The use and management of water resources in Central Asia

A consultation on future directions

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Abbreviations

APC	Agricultural production cooperatives
ASB	Aral Sea Basin
FAO	Food and Agriculture Organisation of the United Nations
GDP	Gross Domestic Product
HPS	Hydropower stations
ICSD	Interstate Commission for Sustainable Development
ICWC	Interstate Commission on Water Cooperation
IFAS	International Fund for Saving the Aral Sea
ISF	Irrigation service fees
IWRM	Integrated Water Resources Management
O&M	Operation and maintenance
ODA	Official development assistance
OECD	Organisation for Economic Cooperation and Development
PFU	Peasant Farm Union
R&D	Research and development
SDC	Swiss Agency for Development and Cooperation
SIC ICWC	Scientific-Information Centre - Interstate Commission on Water Cooperation
WMO	Water management organisations
WUAs	Water User Associations
WUEMoCA	Water use efficiency Monitoring tool in Central Asia
WUO	Water user organisations
UN	United Nations

Opportunities and challenges

Central Asia sits at the crossroads of Europe and Asia and comprises the five former Soviet Union Republics of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan. With a land mass of some four million km2 that spans from the Caspian Sea in the west to China and Mongolia in the east, and from Afghanistan and Iran in the south to Russia in the north, the region is of strategic international geo-political interest and provides economic opportunities including access to natural resources and efficient trade routes.

The region's water resources are critical to the economy of each country and the region as a whole. Water drives irrigated agriculture, which is a significant contributor to the countries' GDPs, and produces vast quantities of energy through hydropower generation. Although regional water resources seem abundant, climate changed induced temperature increases are impacting the region's "water towers", including the glaciers of the Tien Shan Mountains.

Water management in Central Asia is complex and many of the challenges that existed 20 years ago persist today. Water scarcity coupled with governance and management challenges means the region is vulnerable to shocks and is increasingly exposed to the impacts of climate change. Unpredictable water availability with more frequent and severe natural floods and droughts, a growing population and increasing extra-regional water withdrawals mean acting now is critical for a sustainable future.

Having a shared Soviet Union legacy, a path dependency influences water management in the region. The two major rivers within the region, the Syr Darya and the Amu Darya, which provide up to ninety percent of the region's water resources are transboundary. During the Soviet era, a sharing of resources meant the region's water resources could mutually compensate during times of abundance and scarcity. This included the region's energy-for-water trading scheme which supplied electricity generated from downstream countries to upstream countries during winter. This facilitated upstream storage of water in reservoirs for downstream summer-irrigation needs.

Following independence, this system of mutual sharing broke down and countries moved towards sovereign development priorities based on their natural resources and socio-economic characteristics. A lack of water resource monitoring and evaluation throughout the region hinders efficient water management, with knowledge gaps in water resource availability and use. Studies estimate that the lack of cooperation on water management have potential to cost the region more than USD 4.5 billion annually (Pohl, et al., 2017).

Good practice exists throughout the region and can pave the way for replication and cooperation. Examples include Kazakhstan's cooperative monitoring system of its transboundary rivers with China and Russia, where data is collected along each river section and withdrawals and water use from each country are logged, making evaluations of water use and future requirements possible. In Kyrgyzstan, an online water management information system provides data on water resources and uses, facilitating more accurate water accounting and therefore more stringent water management. Regional coordination by the Interstate Commission for Water Coordination in Central Asia (ICWC) has established various foundations for maintaining the integrity of regional water management including developing an annual and seasonal water distribution plan and the CAWater-Info portal with data on water, land, and environment. This practice demonstrates the capacity of the region to develop and improve water management systems and cooperate towards sustainable water use. Reccomendations to promote cooperation include:

- implementing measures for climate change adaptation to increase the adaptability of flow regimes when deviating from normal conditions, cater to changing available water resources, align management to temperature and precipitation shifts, and build resilience against natural disasters.
- introducing economic measures for water saving and to leverage water use efficiency. Reflecting the value of water in tariffs can support future sustainable water management and promote investment in the sector.
- strengthening regional institutional and legal frameworks by detailing and aligning, where possible, national priorities, quantifying the potential benefits foregone due to sub-optimal regional cooperation, focussing on strategic development priorities in the region, and capturing learnings from previous regional projects.

Regional cooperation will be at the centre of sustainable water management in Central Asia and presents significant opportunities for the region. The foundations for sustainable water management largely exist, meaning countries are in a good position to seize these opportunities and improve water management into the future. Improved governance frameworks, supported by national and regional monitoring of water resource availability and use could improve water management potential significantly, leveraging economic gains and delivering social benefits to improve the well-being of Central Asian citizens. This OECD Policy Perspective reviews the trends in water management in Central Asia over the past 20 years and considers opportunities and policy recommendations for strengthening national and regional water management.

Central Asia: Background

Central Asia is a vast region stretching from the Caspian Sea in the west to China in the east, and from Russia in the north to Afghanistan and Iran in the south. It can be characterised as the easternmost end of Europe and the western boundary of Asia. The region consists of five states, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan. Formerly states of the Soviet Union, this legacy creates a path dependency that affects today's water management and socioeconomic characteristics.

Prior to the collapse of the Soviet Union in the early 1990s, the region's population grew rapidly at a rate of more than 3% per year, while today the region's annual growth rate has stabilised at 2%. The share of the rural population is still high in Central Asia (56.2%) compared to the global average of 45% (UNDESA, 2018). Employment rates in the agricultural sector are high, reaching 60% in Tajikistan, reinforcing the importance of agriculture, particularly irrigated agriculture, throughout the region. Economic diversification is ongoing, industrial and service sector development strategies are driving employment growth in these sectors. These trends follow the gradual drop in the agricultural sector's contribution to overall GDP while productivity in other industries is rising.

Independence initially resulted in sharp production decreases. However, Central Asian economies began growing again after 2000, increasing total GDP and per capita income to pre-independence levels (apart from Tajikistan).

Although it continues to contribute to growth, agricultural production is not increasing at the same rate as non-agricultural sectors indicating that the region is prioritising development in the industrial and services sector, including oil and gas production.

Central Asia has several hydrological basins (Figure 1), the largest being the Aral Sea basin. There are number of interstate basins in Kazakhstan (Ural, Irtysh, Tobol, Yesil, Nura), Kyrgyzstan (Sary-Jaz, Issyk-Kul), as well as the Ily River and Chu-Talas basins in the territories of Kazakhstan and Kyrgyzstan. Resource endowment affects development and can drive disparities across the region as it influences supply and demand capabilities. This is particularly important when considering water use in terms of potential agricultural output, and energy production.

Since independence, the Central Asian countries have been searching for acceptable forms of integration – sharing water resources through interstate governance mechanisms, including the Interstate Commission for Water Coordination (ICWC) and the International Fund for Saving the Aral Sea (IFAS). However, there is little enforcement on agreed principles by member states because agreements are not mandated. Further, collective action is hampered due to diverging economic and geostrategic priorities, jurisdictional fragmentation, and a lack of interdepartmental cooperation.

