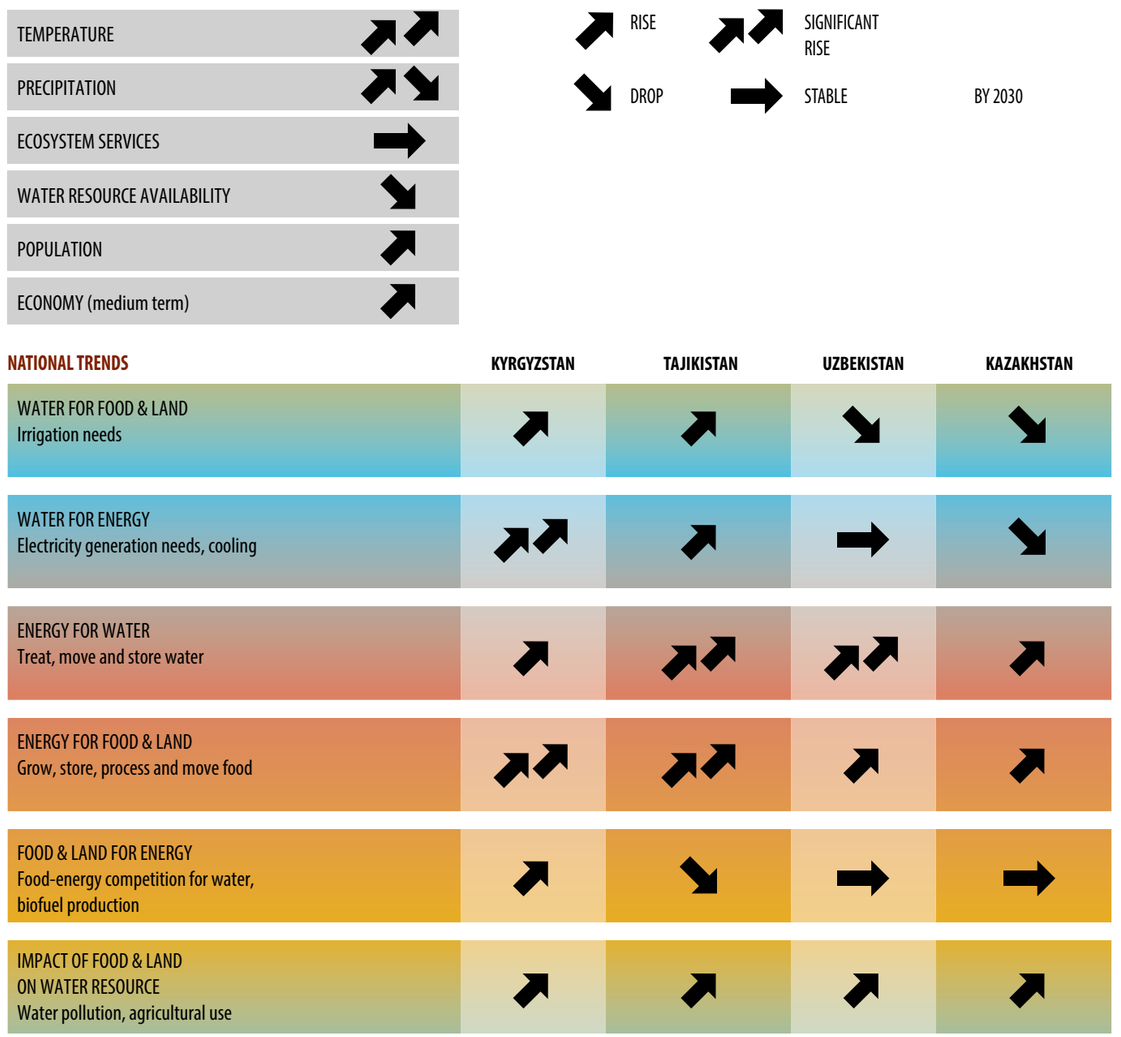
[75] All submitted INDCs can be accessed through the UNFCCC web site: http://unfccc.int.

