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WATER SECTOR DEVELOPMENT IN CENTRAL ASIA AND AFGHANISTAN:

STATUS REVIEW AND DEVELOPMENT OPTIONS

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Introduction

Introduction

Water is key for the socio-economic development of all the countries sharing the Aral Sea Basin (ASB). Home to ancient irrigated agriculture civilizations, the Central Asian Region (CAR) featuring dry arid climate and sophisticated water infrastructure still heavily depends on water resources. In fact, it is the availability of water that much determines its economic performance, social coherence and even political stability.

Water is at the core of food and energy production, environmental safety and livelihood se-curity for the region's population. It contributes 5-28% to the countries' GDPs through irri-gated farming and almost 30% to the aggregated CAR's energy production. Currently, the ASB, including Afghanistan, is utilizing almost 95% of the total water resources available in the watershed *More detail*

The environmental aftermath of water mismanagement in the region is well known. The long-ignored environmental needs during the Soviet period led to the drying of the Aral Sea. The world's 4th largest lake had dried up creating a new 5-million-hectare desert -- the Aral-Kum. Millions of tons of dust and salt from the dried-up seabed are presently spreading across the CAR affecting irrigated lands, people's health, as well as the ice caps in the sur-rounding mountains. To sum up, coupled with biodiversity losses salinization and degrada-tion of land and water have become a norm for the region *(Abdullayev and Atabayeva, 2012)* threating the mere sustainability of national economies.

Since gaining independence in 1991, the countries of Central Asia have made water issues within the region a matter of foreign affairs and international political domain. The Ara Sea Basin with its two major rivers – the Amudarya and Syrdarya – is shared by a total of six countries – five Central Asian states (CAS) and Afghanistan. The five CAS started building their nationhood in 1991 with water issues always in the forefront of inter-state relations. Until recently, Afghanistan -- overwhelmed both with the unending civil war and the follow-up intervention of the International Security Assistance Force (ISAF) -- was not part of the water interactions in Central Asia (CA).

Since then, the countries of Central Asia have been taking steps to institutionalize their water affairs and interactions. Immediately after the Soviet Union's collapse, a number of re-gional-level water institutions were established to maintain the Soviet time agreements. Among these is the Interstate Commission for Water Coordination established in 1992 *(Weinthal, 2006)*. Despite the early-on and timely efforts to continue coordinating water issues in the CAR, the diverging economic interests and egocentric domestic policies had ultimately led to the contestation of the water sharing status-quo.

The collapse of the Soviet economic system immediately resulted in the disintegration of the compensatory system and mechanisms in the region involving water and energy. The coun-tries of Central Asia started moving towards more self-sufficiency and independence in all economic areas, including water, energy, agriculture, etc., as well as established new national water agencies, infrastructure and governance systems. In most cases such systems were unlike, incompatible, which exerted significant stress on the region's limited water resources *(World Bank, 2017; Abdullayev and Rakhmatullayev, 2013)*.

Water sector reforms and transformations were driven by both national and global processes and factors. Nationally, those could be seen as an outcome of political (independence), eco-nomic (moves towards market economy) and societal (from socialist to capitalist system) pressures. Globally, like elsewhere in the world the CAR has been facing the constant influ-ence of Integrated Water Resources Management (IWRM), a new public management para-digm introduced as part of internationally funded development support interventions and projects (*World Bank, 2017;*

Dukhovny et al., 2016).

Low water productivity, irrigation inefficiencies and water losses are most characteristic of water use in Central Asia. Water productivity levels within the region currently ranging from 5 to 16 USD cents/m3 are in a position to at least double. Only 40% of the water with-drawn from rivers reaches irrigated plots *(World Bank, 2015)*. Field-level water use is tech-nologically outdated. Inadequate water services are curbing sustainable agriculture, energy and industrial development in the CAR.

Inadequate education and lacking capacities among the professional water cadre are among the key factors affecting the region's water sector development today. Low wages, unattractive professional opportunities and limited financing are the main reasons for the brain-drain and deficit of highly-qualified specialists in the water sector. The region's education system, as a whole, and water education left over from the Soviet times, in particular, have degraded and to an extent disappeared. Hence, national education systems of post-soviet states require a major transformation and reform *(WWAP, 2014)*.

In one way or another, all ASB countries including Afghanistan have been undergoing con-tinuous water sector reforms. Among other things, they include the upgrading of national water-related legal frameworks and adoption of the "best IWRM elements". Nevertheless, the reforms' specific composition, pace and outputs do differ from country to country. De-spite that de jure the governance system might include some features of participation (inclu-siveness), sectoral integration and decentralization, none of these functions have become fully effective anywhere yet *(Wegerich et al., 2015)*.

Absence of long-term planning seems to be the major challenge of water management sys-tems in CA. Currently, water planning is by far and large based on day-to-day water issues with little or no attention to longer-term planning. The absence of transparent strategic water use plans makes water cooperation rather complicated and cumbersome. Regional and national water strategies as well as basin-wide and/or sub-basin level water management master plans (except Kazakhstan) are lacking altogether since the collapse of the Soviet system.

The water sector's sustainable and long-term financing represents a crucial prerequisite for effective water governance in the CAR. None of the states, however, were able to forge an acceptable and lasting solution to water financing. The lion's share of funding presently comes to the water sector from state budgets. Private investments are still unheard of any-where in the region. Yet, the actual needs for water sector investments are huge given the scale of the existing and continually degrading already dilapidated infrastructure. The minimum needs for rehabilitating and rebuilding the CAR's water infrastructure are esti-mated at 20-25 bln USD *(Abdullayev R., 2019; Petrakov I., 2019; Kurtovesov G., 2019; Musabayeva K., 2019; AREU, 2018)*.

Climate change is another important stress factor which continues to seriously affect the re-gion's water assets. The ever-increasing number of water-related disasters in concert with water quantity and quality issues are most likely to continue eroding the CAR's economy. Only natural disasters like floods and droughts will cost Central Asia around 4% of its an-nual GDP *(World Bank, 2016)*. In addition, in the future water availability in the Syrdarya and Amudarya are most likely to fall by 20-22% and 26-35%, respectively *(FCG Interna-tional, 2014)*.

These days, transboundary cooperation in the region is on the rise and much more pragmatic due to the favourably shifting political landscape. The dramatic changes in Uzbekistan fol-lowing the election of the new President have removed many political obstacles in the way of regional collaboration. Bi- and multi-lateral water dialogues

are becoming a norm in the region. Despite the remaining differences on some key issues, the tone of water discussions is becoming increasingly constructive.

With political tensions and selfish rhetoric much reduced, cooperation and dialogue on con-tested water issues are gaining momentum. According to research estimates, coordinated efforts on water may yield up to 4-5 bln USD per annum in additional benefits for the region as a whole *(Adelphi and CAREC, 2017)*. Given this, today the prospects for stronger and long-lasting water cooperation in the CAR look very promising. In the last few years, this trend has been strengthened and supported by a series of trade, economic and cultural ex-changes paving additional opportunities for water cooperation in Central Asia.

Building on all this, in October, 2015 through the Regional Environmental Centre for Cen-tral Asia (CAREC) the United States Government initiated an innovative multi-country pro-ject endeavour aimed at stepping up water cooperation and mainstreaming the integrated water resource management principles (IWRM) via capacity building, exchange of best ex-periences, networking, support of national water sector reforms and setting up local-level institutions in several shared transboundary watersheds.

More detail

This report is set to look into the status quo and the impending planned changes in the water sectors of all six countries sharing the ASB, including Afghanistan. More specifically, it will focus on:

- governance;
- institutional settings;
- financial and economic aspects as well as;
- nexus issues associated with domestic water sectors.

The report also highlights major achievements, desired changes and potential interventions required for sustainable water governance and management in the CAR.

Based on the above, the report compares the water sectors under review for any differences and similarities to identify challenges for and implications of regional collaboration.

The report comprises 4 chapters each addressing the key aspects listed above: governance and institutions, finance and economics, and nexus. It is concluded with recommendations for prospective interventions to build on the Smart Waters Project's accomplishments. The report is based on survey research, reports and other inputs by national experts, as well as stakeholder interviews.

Chapter 1 Current state of water governance and management: regional and national overview

This chapter presents the results of the analysis of: the current situation in the water sector on the regional level and in each separate country; water governance and management frameworks; and water management interlinkages at different levels in different countries. The chapter also describes the current and ongoing reforms, as well as reviews water legisla-tions, and water sector institutions and hierarchies.

De jure, regional water relations are still regulated by the 1992 Almaty "Agreement among the Republic of Kazakhstan, the Kyrgyz Republic, the Republic of Tajikistan, Turkmenistan and the Republic of Uzbekistan on Cooperation in the Field of Joint Management on Utiliza-tion and Protection of Water Resources from Interstate Sources".

More detail

The Interstate Commission for Water Coordination (ICWC) is a major regional institution mandated by the 1992 Agreement. ICWC is responsible for

- regional water policy;
- integrated and rational use of the region's water resources;
- long-term regional water supply program;
- elaboration and approval of the annual water withdrawal quotas for each country in the CAR (except Afghanistan).

More detail

ICWC consists of the Secretariat, two basin management organizations (BMO's) for the Syrdarya and Amudarya Rivers and the Scientific Information Centre (SIC ICWC). The meeting of the heads of national water agencies (ministries, committees, and departments) is the ICWC's highest decision-making body. Such meetings take place at least twice a year. The meetings' results are reflected in protocols signed by all parties, and decisions are con-sensus-based .

More detail

Since 1992, at least four water-related regional-level agreements were signed by CAS. However, the 1992 Agreement remains the long survived and actual document regulating regional-level water allocation. 3 out of 5 Central Asian countries acceded to international (UN and UNECE) conventions on transboundary waters. Recently, Kyrgyzstan has started to question both the 1992 Agreement and the institutional framework of regional water co-operation. Informally as of 2009 and then formally as of 2016, Kyrgyzstan has frozen its membership in the International Fund for Saving Aral Sea (IFAS) – the umbrella regional environmental and water cooperation organization.