DID YOU KNOW?

Labour migration to Russia and Kazakhstan provides remittances which make up a large part of the region's GDP and highlight the vulnerability of the region's economies to external economic shocks and policies.

Figure 1: **Map of CA, including rivers, and country characteristics. Original image obtained from (Schaitkin, et al., 2014)**

Water resources

Surface water resources

Although the availability of surface water resources in the region have not radically decreased over the last two decades, pressure stemming from various sources is causing issues with water availability. Pressure on surface water resources is being primarily driven by population growth, industrial diversification, water withdrawals and emerging demands external to the region, including from China, Russia and Afghanistan, and slight decreases in river run off.

However, as glacial melt feeds some of the river systems in the Aral Sea Basin (ASB), the presence and effects of this pressure are less obvious today. Despite masking an increased pressure on surface water, scarcity is observed in an average 1.2% lowering of runoff over the last twelve years in the major rivers of the ASB, as compared to 2001, reaching 13.2% in some rivers of the Syr Dara Basin. Though glacial melt cannot continue to bolster regional water resources indefinitely. Figure 2 highlights the dire situation of Central Asia's water resources into the future.

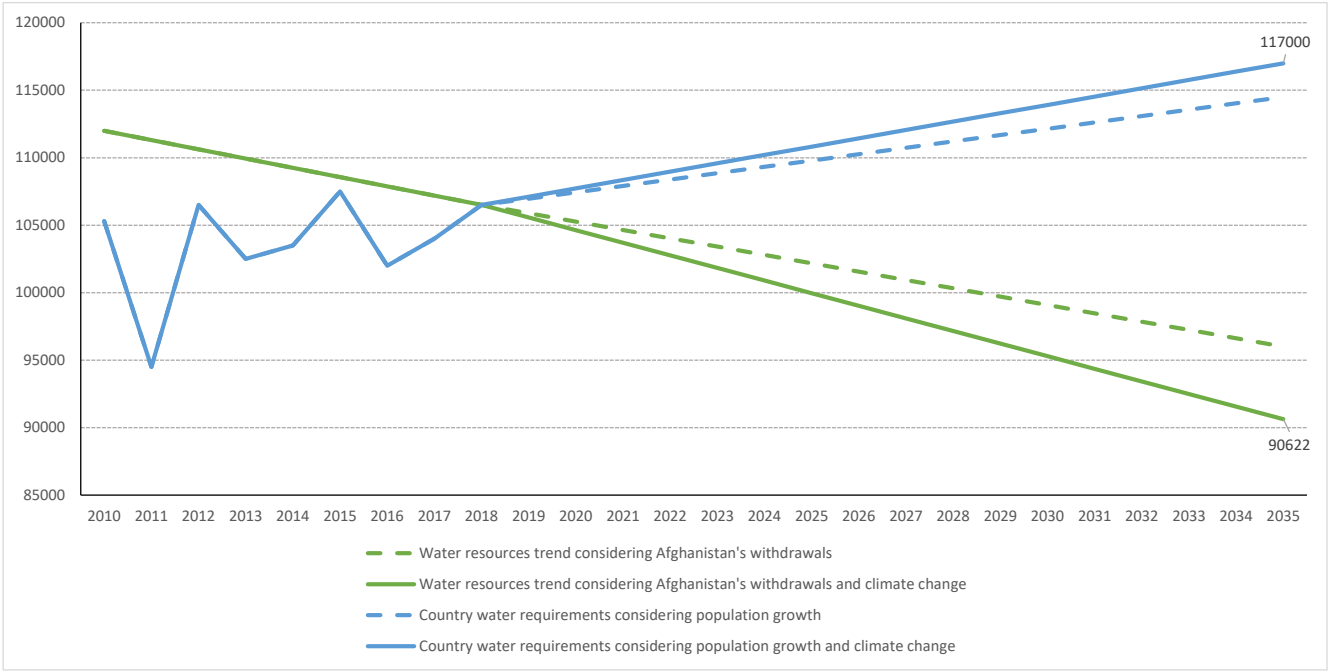
Ground water resources

Groundwater resources in Central Asia are under significant pressure. Industrial and agricultural development have negatively affected groundwater resources in the ASB over the last two decades causing substantial decreases in usable reserves and exhaustion of some aquifers. Unauthorised construction of intake structures and unregulated water abstractions coupled with inadequate groundwater monitoring systems are driving these effects. This is compounded by an overestimation of regional stock because boundaries of aquifers and 'connection' of their sources with these boundaries are only roughly determined. Water deficits faced by groundwater users are compensated through surface water sources increasing the risk of water quality deterioration. Proper accounting of resources and prudent water usage are imperative for reducing the pressure on groundwater systems and ensuring the resource's longevity.

Return water

Return water, although being an additional water source for the region, can be polluting due to high salinity. Currently, roughly 88% of return water is comprised of collector-drainage water produced by irrigated agriculture, with the balance formed by agricultural and industrial wastewater. As compared to the 1990-1999 period, the amount of return water across the 2000-2017 period increased by 11%, with the amount being discharged into rivers increasing by 8%. Of the 35.78 km^3 of the return water generated in the Amu Darya and the Syr Darya basins generated over 2000-2017, roughly 43% was generated in the Syr Darya and 57% in the Amu Darya. Of this, around half was discharged into rivers and another 40% into lakes and natural depressions. The generation and management of these discharges affect water quality and reduce the availability of surface water resources, thus, balancing and prioritising the benefits and drawbacks is important in the general water management scheme.