[76] *European bank, donors fund modernization of 126-MW Kayrakkum hydro project*, HydroWorld.com, 08/07/2014.

[77] Pilot Program for Climate Resilience: https://www-cif.climateinvestmentfunds.org/fund/pilot-program-climate-resilience.

[78] Vladimir Volosskiy, *Electricity Cooperation and Sustainable Development of the Central Asia States*. Unpublished paper for UNECE, 2016.

FIGURE 11
Future trends in the Syr Darya Basin and the riparian countries



CHAPTER 6

Nexus solutions and recommendations

The nexus assessment of the Syr Darya Basin includes the identification of solutions to improve the management of the basin's land, water, energy and ecosystems. These potential solutions have been grouped into five action areas: institutions and governance; information; instruments and incentives; infrastructure and technology; and international cooperation and coordination. Each of the riparian countries have already taken action in a number of these areas. But more could and should be done to ensure that the Syr Darya nexus challenges are duly addressed and that potential benefits are enjoyed by a greater number of actors in more areas.

Prioritizing national solutions over solutions based on regional cooperation has established a vicious cycle. Solutions based on national self-sufficiency that lead to non-compliance with the regionally agreed frameworks created the negative impact for these riparian nations. The effect of this impact led to system fragmentation and a crucial change in the functioning of the key inter-dependent blocks, as well as an additional loss of trust and reduced opportunities for future cooperation.

Cooperation involving all the countries – as well as sectors – has great potential in terms of optimizing the use of available resources, natural geography and the distribution of population and assets. Coordinated monitoring and information exchange on water quantity, quality and hazards would allow for better planning of activities along all of the river. The results of a scoping assessment of transboundary cooperation benefits are summarized in the table that follows the analytical framework of the UNECE guidance on identifying, assessing and communicating the benefits of transboundary water cooperation.[79]

Adopting a nexus approach to managing water, energy and land resources, as well as ecosystem services, would make it possible to capitalize on the potential benefits provided by the basin's resources and increase efficiency in resource use and overall sustainability. Given the existing situation, it would be easier to first apply solutions that focus on national development but which also have concomitant benefits at basin level.

TABLE 5
The benefits of transboundary cooperation in the management of resources of the Syr Darya Basin

	On economic activities	Beyond economic activities
From improved management of basin resources	**Economic benefits** • Protection and increased viability of economic activities relying on water resources (including fisheries and tourism) • Increased security of energy and water supply • Increased revenues from energy and food exports • More diversified, resilient and dynamic agricultural sector • Reduced economic costs of water related hazards (in particular droughts and related power blackouts) • Reduction of infrastructure development costs (thanks to avoidance of duplication and sub-optimal location)	**Social and environmental benefits** • Reduction of poverty (e.g. through agricultural sector development) • Protection of resource based livelihoods • Health benefits from improved water quality • Increased access to and improved sustainability of energy and water services • mproved status and stability of riverine ecosystem Reduced greenhouse gas emissions
From increased trust among Syr Darya countries	**Regional economic cooperation benefits** • Development of regional markets for goods (in particular agricultural products), services (in particular electricity) and labour • Increased cross-border investments • Multiple uses of infrastructure better provided for	**Geo-political benefits** • Improved likelihood of attracting financial resources from development cooperation partners • Compliance with international agreements

[79] United Nations Economic Commission for Europe, *Counting Our Gains: Policy Guidance Note on Identifying, Assessing and Communicating the Benefits of Transboundary Water Cooperation*. (New York and Geneva, United Nations, 2015).