Since gaining independence, CAS and Afghanistan have signed several bilateral agreements, including the following: 2004 Pyandj River Bridge Construction Agreement, 2010 Water Cooperation Agreement for the Rivers of Pyandj and Amudarya between Tajikistan and Afghani-stan *(SIC-ICWC, 2017)*, 2015 Kazakh-Afghan Cooperation Agreement on Emergencies *(Kazakhstan-Afghanistan Agreement, 2015)*.

Figure 1.1. Aral Sea Basin: irrigated areas, main river and irrigation systems.

Source: www.ca-water.info.net

Since gaining independence, CAS have taken several attempts to reform their water governance and management frameworks. In the early 1990's – immediately after the collapse of the Soviet Union – the countries of Central Asia were trying to preserve the Soviet-like wa-ter systems as much as possible. Due to the de-collectivization, the changes at the time af-fected only the lower level (inter-farm and on-farm) water management *(Yalchin and Mollinga, 2007)*. Economic re-integration and reduced growth due to the collapse of eco-nomic links undoubtedly affected the water industry. In mid-1990's, water-related financing dropped considerably, and water ministries suffered downsizing. This period can be deemed the initial phase of the changes in the water systems of CA countries *(Wegerich et al., 2008)*.

State- and nation-building in CAS included water issues. Contrary to the centralized USSR-model, water became an object of independent national policymaking. Domestic water policies started to emerge in the late 1990's and were not intended for coordinating joint efforts by Central Asian states, as water was the matter of national independence and taken care of exclusively on the national level. Five separate water policies focused on independence and maximum protection of individual state

interests. Each country perceived water as a national resource and referred to its transboundary nature only from the standpoint of national priorities. That was the time of breaking down the former Soviet-time water policy frame-work *(Abdullayev and Atabayeva, 2012; Aminova and Abdullayev, 2009)*.

Parallel to national water policymaking, the status of national-level water agencies had also altered. The previously independent water ministries/ agencies became part of agriculture, energy or environmental ministries. Their decision-making power and prestige had downgraded, as water became part of wider national agendas – securing water for irrigation or for hydro-energy production – that depended on a given country's location (down- or upstream). That was the next phase of the transformations in the water systems of Central Asia. Although merging with other ministries and enjoying lesser funding on the national level, not much changes had occurred on the water sector's meso level *(Dukhovny and Sokolov, 2005; Abdullayev and Rakhmatullayev, 2015)*.

After land reforms, in all CAS agricultural production became individual: small holders, farmers, land-leasing companies, etc. Collective land and water control systems became non-functional. Thus, the countries of CA started seeking solutions. Setting up water users association (WUAs) at the lowest operational water management level was promoted by in-ternational development agencies. At different pace and with varying success, almost all Central Asian states countries began establishing WUA's. Although, on paper WUAs have been functioning on the former collective farm (kolkhoz) level, they perform well below the expected. The replacement of collective water management system by WUAs can be recog-nized as the third phase of changes in the water systems of CAS *(Khamidov et al., 2018)*.

The water sectors in Central Asian countries were the least reformed and had kept the Soviet type planning and management styles until mid-2000's. However, limited funding for oper-ating and maintaining the infrastructure had still forced amending of domestic water sys-tems. At that time, CA had become the international "hotspot" for water sector reforms. Multiple international partners active in the region got engaged in water issues. In the early 2000's, countries started to exercise IWRM due to exogenous drivers – international development actors *(Abdullayev and Atabayeva, 2012; Abdullayev and Rakhmatullayev, 2015; Dukhovny et al., 2014)*.

The IWRM exercise began as piloting on different levels: national (Kazakhstan – UNDP), canal/river (Ferghana Valley – SDC) and local (mostly WUAs – USAID). Long-term capacity-building and awareness-raising campaigns took place across the water board promoting IWRM principles. National policy dialogues (UNECE) targeting IWRM were held in each country of Central Asia. Although considerable efforts, the actual changes in the water sectors of CAS remained limited. The following of them may be attributed to targeted IWRM efforts:

- upgrading legal frameworks;
- partial or full introduction of hydrographic (basin) principles;
- irrigation water services pricing;
- partial disjunction of water governance and management.

A number of other issues – including efficiency improvements and participatory schemes – are still waiting to be addressed.

While CAS were embarking on significant water and land reforms, in Afghanistan water reforms had started with the adoption (2009) of the new Water Code and Water Strategy, both documents prescribing IWRM implementation. Likewise, based on them five river ba-sins and river basin organizations were established (MEW, 2008). The majority of the water sector reforms in Afghanistan were executed with the financial support under various inter-national projects. Still, the actual enforcement of the norms laid out in

the aforementioned legal acts "on the ground" was rather slow. In 2016, the Supreme Council for Land and Water Resources headed by the President was created to closely monitor water management regulation and reforms (*Danish, 2017; Kakakhel, 2017)*. In 2018, the Harirud River Basin Council was established under the USAID/CAREC Smart Waters Project. In October 2019, the new Water Law – building on the experience of IWRM implementation in Afghanistan and the traditional mirab water management – came into force.

Agriculture and national administrative reforms had had a significant impact on the changes within the water sector. Traditionally – even before the Russian rule in CA – it had been a matter of state affair. The long tradition of regulating water through state bureaucracies has been an important aspect of water governance and management in this region *(Abdullayev et al., 2019)*. Although after the collapse of the Soviet system, the newly emerged states had provided some level of decentralization inside the water sector, almost all CAS had kept both central planning and strong state role in the water sector *(Table 2.1)*.

Table 2.1. Role of government in the water sector in Central Asia.

Country	Financing	Decision making / planning	Implementation / control
 AFGHANISTAN	State provides funding only for large-scale infrastruc-ture and systems; Local-level water systems are taken care of by water users	State decision-making on transboundary issues and large water systems; Local-level decisions are made by mirabs /landowners	State has limited con-trol over implementa-tion
 KAZAKHSTAN	Funding of major O&M needs, new infrastructure development Local governments are contributing to smaller infrastructure and O&M costs	State sets long-term vision and strategies; Shorter-term decisions are made by local governments	State controls water sector policy imple-mentation through Committee for Water Resources
 KYRGYZSTAN	State is covering major wa-ter sector needs; Contributions from water users (service fees) are a sensible part of water sector financing	State is making major decisions on sectoral water allocations; Local governments are responsible for large infra-structure under their juris-diction	State is partially en-gaged in water policy implementation; most of the control is done by local-rural councils
 TAJIKISTAN	State is funding major costs; User fees cover at least 30-35% of operational costs	Water planning is centralized; Local-level decisions by local executive authorities and water departments	Centralized control over the implementation of decisions in the water sector by the line ministry

Страна	Финансирование	Принятие решений / планирование	Исполнение / контроль
TURKMENISTAN	State fully finances water sector costs at all levels	Water planning is the prerogative of central government	State (Water Committee) is controlling the implementation of water decisions
UZBEKISTAN	State fully finances water sector costs at all levels	Water planning is the pre-rogative of central government	State (Water Ministry) is controlling the im-plementation of water decisions

In Central Asian countries and Afghanistan, water sector policymaking is the state's pre-rogative. Therefore, water industry is a stateled sector. Its funding and operation is within the mandate of corresponding state agencies. National governments are failing to fully fund all the sector's needs. Thus, currently infrastructure, human and transport needs of the water sector are addressed inadequately. All CAS have deployed water use fee schemes. However, service fees are quite nominal and do not cover the actual costs of running water systems *(Sehring, 2009)*. None of the water sector infrastructure facilities in Central Asian countries are planned for privatization. Water systems are not attractive for private investment and enjoy lush state budget subsidies *(Table 2.2)*.

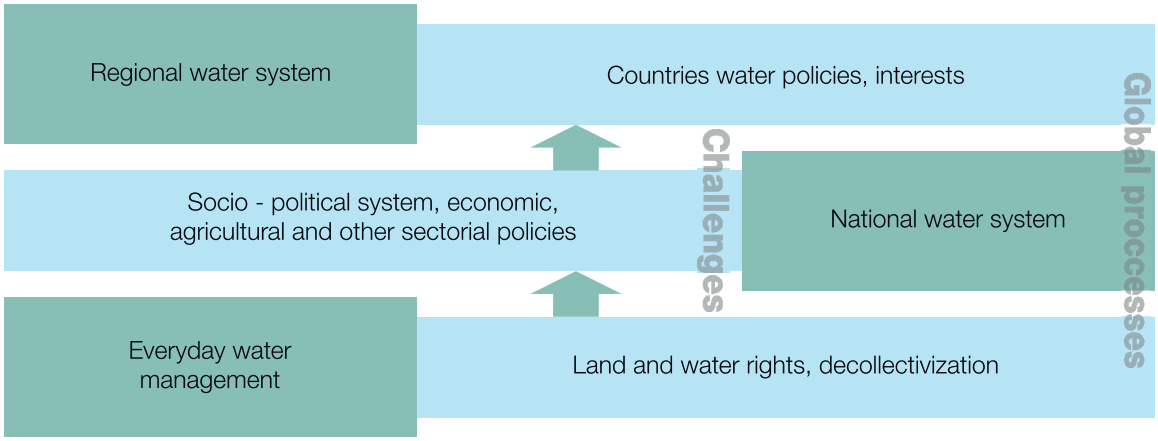
Table 2.2. Water sector subsidies in Central Asian countries (mln USD).

Country	Total subsidies	To energy	To irrigation
Afghanistan	9,6	5,6	4,0
Kazakhstan	150	70	80
Kyrgyzstan	30	25	5
Tajikistan	32	20	12
Turkmenistan	45	20	25
Uzbekistan	50	40	10

The rehabilitation of dilapidated infrastructure and re-configuration of water systems into separate agricultural land units manifest the challenges for Central Asian countries. Presently, almost 60% of the water withdrawn for irrigated agriculture is lost en route. The costs of operating, managing and developing water infrastructure in Central Asia are huge (World Bank, 2016). National budgets have been short of allocating sufficient water infrastructure financing. Since 2010's, CAS's state budget financing to the sector has started to improve reaching 40-69% of the required amount *(Abdullayev et al., 2019)*.