Figure 2: **Comparison of water demand and water availability in ASB, Mm^3.**



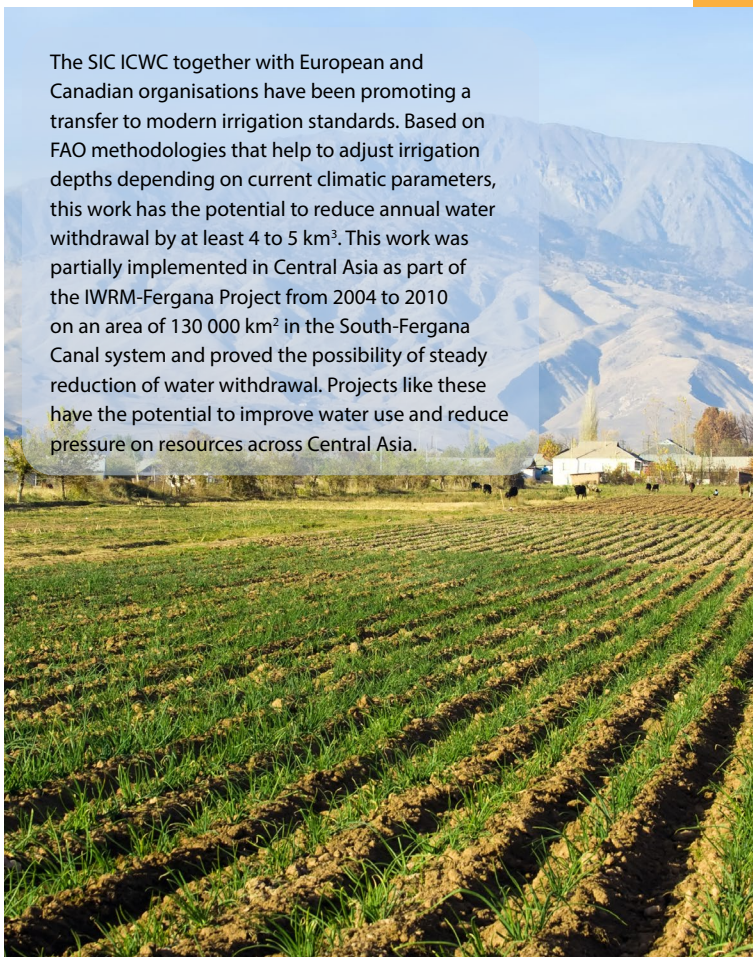
Source: SIC ICWC analysis 2020

Water use and flow regulation

Since the 2000s, total water withdrawal did not vary considerably across Central Asia, decreasing by just 6% between 2002 and 2018. Though, Kazakhstan and Kyrgyzstan increased their withdrawals and some changes were observed in water uses. Regionally, withdrawals for drinking and household needs increased by 6.3% and 25.5% for industrial needs (see Table 1). These trends follow population growth and the development of industrial sectors as the Central Asian economies diversify. Irrigation continues to be the largest water user in the region, signifying the continued importance of agriculture to Central Asia. Methodological differences in water accounting can cause differences in water withdrawal data. Until differences in methodologies are standardised, accurately understanding and comparing water withdrawals across the region will remain difficult.

Open Channel Losses

Open Channel water losses in the Aral Sea Basin are estimated to be roughly 7.9% over the last 20 years. Roughly, 68% of these annual losses occur during the growing season, and 77% are observed in the lower reaches of the Aral Sea Basin. Losses are attributed to factors including a reluctance of downstream countries to maintain water record-keeping, water theft, and an absence of irrigation standards. Joint research and a regional project undertaking water monitoring and accounting has potential to improve data and knowledge in this area, to better understand and address causes of these losses.



The SIC ICWC together with European and Canadian organisations have been promoting a transfer to modern irrigation standards. Based on FAO methodologies that help to adjust irrigation depths depending on current climatic parameters, this work has the potential to reduce annual water withdrawal by at least 4 to 5 km³. This work was partially implemented in Central Asia as part of the IWRM-Fergana Project from 2004 to 2010 on an area of 130 000 km² in the South-Fergana Canal system and proved the possibility of steady reduction of water withdrawal. Projects like these have the potential to improve water use and reduce pressure on resources across Central Asia.

Table 1: **Data on water withdrawal and water consumption in the Aral Sea basin (comparison of 2002 and 2018).**

Country	Total (km³)		Irrigation use (%)		Drinking and household use (%)		Industry use (%)	
	2002	20018	2002	20018	2002	2018	2002	2018
Kazakhstan	13830	18732	74.4	65.7	4.3	4.8	21.2	29.6
Kyrgyzstan	4469	5526	95.4	94.8	2.9	3.7	1.7	1.5
Tajikistan	12691	12301	75.8	83.0	4.9	6.2	3.1	2.8
Turkmenistan	28334	25380	88.2	88.2	2.2	2.2	6.0	6.0
Uzbekistan	60554	50947	78.3	88.5	5.0	5.6	7.8	9.5
Total	**119878**	**112886**	**80.6**	**84.4**	**4.1**	**4.7**	**8.2**	**10.9**

Note: The year 2002 was chosen for comparison because 2000 and 2001 were exceptionally dry years and did not reflect 'normal' values.

Source: SIC ICWC 2020

DID YOU KNOW? Since the Soviet collapse, cropping patterns changed radically in the Aral Sea Basin. The share of food crops increased (grain acreage doubled) as a method to buffer some of the drop in living standards. Industrial crops decreased (from 40% to25 %). Due to breakdown of common agricultural market at the CIS scale, diversification from cotton began.

Competing water needs

Water use and its allocation in Central Asia is dominated by the use of irrigation water and its competing needs with the energy sector. Irrigation is the largest water user and an important driver of agricultural production across the region, contributing to GDP, boosting development of other associated sectors, and impacting human development indicators such as food security. After independence, irrigation water use reduced due to changes in the flow regulation regime, moving from irrigation regimes to either irrigation-energy generation or full energy generation regimes. This pushed irrigated agriculture to adapt to the established regimes of flow regulation by the energy sector. Since 2000, countries maintained their irrigated land areas (except Kazakhstan which saw a reduction and Turkmenistan, an expansion).

Irrigation productivity per hectare doubled, and irrigation water productivity increased by 2.5 times. This productivity has the potential to increase by an estimated 1.5 times in coming years, including through the use of modern irrigation practices. Understanding the importance of agriculture to the region in terms of GDP, associated sector development, employment, and food security, justifies continued efforts in the development of irrigation and agricultural productivity as well as management of balanced water allocation regimes with the energy sector.

All five countries are implementing structural reforms to improve competitiveness, particularly in the industrial sector (Mukhitdinova, 2015). In 2011, Kazakhstan adopted the Law on Science which elevated leading researchers to the highest ranks of decision-making processes and prioritised energy research and innovative technologies in the processing of raw materials (among others) (Mukhitdinova, 2015). In 2012, the Uzbek Committee for the Co-ordination of Science and Technology Development created eight R&D priorities, based on the needs of industry (CCSTD, 2013 and Mukhitdinova, 2015). These included development of renewable energy use and ICTs, and of agriculture, biotechnology, ecology, and environmental protection, among others. In Kyrgyzstan, the economy is oriented primarily towards agricultural production, mineral extraction, textiles, and the service industry. Higher growth is observed in the Central Asian countries that produce crude organic materials and their related processed products. Another important direction of industrial development is the increased in situ processing of agricultural commodities to supply regional requirements.

Balancing hydropower energy production with Central Asia's water needs

Hydropower is a priority water user and the backbone of energy security and economic development in the upstream Central Asian countries. It contributes substantially to electricity production in the region making up one fifth of total production and generated 85% and 98% of electric energy in Kyrgyzstan and Tajikistan respectively, in 2015 (World Bank, 2021). Although hydropower does not withdraw water from streamflow and is a non-consumptive water user, operational regimes and the resulting flow regulation have considerable influence on the integration of interests of all water users and, simultaneously, on water use efficiency.