BOX 5.
Combined wind and hydropower for water management

Kyrgyzstan has hydropower potential estimated at 142 billion kWh per year. Less than 10% of this potential has so far been developed. On the Naryn River and its tributaries, it is estimated that 22 hydroelectric power stations could be built, which could annually produce more than 30 billion kilowatt-hours at a low cost. The Kyrgyz Second National communication under the UNFCCC suggests that the country's water resources are vulnerable to extended drought and the melting of glaciers. Drought and low reservoir levels left Kyrgyzstan with a limited ability to produce enough hydropower-based energy in 2007-2010. The government had to introduce power cuts, which lasted up to eight hours. Importing power from its neighbours, especially Kazakhstan, is a possible option. However, Kazakhstan also faces shortages in its southern grid. The World Bank and others have promoted increased power production and regional trading as a solution.

In 2016 UNECE provided technical assistance for an investigation of wind power in Kyrgyzstan and Tajikistan. In Kyrgyzstan, the preliminary results suggest that wind power potential is good at some locations, especially in the cold period during the peak energy demand. A medium term target of 500 MW wind power turbines by 2030 (less than 15% of the installed power capacity) could provide approximately 1.4 cubic km of water savings per year, equivalent to about 10% of current operating storage volume in Toktogul. These calculations are indicative and need confirmation by field measurements and analysis, but a combined wind and hydropower programme could improve the national energy security benefits and help to regulate water use and mitigate drought impacts. The EBRD's Black and Veitch Renewable Energy Assessment estimated a 1.5 GW wind potential in Kyrgyzstan. While wind power is more expensive than hydropower, it could be pursued at the selected sites to diversify domestic energy supply and enhance energy security.

A similar UNECE-supported assessment in Tajikistan indicates that wind power has good prospects in selected locations of the Syr Darya Basin and other parts of the country. A medium term target of 400 MW wind turbines by 2030 could provide approximately 1 cubic kilometre of water savings per year, equivalent to 10% of the current storage volume in Nurek (in the Amu Darya Basin). These calculations are also indicative.

Source: Royal Institute of Technology, Stockholm, Sweden

6.1. Institutions and governance

Developing institutional capacities to support the optimal allocation of basin resources and the development of integrated approaches to the management of land, water and energy and ecosystems, as well as efficient resource management at the local level by local authorities and water user associations.

Adapting the national legal frameworks to support the implementation of new technical solutions such as recycling, reuse and the cleaning of water in industry, energy, agriculture, and urban areas.

Setting basin-wide and national targets and developing action plans to reduce overall needs in water consumption in the context of the pressures from the growing population and climate change.

Undertaking institutional reforms in the water management, energy and agriculture sectors to separate policy-making, regulation and implementation roles; clarify roles and responsibilities to avoid gaps and overlaps; and support the growth of decentralized institutions such as sub-basin councils and water user associations.

Improving intersectoral coordination at the basin level by increasing representation of, and consultation with, the relevant ministries, notably energy ministries, in water management institutions and processes.

BOX 6.
Potential for 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 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 bio Plato (bio-pond).

Collector-drainage water of 1.5-2.0 g/l is suitable for irrigation. This water accounts for 7-8% of the total and is mainly concentrated in Sogd, Jizzak, Syr-Darya 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 allow water 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 is wedged out (or forces its way) 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 needs to be constructed. Pumped water does not exceed 1 g/l and the composition of the salts is highly suitable for irrigation. The most pronounced example of this is the Ferghana Valley. In this region, in the areas with water that is wedged out, an intensive abstraction of fresh water for improvement of state of land can be observed. At present, across the wedge-out zone of the Ferghana Valley, there are about 1,000 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, in all the wells of the wedge-out area the volume of pumped water ranges between 171 to 300 million m^3 per year. Given that around 5.5 billion m^3 of collector and drainage water is formed in the Ferghana Valley, the 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 demonstrable advantages.[80]

Source: SIC-ICWC

[80] 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".