Currently, water governance and management are not efficient. WUAs and similar institu-tions – which had replaced collective farms – lack strength to address technical and/or equity issues associated with water distribution among individual producers. Therefore, routine water issues have become a major driver of national-level water decisions. On the national level, water systems (governance + management + infrastructure) currently mostly focus on water provision for different uses/needs. The growing water deficit, outdated infrastructure and massive water losses have resulted in high competition for this resource among uses and users *(Wegerich et al., 2012; Dukhovny et al., 2014)*. In light of this, national water systems are forced to deal with systematic issues related to everyday water consumption. Thereat, on the regional level CAS are mainly busy with water allocation rather than coping with the long-term impacts of climate change on water resources *(Figure 2.1)*.

Figure 2.1. Water system levels in CAS and Afghanistan (Abdullayev and Rakhmatullayev, 2016).



Since gaining independence, water-associated interactions among CAS have been both multi-layer and multi-stakeholder, including water users, national water agencies and international partners *(Figure 2.2.)*. The huge conflict potential of water issues at the transboundary level has been acknowledged both by Central Asian governments and international development agencies. International media and experts have maintained strong focus and were tuned on water rela-tions among Central Asian states *(BBC, 2009; CNN, 2008; The Washington Post, 2012)*. Few serious water-related tension events on different levels were reported by international and local media outlets *(Figure 2.3)*. However, CAS were able to prevent full-fledged conflicts and dealt with transboundary water issues in a peaceful manner.

Figure 2.2. Levels of water diplomacy in Central Asia (Abdullayev et al., 2019).

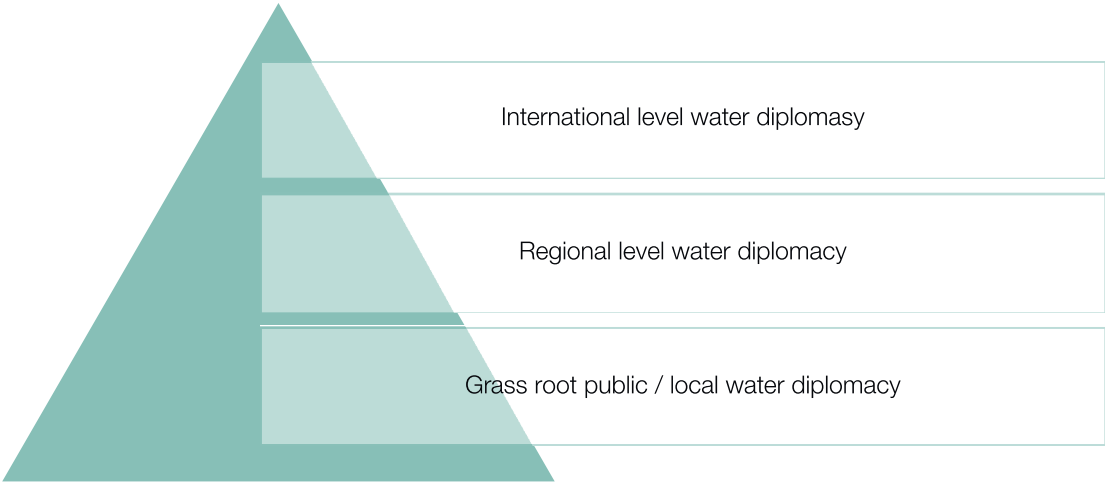


Figure 2.3. Potential water-related flash (conflict) areas in Central Asia (SDC, 2005).

Interstate water governance and management in Central Asia require robust and fundamental changes. Rather than short-term interstate water allocations, transboundary water-sharing should focus more on long-term aspects. Linkages among water use, inter-sectoral dimensions, long-term planning and climate change adaptation should become the principal focus of regional-level water cooperation *(Adelphi and CAREC, 2017)*. Currently, CAS are seeking for pragmatic and rule-based water partnership avenues in the region. Regional water governance and management could be aligned to the two main CAR's river basins – Syrdarya and Amudarya. Basin water conventions could replace the 1992 Agreement, and basin organizations could become transboundary cooperation institutions *(UNRCCA, 2016)*. However, the process of water cooperation is non-linear and depends on socio-political, economic and other interstate relations.

Afghanistan is a riparian for CAS within the Amudarya Basin and a late-comer to trans-boundary cooperation. Although the national water strategy has been in place for already 10 years, domestic water reforms are slow. A national water system based on basin management principles was introduced. However, staff capacities and infrastructure challenges require both political will and financial support *(AREU, 2018)*. At the lowest level, the traditional mirab system is to be replaced by WUA's. This effort must be well-planned. To this effect, the negative experience of Central Asian countries on establishing WUAs could be most instrumental. Security is a major limiting factor for water systems development in Afghanistan.

Water in Central Asia is a precious, limited and non-renewable resource. Access to water is the top-tier economic, social and political aim of each riparian state. The impacts of climate change will lead to reduced water resources and increase water demand. In this context, the business-as-usual scenario will only aggravate the ongoing competition for water at all levels of water systems *(FCG International, 2014)*. The shared waters of the region could become a platform for cooperation. Since CAS and Afghanistan are water-interdependent, closer economic teamplay may lead to sustainable water cooperation in the region.

Currently, Central Asia countries and Afghanistan are using state-led water governance systems with only limited space for none-governmental actors. The state is planning, financing and supervising the implementation of water policies and decisions. Although the limited reforms have started opening up the water sector, it is still confined to the leading water uses (energy – for upstream and irrigation – for downstream countries). Hereby, the sectoral nature of water industry constitutes a major impediment at both national and regional levels.

Chapter 2 Оценка водной политики и систем управления водными ресурсами стран Центральной Азии и Афганистана

This chapter presents the results of comparing the water systems of Central Asian countries and Afghanistan, as well as reviews their achievements and drawbacks. It also describes linkages among local, national and regional water management levels. Likewise, it presents an assessment of IWRM elements, state of sectoral coordination, nexus, and climate adaptation within the water sector.

CAS's water systems have similarities and differences. The former are a result of the com-mon Soviet past. The latter emerged during the post-Soviet period due to differing devel-opment strategies. As was mentioned earlier, so far Afghanistan has been pursuing its own path. The essential similarities of the water systems of Central Asian states were reviewed in the previous chapter.

Specific differences among them are more of a governance rather than technical/managerial nature. Still, most of the target countries share the same technical infrastructure and management methodologies inherited from the Soviet times *(Weinthal, 2006)*. CAS have re-formed their water sectors, developed new legal frameworks and introduced financial, insti-tutional and other IWRM elements.

Although the region's countries have executed similar series of water reforms and are cur-rently facing similar challenges, their water sectors are still characterised by certain peculi-arities. For instance, currently CAS's and Afghanistan's water systems enjoy differing level of financing, governance and management. As a result, their performance and level of complexity also vary. The following analysis sheds light on both water governance and man-agement of water systems in Central Asian countries, including Afghanistan.

Afghanistan

Afghanistan's water sector is the crucial driver of the country's social and political development.

Agriculture is the back bone of the social system and provides both food and jobs for war-prone domestic communities. Afghanistan's water sector concept – designed by international partners in the early 2007 – stipulates for water management within basins and the role of WUAs in dealing with local-level water management issues *(AREU, 2018)*.

However, the real-life implementation of the concept has been quite cumbersome, since almost 90% of Afghanistan's irrigated area is supplied with water via more than 28,000 informal systems (karezes, springs, wells), and only 10% -- through 10 formal irrigation systems built between 1940 and 1970. Most of the irrigation in Afghanistan is localized – construction, operation and management are the responsibility of local land-users and -owners. Water intakes are not engineered and are mainly constructed manually by local communities. The mirab system is at the core of local-level water governance and management. It has been there for centuries, is well-organized and is based on clear informal operation and maintenance procedures. Although, the mirab institute is not inclusive, it is a sustainable and locally crafted model. The payment system for delivering water in the form of natural contributions by farmers is also well-developed. Systems' rehabilitation is often carried out based on the ashar practice, i.e. joint and collective labour *(Rout B., 2008; Mielke, 2010; Abdullayev and Shah, 2011)*.

Afghanistan depends on irrigated agriculture for both economic and social stability. Despite the chronic instability, domestic farming has been able to provide food, jobs and livelihoods for Afghanistan's population. Although currently only subsistence-dominated, the national agricultural industry possesses a huge potential for boosting productivity and expanding the irrigated area. At present, the pace of agricultural development is limited by the ongoing turbulence and undeveloped irrigation infrastructure *(Mollinga, 2008)*.

Owing to prolonged hostilities in Afghanistan, formal irrigation systems have severely degraded due to the lack of funding and staff loss to support their operation and maintenance. Military actions have also affected traditional informal systems. Based on the early 2000 FAO estimates, about 50% of the irrigated land in the country had failed *(Rout, 2008)*.

There have been attempts to establish WUAs in Afghanistan. Their outcomes, however, are limited and not widespread, including due to the resistance on behalf of local landowners *(Abdullayev and Shah, 2011; Mielke, 2010).*

Table 3.1 Main water sector indicators for Afghanistan (as of 2015).

Population, mln	Agricultural water productivity, USD cents/m3	Irrigation system efficiency, % of water reaching fields	O&M and capital cost of irrigation systems, mln USD/year
32,5	8	40%	7

Basin organizations were established for all 5 basins on the territory of Afghanistan. Currently, they are experiencing a number of technical and institutional shortcomings. The ma-jor challenges include linking local-level irrigation networks with state-run basin organizations; and the lack of equipment like excavators, bulldozers and other heavy machinery making cleaning and maintenance of local irrigation systems a tough endeavour. Overall, water delivery mainly depends on water availability in domestic river systems *(Abdullayev and Shah, 2009)*.