The total capacity of all hydropower stations (HPS) in the countries of the Aral Sea basin is 10,240 MW, of which 32% refers to the capacity of HPS' in Kyrgyzstan, 48% in Tajikistan, and 18% in Uzbekistan. However, the available hydroenergy potential of rivers in the ASB is considered under-exploited and is the subject of constant discussion between international funding institutions and the countries of the region. The total hydropower potential is estimated at 460 TWh/year, of which only 30% is used. The vast majority of this potential derives from Tajikistan's and Kyrgyzstan's water resources (317 and 99 TWh/year, respectively). Capturing this production potential presents an opportunity, the region's energy consumption is increasing (1.61 times between 2000-2017) and hydropower production contributes to the region's renewable energy sources in lieu of carbon intensive production methods. However, full utilisation of this energy potential puts irrigation, drinking water, and environmental water needs at risk. Increases in the capacity and number of hydropower stations, with associated reservoirs, may lead to higher irrecoverable losses in water body capacities, growing idle discharges from cascades, and could break water distribution schedules, yet presents an area of great opportunity for the region if well managed and planned with appropriate cooperation frameworks in place to support regional integration. The tension between water, energy and food security within Central Asia, often referred to as "the energy, water, food nexus" is well documented in Central Asia and presents opportunity for future work.

River flow regulations

Balancing hydro-electricity generation and irrigation needs has become more challenging since independence because of differing and sometimes competing national priorities and understanding the challenges of each country to fully satisfy their energy and irrigation requirements highlights the need for improved regional coordination. Currently, river flow is regulated by 121 reservoirs of seasonal and partial multiyear regulation. However, this regulation is often not effective due to the rapid transformation of Soviet-era irrigation centred regimes to hydroenergy-centred regimes and a lack of regional cooperation. Opportunities exist to reach a consensus on water prioritisation through methodologies accepted by all Central Asian states. This could be through a cooperative forum akin to the proposed water-energy consortium where the former Soviet regime of regulation could be restored in the context of market relations. Attempts to develop regulation for balancing hydro and irrigation water supply, based on mutual material and financial commitments of the riparian countries, were made in the 1998 Syr Darya Agreement. Unfortunately, this attempt failed due to a lack of agreed principles of regulation, and the substitution of the core agreement by continually changing annual protocols. Opportunities exist for the region to prioritise interstate and intersectoral dialogue for managing water use between sectors and increasing efficiency and production in energy production. Strengthened regional cooperation has the capacity to increase efficiencies in both energy generation and irrigation water use. When developing regional cooperation strategies, countries may consider the strengths and weaknesses observed in previous strategies.

Multi-annual flow regimes can also improve water management, catering to varying temporal and regional needs. In the absence of multi-annual regulation, countries naturally prioritise national requirements, possibly negatively impacting their regional partners and causing regional inefficiencies. However, irrigation water storage has a cost, and these costs must be balanced through exchanges of either electricity and fossil fuels or in cash, as stipulated in the Long-Term Framework Agreement of 1998 (World Bank, 2004).

Multi-year regulation must be backed by explicit payments for annual and multi-year water storage and regulation services must include arrangements within a multi-year perspective that accommodate normal, dry, and wet years, and must allow variations in the compensation for water services between fixed and variable charges to permit equitable sharing and mitigation of risks arising from rainfall variations (World Bank, 2004). Currently, the price of flow regulation is not set. An attempt was made to establish an interstate water-energy consortium as a financial mechanism to harmonise irrigation and hydropower interests. However, the attempt failed due to opposing opinions regarding flow regulation prices. Despite this, initiatives are being made to revive these efforts.

During the Soviet period, flow regimes catered primarily to irrigation needs (Rakhmatullaev, et al., 2017). Water stored during winter periods was released in summer, catering to agricultural productivity while hydropower, generated during summer, was distributed across the region. In winter, upstream countries used electricity generated from downstream countries and the united power system. The integrated system catered to varying regional needs by balancing differences in energy generation capacities and requirements with irrigation water needs. After independence, the newly autonomous states changed their flow regimes to cater to national priorities. Irrigation centred flow regimes were shifted to energy generation regimes, resulting in inefficiencies in agricultural production and unmet energy needs. Numerous attempts have been made to re-establish Soviet period water allocation regimes, though national priorities and mistrust throughout the region impeded efforts (Rakhmatullaev, et al., 2017).

Environmental matters and water use

Environmental Water

Flow regulation and release schedules must account for environmental flow requirements in order to maintain the health and sustainability of the region's river systems. As discussed previously, water regulation and flow releases impact hydropower and irrigation management, though also natural conditions and environmental water requirements. Environmental water demands were initially determined in 1998 in the "*Fundamental provisions of the regional water strategy*" and reduced (in some cases by almost half) in decisions recommended by the ICWC. Despite these reductions, on average over the last decade, actual environmental water releases were greater than the stipulated minimums set by the ICWC and closer to the initially set limits from 1998. However, the instability of annual water supply across the year resulted in worsening conditions of river deltas. Such as those observed in the southern parts of the Aral Sea basin which observed regional economic losses due to factors including water loss and increasing salinity. However, Kazakhstan, with support from the World Bank constructed a dam in the Syr Darya River which created a small sustainable water body in the Northern area of the Aral Sea (though it was undertaken at the expense of some southern water bodies (Russell, 2018)). These types of infrastructure projects, coupled with regulating capacities have positive economic spill overs for the region allowing increased fishing quotas, livestock farming, and industrial processing.

Climate change and Central Asia

Central Asia is already experiencing the effects of climate change. Available data suggests a seasonally warming climate, increased air temperatures, changes in precipitation, and increases in extreme weather events. These changes are leading to knock on effects including melting glaciers and permafrost, changing water availability, increased competition for water resources, and changes in energy demand and production capacity (USAID, 2018). Particular areas such as western Turkmenistan and Uzbekistan, may observe an increase in the frequency of droughts which could negatively affect agricultural production, increase irrigation water needs, and exacerbate desertification (Hijioka, et al., 2014). Despite this, some areas of Central Asia may see positive effects. For example, cereal production in the northern and eastern regions of Kazakhstan may benefit from longer growing seasons, warmer winters, and possible increases in winter precipitation (Hijioka, et al., 2014).

Broadly speaking, there is a lack of information on the full impacts of climate change in the region, particularly regarding precipitation (Hijioka, et al., 2014; USAID, 2018; IPCC, 2019). Despite this, there is an increasing awareness of the regional impacts of climate change, particularly in agriculture, energy, disaster risks, and the water sector (USAID, 2018). Broadly, it is understood that Central Asia will be severely affected by climate change, even if temperature increases are limited to 2°C. Effects will be severe because impacts will potentially occur simultaneously and compound both each other and wider development challenges (Reyer, et al., 2015). It is essential that the region's water policy development must mainstream climate change considerations.

Glacier melt masking water scarcity in Central Asia

Currently, glacial melt contributes roughly 20 km^3 of water to the Vakhsh and the Panj rivers (the main rivers of the small Amu Darya basin), and 7 km^3 to the three rivers in the Syr Darya basin, the Naryn, Karadarya, and Chirchik (see Figure 3) (SIC ICWC, n.d.). This melting currently makes an essential contribution to water resources and is likely masking water scarcity within the region. Climate change is likely to drive higher melting rates, initially maintaining water resources, though eventually, when glacial resources have dwindled, resulting in a reduced river flow (USAID, 2018). However, in a scenario where half of the current glacial feeding is lost, permafrost and perennial snow as well as predicted increases in rainfall may prevent total surface water resources in the Aral Sea basin from dropping by 11–12% (SIC ICWC, n.d.). Further, changes in snowfall, which contribute to a larger share of mean annual runoff than glaciers will be heavily impacted by climate change, likely shifting from snowfall to rainfall (Ososkova, et al., 2000 and Reyer, et al., 2015).