6.2. Information availability and exchange

Promoting research and implementation of innovative and modern approaches and best practices, including the demonstration of socio-economic and water saving benefits, adoption of new irrigation technologies (drip, sub-surface), crop cultivation practices and energy efficiency upgrades.

Improving monitoring, data management and forecasting, in particular to ensure the resilience of energy generation and agricultural production activities. Boost regional information exchange, to ensure data quality, timely sharing and adequate transparency and accessibility to key stakeholders. Water quality monitoring, regional coordination and data exchange should become a priority. Develop basin-wide inventory of water users and key pollution sources in the Syr Darya Basin.

Regional cooperation in modelling and estimation of the costs and benefits of the alternative scenarios of the basin resource use to meet the interests of sectors, riparian countries and ecosystems.

6.3. Instruments and incentives

Scaling up the integrated water resources management (IWRM) application across the basin, building on the lessons in the Ferghana Valley.

Designing and implementing energy efficiency standards, increasing public awareness, technically feasible and financially attractive incentives.

Reforming water and energy pricing both to support a more rational use of water and energy resources and to generate financial resources to pay for infrastructure upkeep and modernization.

Stepping up enforcement of environmental regulations, including protection of the key water and terrestrial ecosystems and introducing the water quality targets and a basin-wide plan of actions

Adopting environmental flow provisions to ensure sufficient water for the Northern Aral Sea.

BOX 7.
Syr Darya water resources: identifying opportunities for cooperation from the power sector perspective

In order to investigate the dependencies between the Syr Darya water resources and the power systems sector, a multi-region model of the electricity systems of the riparian countries was developed using the energy planning software OSeMOSYS[81]. With this system, causes and effects of changes in upstream hydropower generation can be simulated.

To identify opportunities for cooperation, scenarios were developed for the operation of integrated power systems of Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan. A dynamic response of electricity trade and changes in electricity generation profiles were then analyzed. While there are many 'potential futures', the analysis was limited to three scenarios. A reference scenario was developed to represent business-as-usual conditions (BAU scenario). Another scenario was dedicated to exploring the potential benefits of stated efforts in the implementation of energy efficiency measures, targeting both the supply and demand sides (EE scenario). This included measures investigated in the Power Sector Development Regional Master Plan[82]. A third scenario investigated the impacts of diversifying the power generation mix via the increased deployment of renewable energy technologies (RET scenario), such as wind power and solar photovoltaic power. Electricity trade was analysed across the three scenarios in order to assess how different conditions impact the dynamics of power flows in the region and the generation mix of the countries. Of particular interest are changes in the patterns of hydropower generation in the upstream countries of Kyrgyzstan and Tajikistan.

FIGURE 12
Hydropower generation in the Syr Darya River Basin in 2030 (GWh)

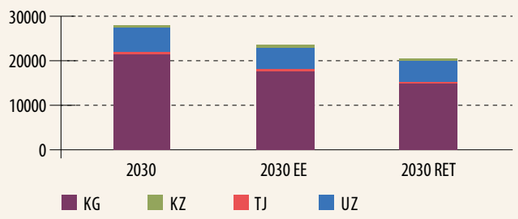


FIGURE 13
Change in hydropower generation in the Syr Darya River Basin (%)

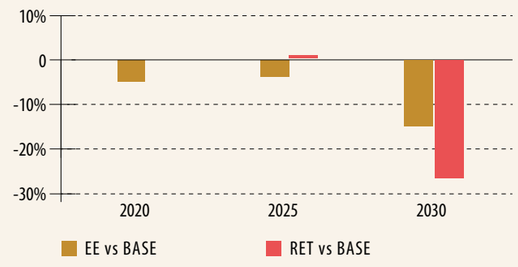
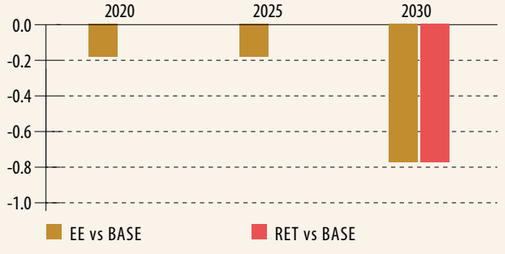