In addition, Afghanistan's water sector is characterized by limited capacities: technical, institutional and human. The attempts to bridge state basin organizations and local water systems have not been successful. Thus, local water supply frameworks – backing only subsistence farming – operate without state support and interventions. Limited in their capacities, state basin organizations cannot offer attractive services or policies for local water systems. The mirab schemes featuring corrupt and non-inclusive practices exclude small landowners and land tenants from water governance. Still, as of today it is the only working local-level water management model in Afghanistan *(Shah and Abdullayev, 2009)*. In 2019, Afghanistan adopted the new Water Code. Its Article 15 enshrines the role of mirabs as traditional water management agents on the local level, as well as acknowledges their role on the national level.

Although Afghanistan is upstream within the Amudarya Basin and downstream within other 3 watersheds, so far the country's engagement in transboundary water cooperation has been limited. As was mentioned in Chapter 1, Afghanistan has several agreements with Central Asian countries, and one agreement on the Harirud River Basin with Iran. The country is taking wary steps building up dialogue with CAS on the Amudarya River, is mainly keen on collecting information, support and aid but reluctant to enter any formal water agreements *(UNRCCA, 2016)*.

To evolve, Afghanistan's water sector requires huge capital investment, robust human capacity and more locally proven policies. The country needs to strengthen linkages among local-level water systems and basin organizations. Their role during the initial phase could manifest itself in technical improvements of local water management

schemes. Another as-pect of water cooperation could take the shape of setting up water dialogue between Af-ghanistan and CAS (on the Amudarya River Basin), as well as Afghanistan and Pakistan (on the Kabul River Basin). These dialogues should lead to settling the corresponding water allocation issues *(Abdullayev et al., 2009)*.

Kazakhstan

Among Central Asian states, Kazakhstan was the first to draft the national IWRM programme in the early 2000's. The country heavily depends on neighbours for water resources and, thus, actively supports transboundary cooperation. Kazakhstan is signatory to dozens of agreements with riparian states and international conventions. 7 of 8 domestic basins are transboundary. The republic has transboundary relations with China, Russia and CAS; target transboundary water commissions and working groups are liaising with all riparians *(Petrakov, 2019)*.

Kazakhstan has deployed the basin management model and formed 8 basins. In Kazakhstan, water management and governance are separated. Basin organizations (Basin Inspections) are responsible for governance, and water management agencies (Kazvodkhoz and its territorial units) are responsible for management. The state covers the major part of the water sector's costs. Kazakhstan has introduced the system of water user fees for every type of use. Service fees are higher than in other CA countries. However, public financing still constitutes the main source of water sector investments.

Table 3.2 Main water sector indicators for Kazakhstan (as of 2015).

Population, mln	Agricultural water productivity, USD cents/m3	Irrigation system efficiency, % of water reaching fields	O&M and capital cost of irrigation systems, mln USD/year
15.8	15	47	50-60

Water efficiency is still low. Farming is the main Kazakhstan's water consumer, followed by industrial and drinking water uses. Almost 75% of all domestically available water goes for agriculture, where it's productivity is also low -- 15 USD cents/ m3 *(World Bank, 2015)*. Water losses are high with only 40-45% of water reaching the fields. Kazakhstan faces regular water deficit – during summer months, it reaches 20% of the demand *(World Bank, 2015).* A downstream country for almost all rivers within its territory, Kazakhstan faces en-vironmental and water quality challenges. Kazakhstan is one of the two countries (together with Uzbekistan) sharing the dried-up Aral Sea.

The country provides water-saving incentives, e.g., application of drip and sprinkler irrigation, as well as other types of water-efficient technologies is subsidized. Local farmers can be compensated up to 100% of corresponding costs. Annual Kazakhstan's water sector investment amounts to 120-160 mln USD *(Petrakov, 2019)*. The actual financing is not stable and depends on the overall economic situation in the country. The currently available funding covers only 30-40% of the actual operation and maintenance costs, and only 50% of capital costs *(World Bank, 2015)*. The country implements state water sector development programmes aimed at enhancing potable and irrigation water supply and other relevant tasks *(Petrakov, 2019)*. Such programmes provide the water sector with additional funding.

According to expert assessments and interviews, Kazakhstan's water sector is facing the fol-lowing challenges:

- demise of water infrastructure,
- weak legal provisions on water use control;
- underdeveloped tariff systems, poor water accounting and absence of incentives for water saving;
- water infrastructure ownership, especially at on-farm level;
- insufficient volume of water reservoirs for water harvesting;
- growing damages due to natural disasters such as floods, rising ground water table, soil salinity, droughts, etc.;
- deficit of water specialists (Petrakov, 2019).

Kyrgyzstan

Located in the Syrdarya's water formation zone and contributing a small share to the Amu-darya, Kyrgyzstan is an upstream country in the region. For its energy, it is dependent on the hydropower resources of the former river. Thus, hydro energy is one of the country's development priorities. Since gaining independence, Kyrgyzstan has staged a series of water sector reforms and tried to establish energy as a cornerstone of its transboundary water policy. Initially, the reforms concentrated on decentralizing routine operational-level water management, and focused on setting up WUAs and handing water management responsibili-ties over to them. Mid-level water management organizations have shrinked both size and funding wise *(Abdullayev et al., 2012)*. WMOs are mandated with basin-level water governance and management.

Kyrgyzstan's water sector has shifted from the centralized territorial model to more decentralized basin-wide governance and management. Today, the country's territory is di-vided into 5 watersheds planned and administered by the corresponding BMOs. In case of Kyrgyzstan, basin limits correlate with provincial borders. Thus, province-level water institutions are still there and transformed into basin organizations. Kyrgyzstan was the first one among CAS to introduce both water service fees and WUAs *(Sehring, 2009; Musabayeva, 2019)*.

Waters sector financing in the country mostly comes from public funds, i.e., state budget. Although, sector-specific funding has considerably reduced compared to that of the Soviet period, at present Kyrgyzstan spends 10 mln USD per annum on the sector's operation, maintenance, and capital costs covering only 40-45% of the required funding *(World Bank, 2015)*. The irrigation service fee (ISF) system is performing poorly, and the money collected does not compensate the incurred expenditure.

In the transboundary setting, being an upstream country Kyrgyzstan is pursuing the devel-opment of viable hydropower. Therefore, it has been consistently contesting the Soviet leg-acy water arrangements – both quantities and timing of water releases from Toktagul Reservoir – the largest artificial water body in the Syrdarya Basin. Since the early 2000's, it has been operated in the hydropower regime releasing the maximum flow in winter months *(World Bank, 2015)*. Kyrgyzstan has suspended its membership in regional water and envi-ronmental cooperation agencies under the IFAS auspices, and prefers bi-lateral collaboration formats instead.

In Kyrgyzstan, the water sector is faced with the same challenges as its riparian neighbours within the Syrdarya Basin, including:

- lack of funding;
- declining water systems;
- growing negative impacts of natural disasters on the national economy;
- aging of water organizations' staff *(Djailobayev, 2018)*.

Table 3.3 Main water sector indicators for Kyrgyzstan (as of 2015).

Population, mln	Agricultural water productivity, USD cents/m3	Irrigation system efficiency, % of water reaching fields	O&M and capital cost of irrigation systems, mln USD/year
	16	56	10

Tajikistan

Tajikistan is the second CAR's upstream state and the main contributor to the Amudarya flow. It is a mountainous country, although irrigated agriculture is a major driver behind social well-being and economic development. The country has put into life a series of re-forms to transform its water sector. The most ambitious of them have been launched in 2015 and are still in progress. The target initiatives have resulted in the introduction of basin management principles, separating policymaking from management, and consolidation of the national transboundary policies *(Abdullayev, 2019)*.

Possessing a huge underutilized hydropower potential, Tajikistan sees its energy sector as a development priority and springboard. Thus, to a large extent the national water policy spins around hydro. However, Tajikistan still sticks to the 1992 Almaty Agreement and complies with its water allocation principles. The republic is member to all regional water-related entities, as well as has initiated few international high-level actions in the water domain.

Water sector financing in Tajikistan comes from the state budget and amounts to 9 mln USD in operation, maintenance and capital costs covering only 50% of the total estimated de-mand. Tajikistan's ISF is performing relatively well but covers only a fraction of the sector's outlays. Pumping irrigation is wide-spread and mostly subsidized. Therefore, the lion's share of the water industry's funding goes for covering energy costs *(Umarov, 2007)*. As to transboundary water management, although prioritizing hydropower Tajikistan has been following a rather applied and pragmatic approach exerting efforts to fulfil its obligations under the 1992 Almaty Water Agreement. Although, confronted with resistance on behalf of Uzbekistan while building the largest infrastructure facility on the Amudarya – the Rogun Dam – since 2016 the countries have cleared all the issues, and Tajikistan has commissioned two generators at the Rogun HPP in 2018-2019 *(UNRCCA, 2018)*. On the global arena, Tajikistan has been actively supporting water initiatives (International Decade for Action "Water for Life" (2005-2015), International Decade for Action "Water for Sustainable Development" (2018-2028) through the UN system.

Tajikistan's water sector challenges include technical, human and financial limitations. The country's water infrastructure is aging, and the local-level competition for water is growing. Competent water experts are few. Repeating climate change induced natural disasters are causing significant economic losses *(Abdullayev, 2019)*.

Table 3.4 Main water sector indicators for Tajikistan (as of 2015).

Population, mln	Agricultural water productivity, USD cents/m3	Irrigation system efficiency, % of water reaching fields	O&M and capital cost of irrigation systems, mln USD/year
7,4	15	52	9

Turkmenistan

Turkmenistan is one of three tail-end countries of the Amudarya River Basin. A significant share of the country's territory is occupied by the Karakum Desert. It has a developed irri-gated agriculture and depends on its riparian – especially upstream – CAR neighbours. Turkmenistan exercises full and positive neutrality fostering its good relations with all other CAS, including on water. The country is a member of regional water and environmental organizations under the IFAS umbrella *(UNRCCA, 2016)*.