Salination

More than half the land in Central Asia is salinized to some extent. Between 1990 and 2015 the area of salinized land in the Aral Sea Basin increased. In the context of irrigation (a main driver of salinization), collector-drainage networks must be developed to maintain good soil conditions. These drainage networks improve soil health by facilitating the removal of excessive saline water from insufficiently naturally drained land, ensuring leaching of salinized land, allowing the maintenance of optimal watering regimes, and providing a source of return water as a resource.

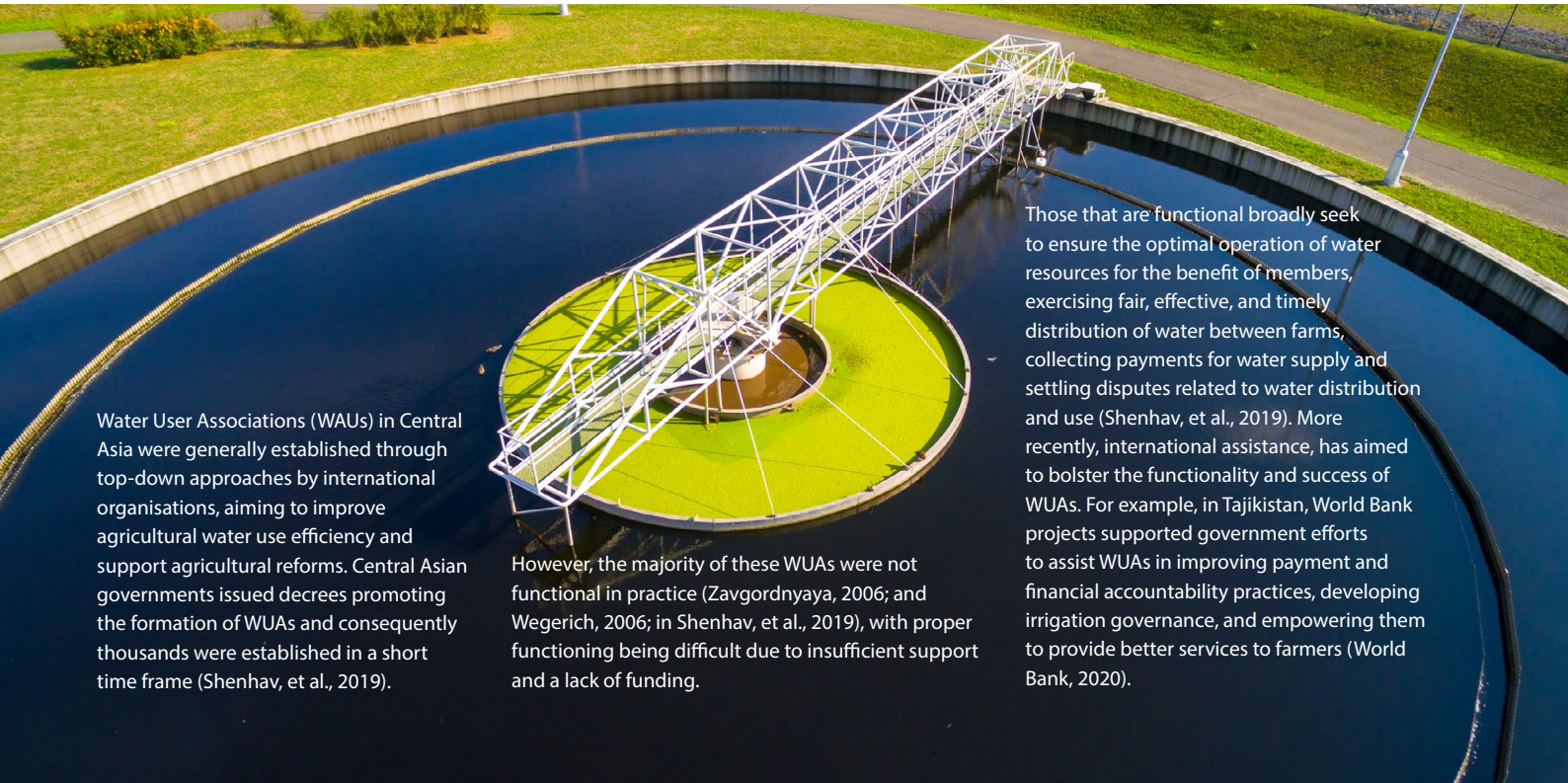
Water management at the national level

Water management in Central Asia is comprised of a complex system of regulating and intake structures at interstate and national levels. There are common characteristics, though also differences in water management hierarchies across states (see Table 2). It is broadly considered that since gaining independence, water sectors in all Central Asian countries have lost their influence with a trend for National water management agencies to have different statuses and undergo regular organisational changes impeding progress. This flux negatively affects the quality of state water regulation, the financial and technical basis of the former single sector, and the capability to invest in technology, innovation, and human resources. At present, some countries have started to restore the status of national water agencies by redesignating ministries dedicated to water management as seen in Uzbekistan with its Ministry of Water Resources re-established in 2018 following the split of the previous Ministry of Agriculture and Water Resources.

While basin level water management is considered good international practice, it has only been implemented in Kyrgyzstan and Uzbekistan (see Table 2), and even in these instances, principles are not always followed. Territorial water-management organisations at the provincial level were transformed into to basin organisations. However, despite re-organisation, several basin organisations still structure their authorities within former provincial boundaries. Difficulties exist in establishing basin councils and in the functioning of already formed councils. In most cases, basin councils' functions and composition operate mainly as technical management bodies, rather than joint governance bodies involving all concerned stakeholders. Considerable work is ongoing in this domain including in Tajikistan.

Water-management organisations at the irrigation level were traditionally established based on both hydrographic principles (Irrigation System Administrations) and administrative-territorial principles (District Water Management Authorities). This level of management is considered optimum, being characterised by a certain degree of stability and adherence to a more traditional management style by national water bodies. These bodies do not interact with stakeholders directly due to the establishment Water User Associations (WUAs).