TABLE 6
Summary of Energy efficiency and Renewable energy technologies scenarios

Country	Energy efficiency scenario (EE)	Renewable energy technologies scenario (RET)
Kyrgyzstan	• Reduction in transmission and distribution losses • Residential sector: use of energy-efficient appliances (refrigerators) and shift of 10% of electricity use to gas for space heating in winter (energy savings of 0.9 TWh by 2030)	• 20% generation from wind and solar photovoltaic power plants by 2030
Kazakhstan	• Reduction in transmission and distribution losses	• 40% generation from renewable energy sources (hydro, wind, solar) and nuclear power by 2030
Tajikistan	• Reduction in transmission and distribution losses • Increase of pumping efficiency in agriculture affecting summer demand (savings of 2.2 TWh by 2030)	• 20% generation from wind and solar power plants by 2030
Uzbekistan	• Reduction in transmission and distribution losses • Increase of pumping efficiency in agriculture (savings of 3.2 TWh by 2030) • Shift to efficient lighting (ILBs to CFLs)	• 20% generation from wind, solar and hydropower by 2030

The comparative analysis of the scenarios allowed for the identification of key implications related to the performance of power plants in the basin and the interaction between energy systems via the trade in electricity. The figures provide an overview of the results with focus on the hydropower output in the Syr Darya Basin under the three scenarios for the selected years of the modelling period.

FIGURE 14
Difference in hydropower installed capacity in the Syr Darya Basin in Kyrgyzstan between scenarios (GW)



Source: Royal Institute of Technology, Stockholm, Sweden

Hydropower expansion in the Syr Darya basin is taking place and anticipated in a least-cost power expansion future. Taking into account identified options under a BAU scenario, 41% of hydropower in the region could be produced within the basin – 32% of which would be in Kyrgyzstan – by 2030. If EE measures are implemented, the dependency on the basin's water resources for electricity generation can be reduced by 15%. The diversification of the generation mix in the region through integration of RET can lower the contribution by 25%.

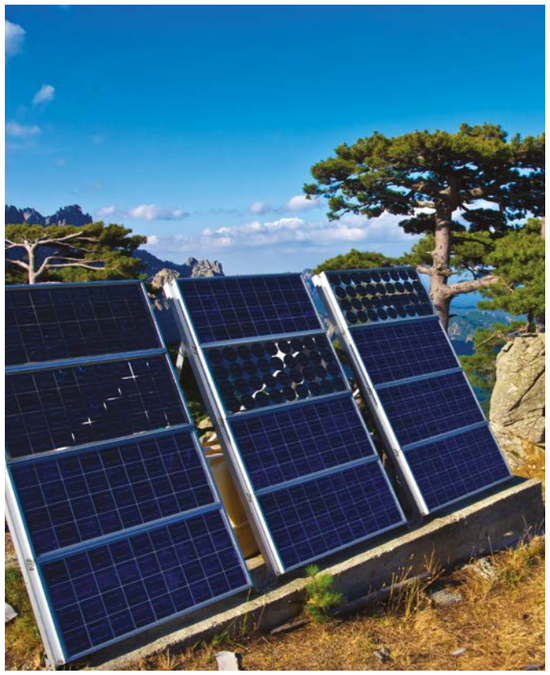
In summary, the implementation of EE measures in a concerted manner would reduce the dependence on hydropower generation as well as electricity import dependency. The analysis further suggests that the re-establishment of inter-regional electricity trade, combined with the implementation of EE measures or increased RET deployment, could allow for a reduction of investments in the expansion of hydropower generation in the Syr Darya Basin. Low fuel prices for electricity generation in the downstream states can compensate for a deficit in seasonal electricity demand upstream via electricity trade.