Turkmenistan is financing its water sector from the state budget. With >240 mln USD of annual target allocations, it covers only 60% of the current sector's demand. The country is rehabilitating several large-scale irrigation systems and constructing new ones. Turkmenistan's irrigation water losses are significant (around 40%) and are coupled with extremely low water productivity in agriculture *(World Bank, 2015)*.

Turkmenistan has pilot-tested basin organizations in a number of its irrigated systems. However, the current water governance setting is still territorial. Territorial water organisations are responsible for state water policymaking and water management. At the lowest level, water users are organized in semi-cooperative type of arrangements. The scale of irrigation in Turkmenistan is very large, inferior only to that in Uzbekistan. This requires con-stant state financing of O&M and capital costs. Turkmenistan is planning to extend its irrigated lands and ameliorate these salinized *(Kurtovesov, 2019)*.

TThe country has implemented a large-scale project on diverting drainage water to Altyn Asyr Lake inside a depression in the Karakum Desert for further re-use and de-salinization. About 40% of domestic irrigated land is prone to salinity. The country is one of the three CAS sharing the Aral Sea disaster zone. Desertification of irrigated land due to climate change poses a clear and present danger to sustainable agriculture. Water use efficiency is low, and the government is promoting water saving as well as funds water efficiency initiatives (*Kurtovesov, 2019)*.

Table 3.5 Main water sector indicators for Turkmenistan (as of 2015).

Population, mln	Agricultural water productivity, USD cents/m3	Irrigation system efficiency, % of water reaching fields	O&M and capital cost of irrigation systems, mln USD/year
6	7	53	243

Turkmenistan has been building both bi- and multilateral water collaborations with CAS riparians and Afghanistan, including the long-term water sharing and water cooperation agreements with Uzbekistan. The country is rich in gas, produces excess energy and exports it to neighbouring countries. Turkmenistan has initiated several important water and envi-ronment initiatives within the UN system. It had chaired the IFAS Executive Committee from 2016 till 2019. The country is a member of the 1992 Almaty Water Agreement and international water conventions *(Kurtovesov, 2019)*.

Turkmenistan's water sector is facing:

- significant climate change impacts. Water availability and temperature fluctuations are seriously effecting access to water, crop yields and water productivity;
- drying-up of the Aral Sea that had negatively affected irrigated lands (soil salinization and degradation, etc.);
- absence of basin-wide water conventions/ agreements which could potentially enhance transboundary riparian partnerships;
- technical condition of farm-level infrastructure;
- water related natural disasters *(Kurtovesov, 2019).*

Uzbekistan

Uzbekistan is the largest water consumer in the Amudarya and Syrdarya Basins. With around 4 mln ha of irrigated land and more than 36 mln population, the country is absorbing over 50% of the total CAR's water resources. Uzbekistan is a downstream country and depends on its upstream neighbours for releasing water in summer, mainly for irrigation.

The country possesses well-established water governance and management systems focusing on water delivery and management of dense irrigation and drainage infrastructure *(Abdullayev et al., 2008; Abdullaev and Rakhmatullayev, 2016).*

Since gaining independence, Uzbekistan's water sector has undergone several rounds of reforms. At present, water is managed within irrigation basins in most cases matching provincial borders. Mid-level water management has a governance + management format. Every-day water governance and management is done by WUAs, although their performance is limited, and they don't hold capacities to operate on-farm irrigation systems. The government covers all water sector costs, including power for operating water pumps. Currently, Uzbekistan is allocating half a billion USD for O&M and capital costs in the water industry, covering around 65% of its total needs *(World Bank, 2015).*

With over 40% of irrigation water lost, its efficiency constitutes a major hurdle. Recently, the national government has started subsidizing drip irrigation with the intention of covering 50% of its irrigated farmland with drip systems by 2030. In the course of the last 25 years, Uzbekistan has reduced the area under cotton production by 60%. Today, only 30% of irrigated land is under this crop. Uzbekistan's water intake from the two rivers has dropped by 10 km3. The country is planning to engage in public private partnership schemes, including handing over the ownership of reservoirs to private companies keeping in state hands only their operation *(MWR RU, 2019)*.

Table 3.6 Main water sector indicators for Uzbekistan (as of 2015).

Population, mln	Agricultural water productivity, USD cents/m3	Irrigation system efficiency, % of water reaching fields	O&M and capital cost of irrigation systems, mln USD/year
36	13	56	510

Chapter 3 Water sector's financial and economic dimensions

This chapter presents the assessment of both state and needs of the water sector financing. Likewise, it reviews the funding structure and sources, role of various players – such as state, users and private entities – in the sector's financing, as well as economic and financial stability issues within the industry. Financing is an important dimension of both water gov-ernance and management. Public and private funding schemes are utilized in the water sec-tor across the globe. However, none of these two schemes alone are considered successful.

Water sector financing in Central Asia is still mostly public, although user fees were introduced for all types of uses: irrigation, drinking and industrial. Nevertheless, user fees cover only a fraction of water delivery costs in different sectors. Both low public financing and low user fee collection rates pose a challenge. According to the World Bank, CAS's water sector receives only 50% of the required amount *(World Bank, 2015)* with the main reasons being budget shortages and users' reluctance to pay due to unreliable water services.

Almost all water infrastructure in CA is public, although on the local level, O&M responsibilities are vested with various user organizations or land users/farmers. With no well-established cost-sharing, financing schemes exist between public and private bodies. The major part of infrastructure maintenance costs is incurred by the state. Only regular repairs of local water systems are done by water users themselves. At the regional level, large-scale water infrastructure is funded on a territorial basis. Since the collapse of the Soviet Union, each country invests in infrastructure located within its sovereign territory.

Privatization, concessions or any other private engagement schemes in the water sector are not common in CAS and Afghanistan. Both ownership of and investment in water facilities by private entities is not observed in the region, with the only examples present in Kazakhstan, where during privatization separate installations and facilities were transferred into private hands. In fact, that had only aggravated the overall situation, as becoming monopolists the owners of small reservoirs drove water users operating within irrigation-dependent zones into financial debt dependence (*Petrakov, 2019)*.

Over-regulation and unclear ownership of water infrastructure act as the main reasons and obstacles for private engagement. Although water agencies are operating and maintaining water infrastructure, the corresponding ownership rights are vague. In some cases, ownership may be municipal, in others – infrastructure may belong to different line ministries and/or agencies (e.g., energy, water supply, etc.).

Other reasons for limited private engagement in the water sector are agricultural policies and land ownership issues. In almost all CAS, agricultural water supply (including irrigation) is deemed a state's social function. In this context, governments are planning to introduce neither full market system in agriculture, nor full water delivery pricing schemes. Although in 3 out of 5 Central Asian countries (Kazakhstan, Kyrgyzstan and Tajikistan), land rights are private (long-term lease), none of CAS have competitive land markets. Thus, water pricing is not market-based and is regulated by the state.

The new Afghanistan's Water Code stipulates for private investment opportunities, but – given that 90% of its irrigation systems are informal and managed jointly by mirabs and local communities – financing mechanisms for such systems are still undergoing fine-tuning and are not attractive to investors. 10% of centralized irrigation systems are financed from the state budget *(Rout, 2008)*. Afghanistan's Water Authority is responsible for charging for delivery, storage, operation and maintenance of priced irrigation systems *(Water Law in Afghanistan, 2019)*.

Service fees charged by state water organizations are not collected in full, as water users are reluctant to pay them because of unreliable water supply. However, lately household water supply fee collection has improved due to better metering and infrastructure improvements. In irrigation water supply, the volume of collected service fees is still far below to be a sensible part of at least O&M costs.

Target countries are trying to boost service fee collection by introducing water-metering (Uzbekistan), empowering user organizations (Kyrgyzstan) and management organizations (Tajikistan) and allowing them to keep a share of fees, as well as implementing more com-mercial water supply models (Kazakhstan). None of these schemes alone can help address-ing the water sector's financing challenges, as more robust systemic changes are necessary to ensure water financing sustainability.

To this end, one option could be the commercialisation of the major water consumer, i.e. farming. If land was privatized, agricultural production would become more market ori-ented, and if land market was institutionalized, then mid- or local-level private water companies would become feasible, thus, triggering private financing inflow into the industry. Nonetheless, in the context of state-run models dominating the CA water system this is the least likely scenario. Overall, this scheme has been propelling socio-economic resistance on behalf of users and governments globally.

A more realistic approach would be to introduce public-private partnership irrigation schemes allowing utilizing these multi-purpose water use models to cover water supply costs. Concessions of infrastructure and land around irrigation installations, renting out facilities to private users would also drive more money into the sector. The state could play the role of a social regulator making sure that each water user receives a fair share of water resources. Still, this model requires additional financial control and regulation in order to avoid corrupt schemes and malfunction of water supply systems.

Chapter 4 Water-Energy-Agriculture Nexus in Central Asia

Energy-water-food linkages play a critical role for socio-economic development and shared prosperity. These three resources are tightly interconnected, forming a resource and policy nexus. In the coming decades, water, energy and food demands are projected to increase across all CAS due to population and economy growth, changing lifestyles and consumption patterns.

New water sources are increasingly expensive to develop, spatially and temporarily variable in most of arid and semi-arid Central Asian countries. Based on forecasts, by 2040 CAS will be experiencing "extremely high" levels of water stress *(WRI, 2019)*.

Water quality is as important as water availability. Water quality degradation, for instance, directly translates into risks impacting human health, limiting food production, curbing eco-systems' functionality and hindering economic growth *(World Bank, 2019)*.

Irrigated farming accounts for approximately 80% of the total current water withdrawals in the CAR. It can produce crop yields 2-4 times greater compared to rainfed farming *(FAO, 2018)*. For example, global irrigated agriculture currently provides 40% of the world's food from approximately 20% of all agricultural land *(WRI, 2019)*.

Approximately 90% of global power generation is water-intensive. Energy is required for pumping and distributing water (including for irrigation), water supply, wastewater treatment and water desalination. Vice versa, the power industry requires water to cool thermal power plants, generate hydropower and grow biofuels *(WWAP, 2014)*.