Organisations of water users remain the weakest link in the water hierarchy of Central Asian countries, demonstrating low productivity in general. Virtually all WUA's bodies (general assemblies, councils, arbitration commissions, inspection committees) are considered not to function as originally designed. Due to poor material bases, an inefficient loan system, and unclear legal statuses, WUAs do not get state support, despite partial fulfilment of public functions on water delivery to end users. This has led to huge debts from the side of water users meaning the organisations cannot function sustainably. Here a vicious circle is observed. The poor financial viability of WUAs is the consequence of low fee collection for irrigation services provided by WUAs, while the low levels of fee collection are the result of poor quality of the irrigation services, which is caused by the weak financial viabilities of WUAs. Under discussion are interventions such as effective state support, re-establishment of cluster-based systems, or mechanisms of public-private financing partnership (SIC ICWC, 2020). Currently, countries are investigating ways to improve water user organisations through their integration or consolidation



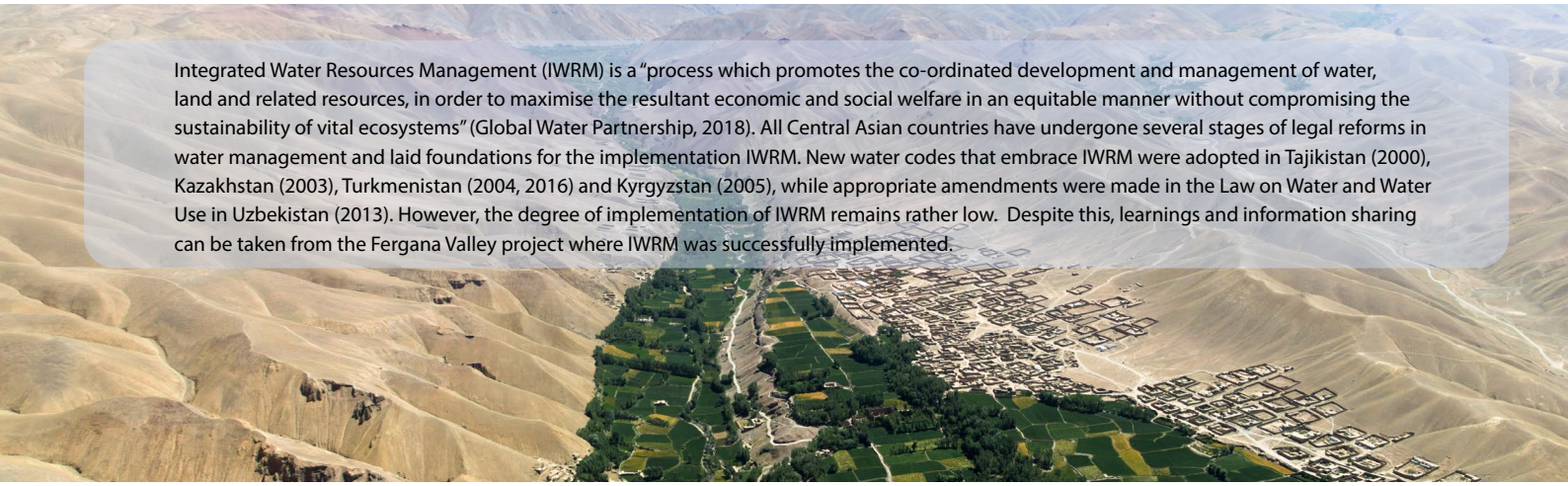
Water User Associations (WAUs) in Central Asia were generally established through top-down approaches by international organisations, aiming to improve agricultural water use efficiency and support agricultural reforms. Central Asian governments issued decrees promoting the formation of WUAs and consequently thousands were established in a short time frame (Shenhav, et al., 2019).

However, the majority of these WUAs were not functional in practice (Zavgordnyaya, 2006; and Wegerich, 2006; in Shenhav, et al., 2019), with proper functioning being difficult due to insufficient support and a lack of funding.

Those that are functional broadly seek to ensure the optimal operation of water resources for the benefit of members, exercising fair, effective, and timely distribution of water between farms, collecting payments for water supply and settling disputes related to water distribution and use (Shenhav, et al., 2019). More recently, international assistance, has aimed to bolster the functionality and success of WUAs. For example, in Tajikistan, World Bank projects supported government efforts to assist WUAs in improving payment and financial accountability practices, developing irrigation governance, and empowering them to provide better services to farmers (World Bank, 2020).

Integrated Water Resources Management

All Central Asian countries undertook legal reforms in water management to implement integrated water resources management (IWRM). Despite this, full implementation of all IWRM components remains low. However, projects, such as the "*Integrated Water Resources Management in the Fergana Valley*" (IWRM-Fergana), demonstrate IWRM successes and highlight potential for the future efficiency gains. The project was successfully implemented in four provinces in Kyrgyzstan, Tajikistan, and Uzbekistan by national water agencies, SIC ICWC and IWMI, with the support of SDC. It led to all components of IWRM, including hydrographic principles, public participation, updating of water requirements, inter-sectoral and inter-level coordination, improvement of water accounting, water conservation, and consideration of environmental demand being developed in the project. This resulted in, on average, decreases of 20-25% in water withdrawals for irrigation between 2004 to 2010 while increasing land productivity and water productivity (by twofold) due to extension services. The project solidifies the importance and benefits of implementing IWRM across Central Asia.



Integrated Water Resources Management (IWRM) is a "process which promotes the co-ordinated development and management of water, land and related resources, in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" (Global Water Partnership, 2018). All Central Asian countries have undergone several stages of legal reforms in water management and laid foundations for the implementation IWRM. New water codes that embrace IWRM were adopted in Tajikistan (2000), Kazakhstan (2003), Turkmenistan (2004, 2016) and Kyrgyzstan (2005), while appropriate amendments were made in the Law on Water and Water Use in Uzbekistan (2013). However, the degree of implementation of IWRM remains rather low. Despite this, learnings and information sharing can be taken from the Fergana Valley project where IWRM was successfully implemented.

Table 2: **Water Governance in Central Asia: Management levels and associated responsible agencies and organisations in each country (SIC-ICWC, 2020).**

Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan
Intersectoral level				
Government Inter agency Council on Water Resources	National Water Council	Water-Energy Council at the Ministry of Energy and Water Resources	Water Council at the State Committee for Water Management	Water Council at the Ministry of Water Management
Sectoral level				
Committee for Water Resources of the Ministry of Ecology, Geology and Natural Resources	State Agency for Water Resources at the Government	Ministry of Energy and Water Resources Agency for Land Reclamation and Irrigation at the Government	State Committee for Water Management	Ministry of Water Management
Inter-basin level				
			Garagumderya-suvkhodjalyk Administration	Administration of Operation of Large Main Systems
Basin (provincial level)				
Basin Inspectorates Provincial Departments (branches) of RSE "Kazvodkhoz" Basin Councils	Basin Water Authorities Basin Councils	State Provincial Authorities for Land Reclamation and Irrigation	Provincial (veloyat) Water Authorities	Basin Irrigation System Authorities Basin Councils
Irrigation system level				
District Production Units	District Water Management Authorities	State Authorities of Main Canals District Water Management Authorities	Canal Operation Authorities Districts (etrap) Water Management Authorities	Irrigation System Authorities District Irrigation Departments
Lowest (local) level				
Agricultural Production Cooperatives	Water Use Association and their Unions	Water User Associations	Peasant (daihan) Farm Unions	Water Consumer Associations

Source: SIC-ICWC, 2020

Water management at the interstate level

The importance of regional water management is highlighted by the potential economic benefits of cooperation which could, in terms of quantifiable factors, contribute to roughly 5% of regional GDP (Diebold, 2014). However, currently, water management at the regional level is hampered by misaligned national priorities and interests including tension between upstream and downstream countries due to differences in preferences regarding water release schedules, a weak legal framework, and a lack of clear enforcement mechanisms within interstate agreements such as the Agreement on Cooperation in the Joint Management, Use and Protection of Water Resources of Interstate Sources (1992) [1]. Strengthening regional cooperation is important for managing water resources, attracting foreign investment, and increasing knowledge and technology transfers. Siloed nations cannot succeed when faced with regional challenges such as transportation and customs issues, climate change, migration, geopolitical insecurities, and increased water scarcity. Although progress has been made and strengthened regional water management to an extent for example, by the ICWC's development of a system of annual and seasonal water distribution planning and control every ten days, there are still key bottlenecks in its functioning which prevent efficient coordination. Key bottlenecks in ICWC functioning include lax flow forecasts and accuracy, and water monitoring and accounting, and the lack of involvement of public stakeholders. Bi-lateral agreements stipulating water management between countries exist and function as good starting points for further developing regional and multi-lateral agreements by providing experience and models of success.