Wind and solar power potential could play an important role in reducing the dependency on water resources in the region and support potential agreements over scheduling water releases from reservoirs during different seasons. Such investments in renewable energy would however translate into increased electricity costs and would impact electricity tariffs. Funding options and mechanisms would thus have to be investigated in order to minimise the impact of increased energy prices on end users.

[81] The OSeMOSYS tool is based on a cost optimisation-principle, choosing the least cost group of technologies to operate on techno-economic criteria, such as availability, capacity factor, and costs such as the capital, operating, fuel costs, or other considered in the system. The software is a transparent open source cost optimisation tool. It allows for the full representation of the energy system, from resources and generation technologies to transmission and distribution, meeting specific energy demands. More information is available at osemosys.org and in the publication: Howells, M., Rogner, H., Strachan, N., Heaps, C., Huntington, H., Kypreos, S., Hughes, A., Silveira, S., DeCarolis, J., Bazillian, M., OSeMOSYS: the open source energy modelling system: an introduction to its ethos, structure and development. *Energy Policy* 39: 5850–5870, 2011.

[82] Fichtner GmbH & Co. KG, *Central Asia Regional Economic Cooperation: Power Sector Regional Master Plan*. Technical assistance consultant's report for the Asian Development Bank, (Manila, ADB, 2012).

6.4. Infrastructure and technology



BOX 8.
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.[83] Compared to traditional means of irrigation (floods, channels) drip irrigation significantly helps to avoid 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 necessary moisture. This enables the use of saline water, which would be unsuitable for 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, its usage requires clean water free of suspended matter like sediment and algae as well as from precipitating substances which may block the small waterways.[84] Kazakhstan plans to launch the Project to Improve Irrigation and Drainage systems (phase 2) funded by the government and the World Bank.[85]

Source: FAO

Scaling up automation and monitoring of water provision through SCADA and other technical applications to improve precision of water supply from the current 10% to 2%.

Investing in the modernization of existing infrastructure to ensure higher efficiency of the use and protection of the basin's resources. These should include energy generation capacities and energy transmission lines to reduce system losses and expand trading possibilities, irrigation canals and equipment to increase water efficiency, as well as wastewater treatment plants to reduce water pollution.

Investing in diversification of energy sources, particularly in upstream countries – since local use of additional renewable energy sources such as wind, solar and small hydro would reduce peak demand for large hydropower. Current dynamics towards expansion of coal-based generation capacities in the upstream countries improves their energy security and production on the one hand, but may increase negative environmental impacts on the other.

Investing in expanding electricity networks and re-establishing grid interconnections to facilitate the development of an integrated regional energy market as well as diversity of energy exports to non-riparian countries. Developing connections to sell electricity outside the region could make the summer discharge operation more interesting for upstream states in the basin, and would benefit the irrigation demands of downstream states.

Expanding agricultural programmes that support crop diversification and sustainable land management practices, including the adoption of water saving technologies.

6.5. International coordination and cooperation

Clarifying roles and responsibilities of basin institutions and developing their capacities.

Improving basin-wide monitoring, data verification and exchange, and knowledge-sharing, including joint monitoring (e.g. water flows and quality), joint forecasting (e.g. energy demand), as well as the identification of good practices at local and national level.

Developing a regional energy market and exploring opportunities for energy-water exchanges on the basis of **coordinated strategic planning** of the development of electric power systems and water use.

Lowering barriers to trading in food and agricultural goods, thus promoting their more cost-, water- and energy-efficient production and exchange within the region.

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

[84] Andreas Phocaides, *Handbook on Pressurized Irrigation Techniques*. (Rome, FAO, 2007)).

[85] World Bank, *World Bank to Help Kazakhstan Modernize Irrigation System*. Press Release, Astana, April 29, 2014).