Physical degradation of infrastructure and poor institutional operations prompt issues with irrigation, as well as water collection, transportation, and treatment for human purposes. In addition, water resources are neither distributed evenly across countries nor equally accessible throughout the year.

Table 4.1. Energy consumption in irrigated agriculture.

Country	Total area fit for irrigation ('000 ha)	Actual irrigation ('000 ha)	Total power-irrigated area ('000ha)	Share of power-irrigated lands (%)	Area fit for ground-water irrigation ('000ha)	Share of area irrigated by groundwater (%)
Afghanistan (Rout B., 2008)	3,208	1,560	0	0	367	11
Kazakhstan	2,066	1,265	41	2	2	0,1
Kyrgyzstan	1,023	1,021	51	5	7	1
Tajikistan	742	674	296	40	33	4
Turkmenistan	1,991	1,991	318	16	9	0,5
Uzbekistan	4,199	3,700	1,133	27	274	6

Note: Zero means 'no data available".

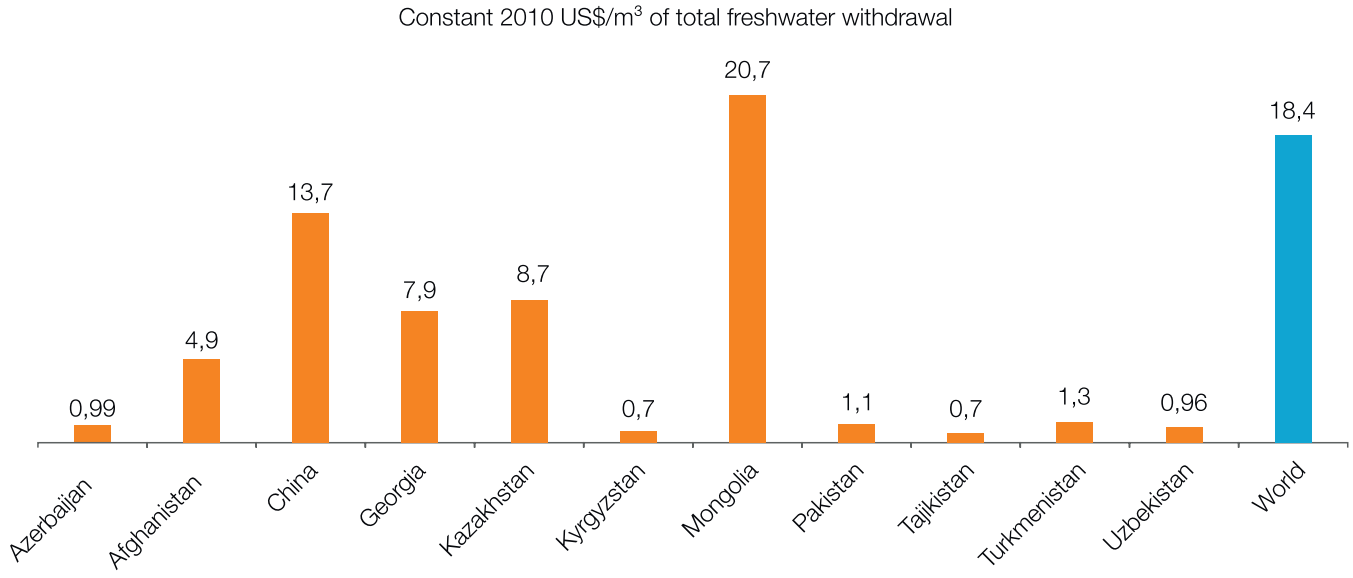
Annually, billions of cubic meters of water are lifted, conveyed and transported via a sophisticated network of pumping stations, water intake facilities, boreholes and vertical drainage systems from surface and ground sources depending on the prevailing topographic and hydrogeological settings *(Table 4.1.)*.

In fact, the share of electricity used for irrigation varies from country to country. For example, Tajikistan and Uzbekistan irrigate over 20% of their lands under electric pumped schemes. In Uzbekistan, about 20% of the total power consumption falls on irrigated farm-ing. Half of the CAR's powered lifting infrastructure – 43 large-, 1,400 medium- and 30,000 small-size pumping facilities – operate in Uzbekistan (Rakhmatullayev and Abdul-layev, 2014). In Uzbekistan alone, the annual cost of operating pump-lifted systems is about 425 mln USD (1 kWh = 0.047 USD or 450 Uzbekistani soms).

More detail

Relative to their populations, CAS have plenty of water, but the economic return on water is well below the values in some parts of the world (Figure 4.1). Water productivity is calcu-lated as GDP in constant prices divided by annual total water withdrawal. Given the different economic framework in each target country, it is necessary to use these indicators with caution taking into account a country's sectoral activities and natural resource endowments. It is still evident that the majority of CAS need to boost water productivity, especially this in agriculture.

Figure 4.1. Water productivity across Central Asia and neighbouring countries in 2014 (World Bank Data, 2019).



Jobs in agriculture – still a vital sector of economy across all Central Asian countries providing livelihoods for millions of people – are highly water-dependent. Experts claim that even a higher than official proportion of rural residents are employed in agriculture through informal arrangements. The material evidence of the past 25 years shows that arable land (hectares per capita) in all CAS has substantially decreased *(Table 4.2)*.

Afghanistan, Tajikistan and Uzbekistan should pay special attention to this fact. With the projected population growth, the situation will become even more alarming against the backdrop of degrading soil quality. The only promising avenue may be increasing land productivity. In order to address these challenges, breakthroughs in water and land productivities, as well as agricultural production diversification are required.

Table 4.2. Arable landdynamics (hectares per capita) in CAREC countries, 2016 (World Bank Data, 2019).

Country	1992	2016	Change (decrease)
Afghanistan	0,546	0,218	150%
Kazakhstan	2 132	1 652	29%
Kyrgyzstan	0,292	0,212	38%
Tajikistan	0,156	0,08	95%
Turkmenistan	0,381	0,343	11%
Uzbekistan	0,209	0,14	49%
World	**0.232**	**0.192**	**21%**

National statistics demonstrate that tremendous enhancements have been reported on agri-cultural value added per worker across CAS *(Figure 4.2)*. Yet, half of target countries still lag behind the global average estimates. In developing countries, a large share of agricultural output is either not exchanged (because it is consumed within households) or not exchanged for money.
Agriculture comprises the value added from forestry, hunting, and fishing as well as crop cultivation and livestock production.

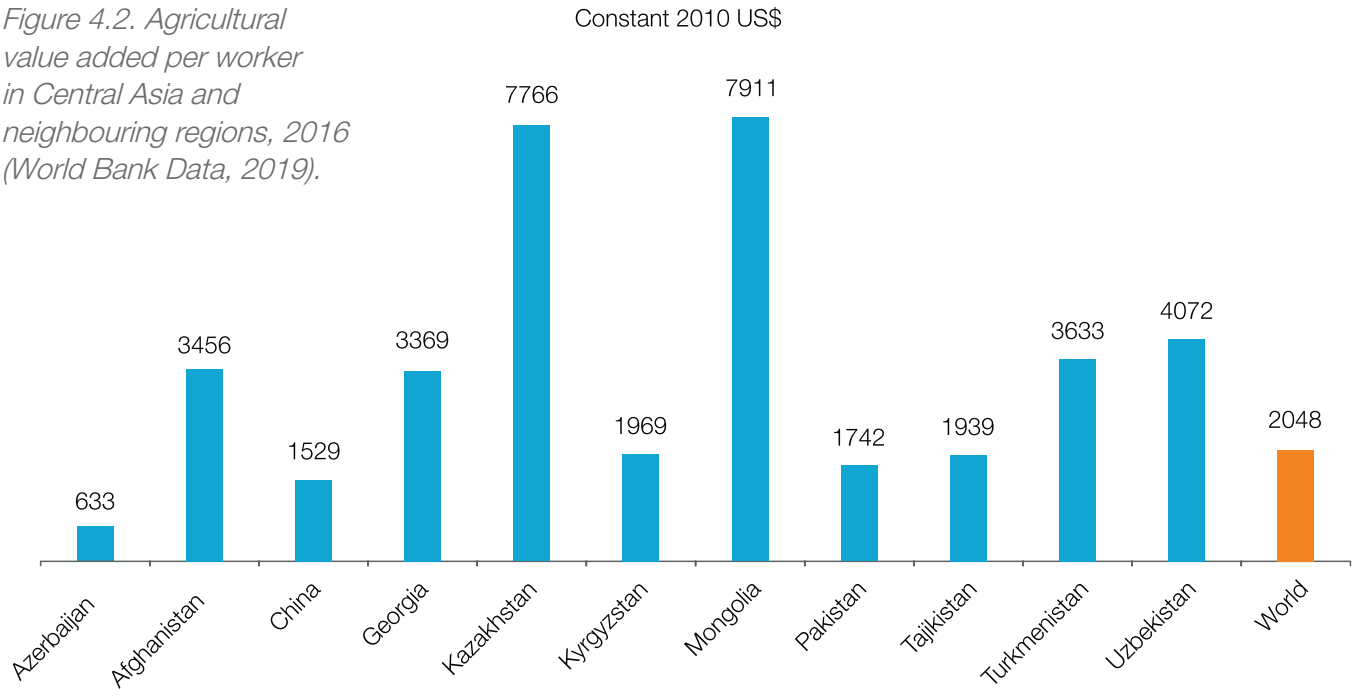
The water footprint of a product is the volume of freshwater used to produce it measured at the actual production location *(Aldaya et al., 2010a; Aldaya et al., 2010b; Mekonnen and Hoekstra, 2010)*. Water footprint assessment of agricultural crops could inform production and trade decisions most suited to local environmental conditions under projected climate change impacts, especially these related to changes in precipitation patterns and water availability. A nation can strategically re-think its domestic water resources by importing rather than domestically producing water-intensive products.

The green water footprint measures the volume of rainwater used while growing a crop. The blue

water footprint measures the volume of surface and groundwater consumed. Wheat, rice and cotton are important agricultural crops in the CAR in terms of export revenues and food security. On the global scale, wheat and rice have the largest blue water footprints, combined accounting for 45% of the global blue water footprint *(Mekonnen and Hoekstra, 2014)*.