Legal framework

As agreed by the five Central Asian countries, water management in the Aral Sea Basin follows the "*Agreement on Cooperation in the Field of Joint management of the Use and Conservation of Water Resources in Interstate Sources*", and replicates management during Soviet times. Repeated attempts have been made to improve the existing legal framework. However, disagreements between countries have hampered progress. The major shortcomings of the current legal framework are the lack of compliance with agreed water allocation principles due to absence of regulatory and enforcement mechanisms, the breaches of reservoir operation regimes due to an absence of an agreed optimal and mutually beneficial balance between irrigation and hydropower needs, inconsistent provision of environmental water needs due to a lack of relevant agreements, and non-fulfillment by the countries of provisions stipulated by international treaties, for example the UN's 1997 Water Convention [2], concerning environmental monitoring and information systems, among others. Pressure on water resources, coming from internal stressors, such as population growth and changes in sectoral water use, as well as external stressors, like increased withdrawals from China mean interstate management must be developed. Countries must continue dialogue around interstate management until binding agreements are reached that recognise the need of citizens, the environment and the economy and consider long-term climate change impacts.

The Interstate Commission for Water Coordination of Central Asia (ICWC) was established in 1992 to maintain the integrity of water management after the collapse of the Soviet Union. It aims to establish "*principles of collective decision making on common water-related issues and on measures for implementation of joint programs*", while respecting the interests of the CA countries (ICWC, n.d.).

Among various achievements, the ICWC has contributed to maintaining stability and peaceful water relations throughout the region and developed and implemented integrated water resources management in the Fergana Valley. Opportunities to strengthen the work of the commission include improving annual flow forecasts and developing long-term forecasts, promote improved adherence with water distribution plans and release schedules, and work with the countries to increase harmonisation between energy water releases and irrigation needs. Improving these elements has potential to strengthen water management across the region. In addition, in 2018 a Memorandum of Cooperation was signed between ICWC and Interstate Commission for Sustainable Development (ICSD), spurring the foundations for better collaboration and joint multidisciplinary research in the sphere of water and environment.

[1] For example, within the Agreement, the legal framework obligates the coordination of national environmental impact assessments (EIA) procedures. However, activating these obligations is ineffective due to the various thresholds that exist as thresholds for triggers (Janusz-Pawletta & Gubaidullina, 2015).

[2] International treaties stipulating transboundary watercourses management generally stipulate principles of equitable and reasonable utilisation of waters, principles of "no significant harm," and principles of cooperation (such as the UNs 1997 Water Convention). However, CA lacks cooperation mechanisms in their transboundary practices and the "*typical legal instruments of cooperation have* [not] b*een fully implemented into the legal framework on transboundary watercourses in the Aral Sea basin*" (Janusz-Pawletta & Gubaidullina, 2015).

Key pillars towards strengthening water management systems in Central Asia

Forecasting and adherence to allocation agreements

The effectiveness of water-management systems in Central Asia depends on factors including the appropriate estimation of water demands, accurate forecasting of water availability, realistic scheduling of water delivery of water hierarchy levels, and coordination of intersectoral requirements, among others. Currently there is significant room to improve these factors which would result in more efficient and sustainable use.

Water resource forecasting including estimation of supply, demand, and losses, are often breached at the river reaches resulting in incorrect water balances across the entire water hierarchy. This is due to the low accuracy of seasonal flow forecasts, particularly long-term forecasts, and underestimating open channel losses (at times by twofold or more) resulting in the incorrect estimation of usable water resources at each river section. Further, problems arise in scheduling water releases and distribution, and obtaining and adhering to approvals for these schedules with all agencies. Water management should aim to have binding multi-year regulation that accounts for all sectors and water users that is agreed upon by all agencies.

Pricing of water: Irrigation service fees and household water use tariffs

Water management reforms in Central Asian countries generally aim to promote market principles to reduce water demand. Though currently water is undervalued, and the true cost of water is not reflected in financing mechanisms. This leads to misuse of the resource and underinvestment in infrastructure and operation and maintenance. The proper valuation of water and the application of tariffs that reflect this value present opportunities for strengthening water management throughout the region.

Regarding irrigation service fees, water users in Kazakhstan, Kyrgyzstan and Tajikistan pay for irrigation services provided by both water management organisations (WMO) and water user organisations (WUO). In Uzbekistan and Turkmenistan, water users pay for services provided by water user organisations only, while the irrigation services provided by state water-management organisations are still free (see Table 4). Across the region, relative payments (actual/planned) and unit payments ($/ha) for irrigation services provided are insufficient and compound the poor financial health of water user organisations. Limited funding prevents organisations from employing the necessary staff to ensure the required quality of irrigation services and does not cover operation and maintenance costs.

Therefore, it is difficult to fund the necessary improvements in staffing and infrastructure upgrades that are required for improving water management services and promoting water use efficiency. Concurrently, raising tariffs is challenging as it depends on the capacity and willingness of users to pay for irrigation services. Examples of opportunities for improvements of water tariffs can be seen in Tajikistan, where uniform irrigation service fees (ISF) could be differentiated depending on the irrigation scheme, and tariffs to cover not only purchased water, though also for covering WUA costs – including delivery costs and O&M of on-farm systems could be introduced (OECD, 2020). Recently in Uzbekistan, tariffs have been raised to create incentives for more efficient use of water resources, although they are not yet at cost recovery levels (UNECE, 2020).

In the domestic and drinking water supply sector inconsistent tariff application limits the financial strength and performance of utilities and prevents investments that support water supply solutions and propagates high water losses. (see Table 3). The highest tariffs within the region are seen in Tajikistan where some communities pay up to US 0.80 per m^3, while in Turkmenistan, water for drinking and household needs is free (when consumption is less than 250L per day). Regional and within country disparities can lead to inconsistencies in water supply and service quality. Further, set tariffs may not fully cover supply costs, meaning states must fund the difference.

Undertaking studies on the real costs of supplying drinking water and sanitation services to communities and different sectors of the economy, plus understanding the capacity of communities to pay for water and raising awareness on the benefits of paying for water could provide a basis for tariff reform, investing revenues into operation and maintenance, and providing more consistent, reliable, and safe access to water.