CHAPTER 7
Conclusions

The Syr Darya's basin resources play a key role in the economy and development of each riparian country

The basin provides fertile agricultural land and water resources that support hydropower generation and irrigated agriculture.

The basin's resources are under significant and diverse pressures

The drying up of the Aral Sea and the related degradation of the environment exposes the dramatic extent of some of those pressures. In addition to water use for irrigation, the basin also experiences pressures from energy development, industrial development, household consumption and climate change. In turn, this effects the socio-economic development of the basin population, energy and food security, and the sustainability and resilience of economic activities including agriculture. In the future, environmental and social challenges will become increasingly urgent as resource demands increase with higher living standards.

Most links between countries and sectors in the basin take place through water resources

The Syr Darya's water resources are central to hydropower generation in upstream countries as well as agricultural production in densely populated parts of the basin downstream. There is a clear trade-off as demand for energy, particularly electric power, in upstream countries peaks during winter, while irrigated agriculture requires water release in summer time. These demands and dependencies could be reduced: for energy, through an increased diversification of energy sources, energy trade and improved energy efficiency, and for water through furthering the ongoing transformation of agriculture involving improved efficiency of water use, crop switching and land reform, among others. Water quality issues, driven by untreated wastewater discharges and inadequate agricultural practices, are also relevant given their impact on human health and the environment.

Reduced cooperation has left riparian countries more exposed to external shocks

In the Soviet era, the basin resources were to a significant extent managed in an integrated way to address development as well as production priorities with compensation mechanisms facilitating the acceptance of centralized planning decisions. Since 1992-1994, cooperation between countries has reduced despite the establishment of agreements and new regional governance institutions to address the Aral Sea crisis and the basin's water management. Opportunities to seize cooperative solutions have not been exploited as expected, in particular on energy exchanges and water discharges, leading the countries to act independently and without coordination to ensure economic growth and resource security. This has not only caused transboundary tensions but also increased the exposure of each country to external shocks and river system fragmentation.

Transboundary cooperation in the management of basin resources can generate large economic benefits

A lack of trust between riparians is a serious bottleneck. Cooperative solutions are available and could generate massive economic benefits by reducing input costs, increasing the value of agricultural production, promoting exports of energy carriers, enhancing the sustainability of economic activities, reducing the effects of droughts and power cuts, and promoting cross border investments and the development of regional markets for goods, services and labour. Improved cooperation in managing the basin resources can also generate a number of social and environmental benefits, including poverty reduction, employment generation, health benefits, improved status of riverine ecosystems and geopolitical benefits.

Realizing the potential benefits of improved management of the basin resources demands an ambitious programme of action

Such a programme would encompass: (i) energy diversification in upstream countries to reduce dependency on hydropower in winter time and crop diversification; (ii) modernization of energy and water infrastructure to minimize system losses; (iii) policy packages to increase energy and water efficiency (including pricing reforms, public awareness campaigns, and the introduction of energy efficiency standards); (iv) agricultural extension programmes to support crop-shifting and the adoption of sustainable resource management practices; and (v) the development of regional energy and agricultural markets. Planning and implementation of such measures would also require institutional reforms and capacity development to facilitate basin-wide integrated resource planning both at national and basin level. The Third Aral Sea Basin Programme (ASBP-3), a regional action plan for 2011–2015 to alleviate the environmental and socioeconomic consequences of the Aral Sea crisis and to facilitate progress towards IWRM and sustainable development in the Aral Sea basin,[86] envisages addressing a number of topics relevant to the nexus. Improving the efficiency of the responsible institutions operating in the area of water and related resources in Central Asia requires harmonization, better coordination and the improvement of inter-institution relations. The involvement of the energy sector in the basin-wide cooperation would improve the opportunities for addressing nexus issues.