Globally, about 53% of cotton fields are irrigated and produce 73% of the world's cotton. The blue water footprint is the largest in arid and semi-arid zones inter alia located in Central Asia, Pakistan and northeast China.

Figure 4.2. Agricultural value added per worker in Central Asia and neighbouring regions, 2016 (World Bank Data, 2019).

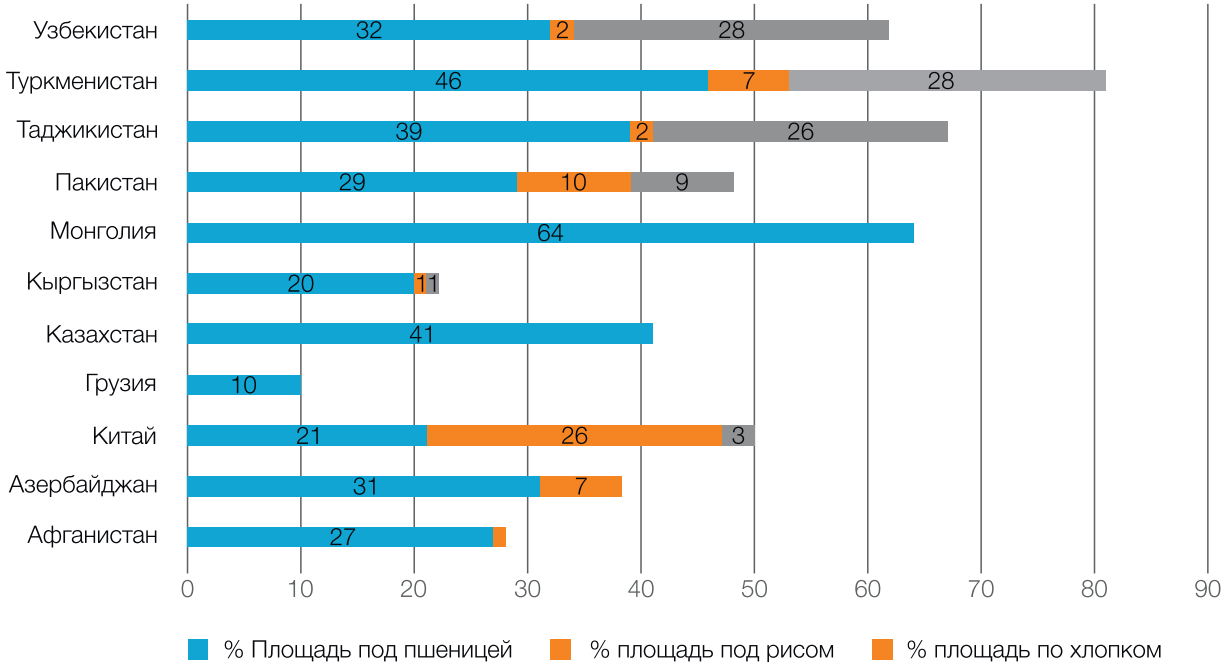


While CAS are growing a diverse crop mix, three agricultural crops (wheat, rice and cotton) still dominate. Only Kyrgyzstan and Afghanistan allocate 22 and 28 per cent of agricultural land, respectively, for these three crops. The remaining Central Asian countries use about 40% of their farmland for the same crops. The highest shares of land under these crops are reported by Turkmenistan – 81%, Tajikistan – 67%, and Uzbekistan – 62%.

Wheat acts as the leading food grain in human diet; rice takes the second staple food crop position across the CAR. As a matter of fact, wheat and rice provide 38% of the total hu-man food available *(FAO, 2019)*. In addition, wheat is also used as fodder in livestock and poultry husbandry (*Figure 4.3)*.

Kazakhstan is one of the top global wheat producers. Winter and spring wheat varieties are cultivated throughout the region both in rainfed and irrigated areas with the water footprint comparable to the global average estimated at 1,620 m3/ton *(Mekonnen and Hoekstra, 2014)*. Altogether, 309 bln m3 of water are used for growing wheat in CA.

Figure 4.3. Land shares under wheat, rice and cotton to the total arable land across Central Asia and neighbouring countries (IFPRI, ADB, 2019).



Turkmenistan and Uzbekistan are among the top world cotton producers. Their total cotton production is estimated at 4 mln tons. The average global total water footprint for cotton is about 3,589 m3/ton *(Mekonnen and Hoekstra, 2010)*. The total of 20 bln m3 of freshwater goes for cotton-growing in the Central Asian Region.

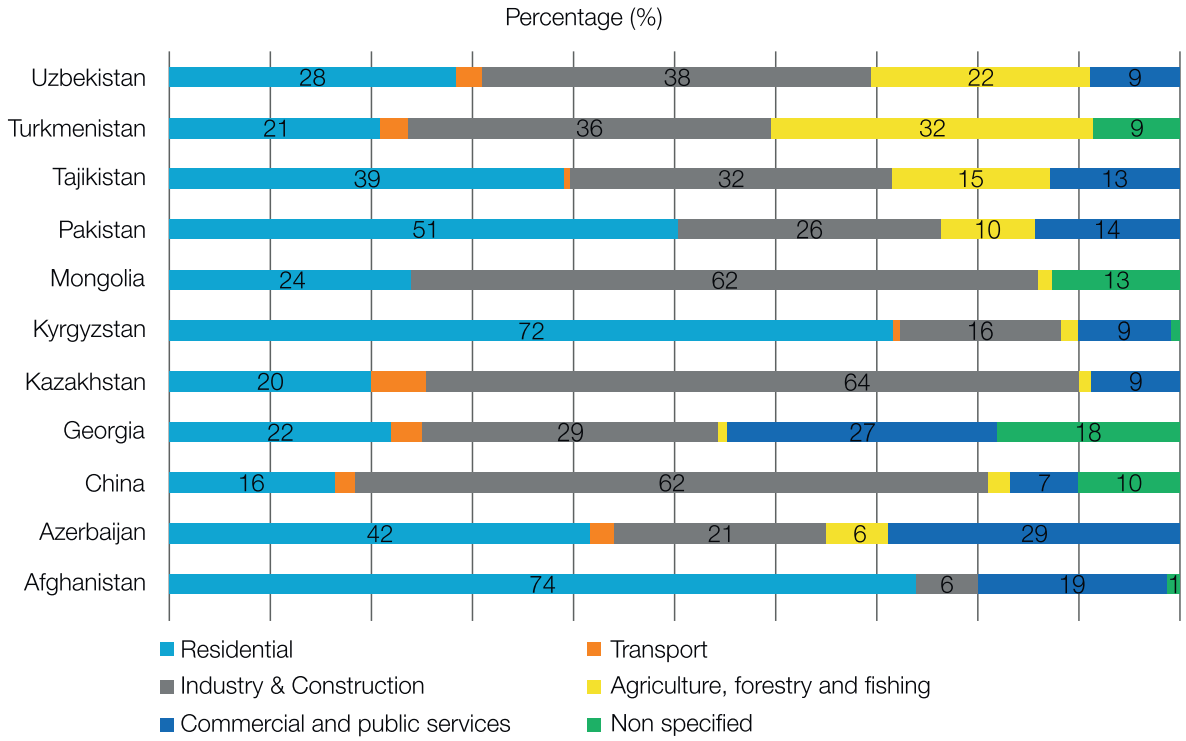
The total renewable water resources of CAS are estimated at 120-128 bln m3/year. The total volume of water needed for producing wheat, rice and cotton is estimated at approximately 21% of the region's total renewable water resources. Uzbekistan, Kazakhstan, Turkmenistan use considerable amounts of their water for growing wheat, rice and cotton.

Countries across the region differ in their food security strategies. For example, whereas Turkmenistan and Uzbekistan emphasize food self-sufficiency, others pursue a more liberal trade regime and active agricultural development policies as the path to food security. The government of Uzbekistan has been persistently working on transforming its cotton- and wheat-growing zones (about 285,000 ha) into horticultural production areas. According to a recent World Bank report, horticulture crops may offer a better export potential, tend to be associated with a less water-intensive production, and generate higher value-added margins, i.e. gross margins per hectare are up to five times higher than for cotton and wheat.

Water and energy are closely linked. As energy cost is usually the greatest expenditure item for water and wastewater utilities, audits to identify and reduce water and energy losses, as well as to enhance efficiency can result in substantial energy and financial savings. Additional production capacity is needed to meet the forecasted CAR's growing electricity con-sumption either by building new power generation capacities and/or increasing the efficiencies of the existing ones.

It is important to look at the structure of electricity use by different sectors of national economies, which will assist CAS in making weighed decisions on mitigation and adaptation measures. It is evident that two sectors – residential and industry & construction – on average consume about 37% and 36%, respectively, of the total power usage in Central Asian countries (Figure 4.4.).

Figure 4.4. Final electricity consumption by sectors in Central Asia and neighbouring countries in 2017 (IEA, 2019). Data for Afghanistan were derived from a presentation by DA Afghanistan (Breshna Sherkat, 2011).