The riparian countries are already taking various initiatives that go in the direction of the identified solutions both technical and in the field of legislation and policy

Furthermore, at the level of national strategic documents – for example the Presidential Decree in 2014 on Kazakhstan's Transition to Green Economy, the National Sustainable Development Strategy of the Kyrgyz Republic for 2013-2017 – the importance of efficiency and sustainability in managing resources (water, arable land, energy and/or environmental services) is recognized, in some cases with a set of explicit targets. However, unless concerted action is taken, there is a risk that efforts do not achieve the desired level of impact. Improved coordination, between the riparian countries but also between sectors at the national level, is necessary to that end. Improved transboundary relations, as well as consistency in

[86] The Board of IFAS reviewed the draft ASBP-3 in December 2010 in Almaty, Kazakhstan, and submitted it for approval to IFAS member states: Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan. Source: IFAS. *Serving the People of Central Asia: Aral Sea Basin Program 3* (ASBP-3). Executive Committee of the International Fund for Saving the Aral Sea, 2010.

national policies (making a business case for energy efficiency and renewable energy production, providing incentives for rational water use etc.) would improve investor confidence, which is important for mobilizing resources, in particular for major projects.

Moving forward will require progressive trust-building to gain high-level political backing

The Syr Darya Basin is an example of a river basin where there are evident trade-offs across sectors, resulting in the inefficient use of resources, 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. A number of efforts to enhance resource management, based on integrated approaches and the promotion of multi-sectoral cooperation, have already been proposed in the basin. But at present the riparian countries find themselves in a vicious cycle in which solutions based on self-sufficiency lead to negative effects on co-riparians, an additional loss of trust and reduced opportunities for the advancement of cooperation. Uncoordinated national policies risk pushing countries further away from each other and undermining opportunities to optimize resources and maximize benefits. Transboundary relations and confidence in cooperation could and should be developed step by step, with a focus on actions that, while benefitting national economic development, also reduce pressures on shared natural resources, increase sectoral efficiency and strengthen economic ties between the countries.

This scoping level assessment provides an overview of the importance of the basin's resources, the intersectoral linkages, potential solutions and benefits

Further analytical, stakeholder engagement and planning work is needed to identify precise governance reforms, policy measures and investment opportunities to address all the challenges and seize any corresponding opportunities.

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Reconciling resource uses in transboundary basins: assessment of the water-food-energy-ecosystems nexus in the Syr Darya River Basin

(shared by Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan)

Coordination between the water, energy, food and environment sectors is fraught with difficulties even at the national level, but the complexity increases substantially in transboundary basins where the impacts spread from one country to another. The "nexus approach" to managing interlinked resources has emerged as a way to enhance water, energy and food security by increasing efficiency, reducing trade-offs, building synergies and improving governance, while protecting ecosystems.

This publication contains the results of nexus assessment in the Syr Darya Basin shared by Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan, that has been carried out in the framework of the UNECE Water Convention's programme of work for 2013–2015. The methodology employed was developed specifically for assessing the nexus in transboundary basins with multi-disciplinary expertise and was applied with support from various partner organizations.

The assessments aimed to foster transboundary cooperation by identifying intersectoral synergies and determining measures that could alleviate tensions related to the multiple needs of the riparian countries for common resources. The process looked to generate relevant information to support decision-making, and it engaged diverse expertise and key actors in the basins. The participatory assessment in the Syr Darya Basin included an intersectoral workshop to identify key issues and solutions; detailed analysis of the latter; and further consultations with the various affected sectoral stakeholders.

The nexus assessments describe the characteristics of the resources of water, food and land, energy and ecosystem services, and their governance. The assessment presents multiple examples of interlinkages among the various resources in the Syr Darya Basin, and highlights real benefits from strengthening transboundary cooperation for the integrated use of basin resources. Graphics illustrate the interlinkages identified. Climate change and socioeconomic drivers, and their effects on intersectoral dynamics, are also considered. Finally, a broad range of beneficial response actions are outlined. Such solutions to the nexus span institutions, information, instruments, infrastructure as well as international coordination and cooperation.

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