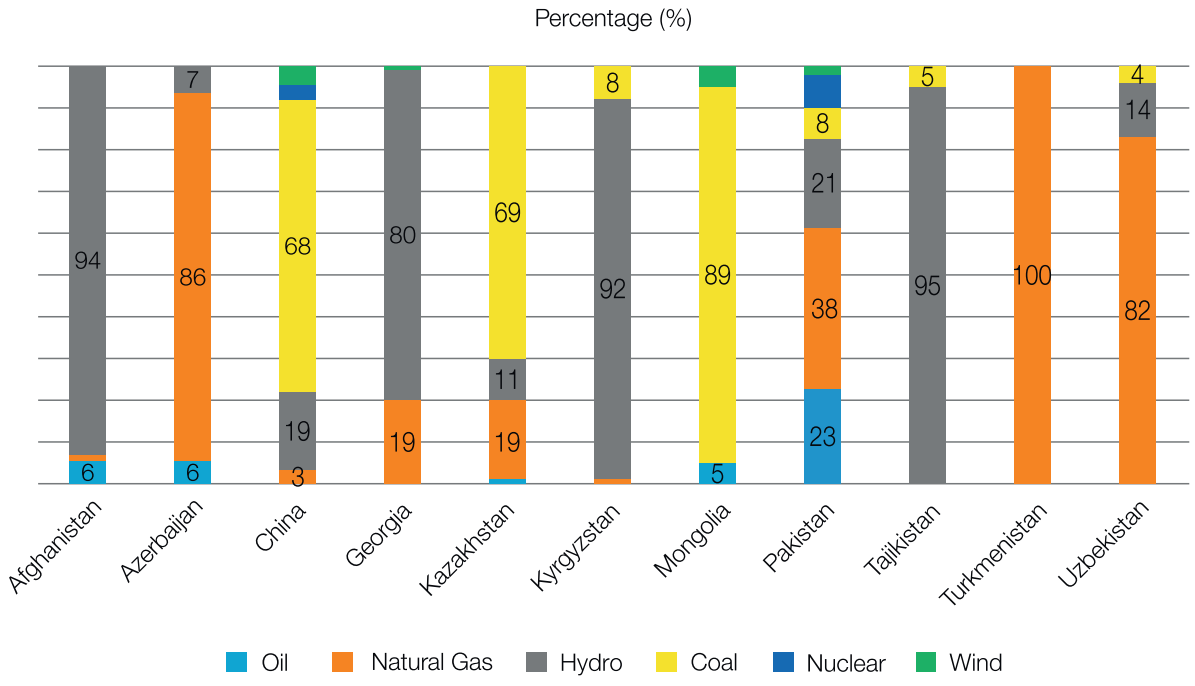


For example, as a priority Afghanistan and Kyrgyzstan governments could look into designing energy efficiency programs for the residential sector, as it consumes over 50% of their total power consumption volume. Kazakhstan's industry & construction sector eats up more than 60%; commercial and public services are an integral part of its economy and consume about another 12% of its total electricity supply.

Ironically, climate change impacts on water availability may force countries to step up their dependence on coal and oil further increasing their carbon emissions. For instance, power shortages due to low dam reservoir levels have already intermittently forced the use of coal-fired energy. CAS governments come under pressure to rebalance fossil fuel subsidies and support cleaner energy as part of their Paris commitments.

CAR economies are still heavily dependent on fossil fuels for power generation, including coal, oil, and natural gas, all contributing to the greenhouse gas effect *(Figure 4.5)*. Hydro-power generates more than 80% of electricity in Afghanistan, Kyrgyzstan and Tajikistan. Natural gas amounts for over 80% of electricity production in Turkmenistan and Uzbekistan. In Kazakhstan, coal is the primary power generation fuel. Approximately 60% of the re-gion's electricity comes from fossil fuels (coal, oil and natural gas). This feature of the region's energy sector explains its high share in global GHG emissions in general and carbon dioxide, in particular.

Figure 4.5. Electricity generation by sources in Central Asia and neighbouring countries (IEA Data 2019).



CAS governments do recognize that higher renewable energy (RE) use will reduce their economies' carbon intensity and strengthen their energy security by diversifying the energy mix through increased RE investment. At present, the necessary enabling environment for fully realizing the good intentions is in nascent condition. Yet, it is unfortunate that solar, wind, bio and geothermal (modern renewables) constitute a rather small portion of power generation in Central Asian countries. This means that national governments declare green economy and resource-efficient economic models as their strategic development milestones in absence of any practical proof of such a paradigm shift.

Whereas energy is required mainly for providing water services, water resources are required for power production. As a country's or region's energy mix evolves, say from fossil fuels towards renewables, so will the implications for water and its supporting ecosystem services.

Chapter 5 Recommendations and road map for future interventions

This chapter comprises policy, institutional and technical recommendations on enhancing water governance, management and coordination in Central Asia and Afghanistan. It also provides recommendations for potential development priorities. The recommendations herein are based on both regional and country-specific analysis, with the main focus on regional activities, although local- and country-level measures also requiring due attention.

In addition to seeking new technical solutions, a new policy and economic framework is required to facilitate cooperation and integrated cross-sectoral planning. Integrated planning and multi-sector collaborations will leverage potential synergies for bringing down costs, assessing trade-offs, demand-side interventions, and decentralized services for achieving infrastructural and sectoral resilience. On this account, it is necessary to continue supporting water sector reforms in Tajikistan and Uzbekistan, as well as sectoral changes in Turkmen-istan. Ideally, expert groups should be established encompassing all parties engaged in such reforms, including national water agencies, international financing institutions and develop-ment agencies. Their meetings will allow pinpointing the most effective supports to national water agencies while the reforms progress.

Networking at various levels (regional, national and local) and among various stakeholder groups (educational institutions, industry agencies, water specialists, etc.) will foster synergies among different types of actions, as well as achieving multiple-level benefits and/or among different stakeholder groups. It is important to maintain this multi-level and multisector approach stimulating wider knowledge and better understanding of changes tak-ing place in the water sectors of Central Asian countries, as well as will render opportunities for adapting (adjusting) interventions based on real-time findings.

According to the analysis in this report, the cardinal challenge for the water sector in Central Asia is its financial sustainability. Shrinking and insufficient funding has remained a major obstacle to sustainable and reliable water supply in all sectors in almost all concerned countries. Sporadic financing also prevents strategic water sector planning and leads to serious O&M delays. Almost 70% of the irrigation infrastructure and 50% of water supply systems are outdated and require rehabilitation and/or replacement making the water sector extremely investment-hungry. Therefore, national governments should introduce sector-specific incentives and make it attractive for private and international investments.

To promote new financial instruments, it is necessary to support the development of mechanisms ensuring the water sector's financial sustainability at various levels: basin, national and regional. On the regional level, a major focus could be on the renewed discus-sions on setting up a water-energy consortium for the Syrdarya and Amudarya. Joint operation and maintenance of transboundary water infrastructure and benefit-sharing schemes could also become the project's focus. In the current small basins, PPP schemes associated with the operation of small- and medium-size infrastructure could be piloted. On the na-tional level, the focus could be on providing both legal basis and financial tools for water sector financing from private sources. Regional scale benefit-sharing issues were reviewed in the Adelphi & CAREC (2017) report on regional cooperation. It highlighted the introduction of mechanisms for joint project financing and benefit-sharing within transboundary water systems as important regional collaboration themes.

Capacity-building, education and research is yet another area where new approaches are necessary. This area is experiencing difficulties in all Central Asian countries and requires fundamental reformatting. Improving the quality of specialized training and scientific research is key for proper planning and managing water infrastructure, as well as for designing effective strategies for advancing the water sector. CAS need to complete the

transformations that have been launched in public education, research and public service domains. Without a fundamental change, the training of qualified water professionals will remain a major challenge. Creating an advanced training system for water specialists and a compre-hensive master-level water training network on the regional level – which will include universities in all CAS – can serve as a basis for bringing up the next generation of water workers with a shared regional vision of using and managing water resources. The existing mechanism of cooperation between German-Kazakh University and Tashkent Institute of Irrigation and Agricultural Mechanization Engineers could lay the foundation for such a regional academic platform. In the future, this platform can be strengthened and expanded by including agricultural universities in Kazakhstan, Kyrgyzstan, Tajikistan and Turkmenistan. On-line and web-based training (webinars) systems could be applied more widely and frequently. Support for curricula and text-book development could be also considered a viable potential cooperation area.

Research and academic cooperation should serve basis for addressing the ongoing water sector challenges and planning its future development. The growing number of research grants, joint research efforts and publications will make regional water collaborations stronger. Thus, research grants targeting and linked to both regional agreements and national priorities should also become the elements of the project. The development of the regional academic network, as well as regular meetings of its members could manifest the best option for executing regional studies and engaging in academic partnerships.

The new impetus for water and energy saving in the CAR has brought about new opportunities for improving the water sector overall. In Chapter 4 of this report, it was mentioned that inefficient water use leads to both water and energy losses. Increased competition for water and energy in the context of growing economies will become a good incentive for water and energy saving in the water sector. Piloting and testing water and energy-saving technologies, using solar, wind and other renewables in separate basins to power water pumps, as well as testing financial instruments (in particular, attractive to private business) and mechanisms, simultaneously with uncovering benefits for various stakeholders can serve a good ground for the region's subsequent development and dissemination of best practices.

The region faces a tremendous infrastructure bottleneck, including in the water sector. Aging and dilapidated water systems are responsible for most of the losses. The demand for water infrastructure rehabilitation support will grow in the next 5 years. However, scattered and unplanned rehabilitation will not improve water distribution, but rather widen the gap between water users in rehabilitated and non-rehabilitated areas. In this regard, it is necessary to embark on a complete inventory of the current state of CAS's domestic irrigation networks and draft long-term infrastructure rehabilitation plans. The plans could cover a period of 10 years and should prioritize location-specific water infrastructure enhancements and clearly indicate costs and financing sources.

New and contemporary ideas such as Industry 4.0 (Forth Industrial Revolution), artificial intelligence, application of drones and other cutting-edge technologies are also seeping into and becoming a norm in the water sector. These innovations are shaping the new water management reality. Thus, promoting and supporting the so-called IdeaLabs (Water Inno-vation Laboratories) can help engaging young and talented specialists in developing water innovations and designing new breakthrough technologies fostering water sector evolution.

Afghanistan has a different water governance and management setting. Security and instability inside the country make any project implementation and monitoring almost impossible. The previous experiences associated with establishing a

project sub-office in Kabul and selecting local co-implementers could be utilized during the project's next phase as well. However, the increased attention to capacity building for water staff, managers and decision makers also hold much promise. Thus, forging conditions for bringing Afghanistan on board of regional cooperation and the joint CAS-Afghanistan discourse on further developments are key for ensuring stability and mitigating/preventing conflicts in the future.

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