DID YOU KNOW? The poor financial viability of Water User Associations in Central Asia is driven by a vicious circle. WUAs They have limited financial capacities due to low levels of fee collection for provided irrigation services. Concurrently, the low level of fee collection is the result of the poor quality of irrigation services, which is in turn caused by the weak financial viability of WUAs. Options such as public-private partnerships to support WUAs could be explored as mechanisms to break this vicious circle.

Water quality monitoring

Water quality monitoring in most transboundary rivers in Central Asia is performed by one riparian country only, with some exceptions seen on the Amu Darya and the Syr Darya. There are typically few water quality monitoring points, sampling frequency is low, and the spectrum of quality parameters monitored is limited. This poses problems for water management and inhibits management that corresponds to the current river conditions. Further, monitoring of groundwater and water quality parameters are inconsistent and insufficient. In Kazakhstan, all basic transboundary watercourses are monitored with all posts sampling between 12 to 36 samples. In Kyrgyzstan water quality monitoring is carried out in the basin of the Chu River only.

In Tajikistan, all main interstate watercourses are covered by water quality monitoring systems; however, the frequency of monitoring and number of observations on most interstate rivers has reduced over the last years. In Turkmenistan, three monitoring posts provide information on water quality along the Amu Darya River. In Uzbekistan the monitoring of water quality is carried out on the main courses of the Amu Darya and the Syr Darya, as well as along Surkhandarya and Karadarya rivers. Monitoring efforts must be strengthened to increase the reliability of water accounting and the general awareness of the state of water resource conditions. Efforts, such as those initiated in the ICWC's WUEMoCA provide opportunities to build on established strengths and know-how to expand monitoring efforts.

DID YOU KNOW? Kazakhstan carries out regular transboundary monitoring and sampling with China and Russia. Data on 28 water quality parameters of the Ily, Kara-Irtysh, Tekes, Korgas and Yemel rivers are exchanged during annual meetings of the Kazakh-China Commission. Further, joint sampling and exchange of hydrochemical information is maintained with Russia on 16 transboundary rivers. Water in the rivers shared with Kyrgyzstan is monitored monthly and every ten days on 48 quality parameters at 8 river sections. Kazakhstan itself performs monthly and ten-day monitoring of water quality on 49 parameters in one section of the Syr Darya River.

Table 3: **Water tariff characteristics of the Central Asian countries**

Country	Service Provider	Irrigation service tariffs (USD)	Drinking and household water supply tariffs ($/m³)	Fee collection rate (%)
Kazakhstan	WMO	4.15cents/m3 (pumped irrigation)	0.10 – 0.58	85
		0.074 cents/m3 (gravity irrigation)		
	APC	4.1-6.43 dollars/ha		
Kyrgyzstan	WMO	0.043 cents/m3	0.07-0.11	65
	WUA Union			
	WUA Union	6-11 dollars/ha		
Tajikistan	WMO	0.21 cents/m3	0.4-0.8	75
	WUA	4-12 dollars/ha		
Turkmenistan	PFU	3% of the farm's yield	0.5 (after free consumption)	70
Uzbekistan	WCA	2.6 -5.2 dollars /ha	0.11 - 0.25	85

Source: SIC-ICWC, 2020

Water use monitoring in Central Asia (WUEMoCA)

ICWC recently developed a tool for monitoring water use efficiency in Central Asia (WUEMoCA). WUEMoCA tracks dynamics of crop acreage and irrigated areas and allows temporal comparative analysis. Further, the tool estimates the degree of available water supply and water use efficiency by comparing remote sensing data and ground-based data. Data can indicate where unused irrigated land lies and where unsustainable and insufficient water provisions reduce water use efficiency. New functionalities of WUEMoCA are being developed as part spectral data for remote online assessment of crop conditions.

Looking to the future: Policy recommendations

Diverse national and regional priorities, economic growth, demography, environmental requirements, and future sustainable development under a changing climate highlight water as a principal regional concern. Over the last 20 years, only modest progress on water challenges has been made. Issues, including regional cooperation, unbalanced and unadhered to flow regulation regimes, weak legal and institutional frameworks, environmental issues, a lack of monitoring and evaluation, and insufficient research and development still dominate water management discussions in Central Asia today.

In addition, the region is facing a growing population, increased water withdrawals from outside the region, and pressures stemming from climate change which will further contribute to future water scarcity. In this context, regional cooperation, a proper understanding of future climate and water resource scenarios, and strong, coordinated water management are crucial.

It is considered that the foundations for good water management exist. Achievements across the region include increased irrigation productivity and irrigation development, success in implementation of Aral Sea basin programmes, the establishment of regional databases including the water use efficiency monitoring system (WUEMoCA), efforts to reduce environmental problems and salinity in the Aral Sea, increased hydropower generation, and examples of regional and extra-regional cooperation around water management and monitoring.

There foundations are supported by practical case studies of good practice which can provide key learnings and inspiration for replication throughout the region. The Fergana Valley project, which successfully implemented IWRM in four provinces in three countries demonstrates the region's capacity to cooperate, achieve water savings, increase the efficiency and sustainability of water management, and utilise international aid to yield positive results in water management.

Opportunities exist throughout the region to strengthen water management and prepare for future challenges. Priority areas for policy reform to strengthen regional water management and for establishing robust national water management into the future include:

- Improving the coherency of water management systems at all levels (user, sub-basin, basin, sector, national, and regional). Particularly improving the accuracy of annual flow forecasts and absence of long-term forecasts, addressing deviations from agreed water distribution plans, poor water accounting, idle discharges, and the lack of harmonisation between water releases for energy and irrigation needs.
- Strengthening the accuracy of water accounting and flow forecasting to overcome issues with flow distribution plans, in particular, reducing deviations from established plans.
- strengthening regional cooperation and institutional and legal frameworks by detailing and aligning, where possible, national priorities, understanding the potential benefits that are being foregone due to hampered regional cooperation, finding mutual strengths and focussing on strategic development priorities in the region, and understanding and emulating learnings from past successful regional projects.
- employing water conservation techniques as one of the pillars supporting sustainable water management. Particularly in the agricultural sector which is the largest water user.
- increasing monitoring and evaluation efforts and collaboration around water use and supply, water quality, and water projects' impacts and outcomes. Monitoring and evaluation should underpin water information systems in Central Asia.
- revising river flow regulation and implementing multiyear regulation as river flow regulation underpins major water management issues within the region. Simultaneously catering to irrigation norms and schedules and energy generation schedules is crucial for balancing both hydropower generation, which supports energy security throughout the region, and agricultural production which supports food security, employment and rural livelihoods.
- implementing measures for climate change adaptation which are necessary to increase the adaptability of flow regimes when deviating from normal conditions, cater to changing available water resources, align management to temperature and precipitation shifts, and build resilience against natural disasters.
- introducing economic measures for water saving and to leverage more effectiveness in water management, water use efficiency, and encourage sustainability. Properly valuing water and reflecting this value in tariffs is a crucial element of sustainable water management in the future and will support investment in the sector.
- increasing the efficacy of international aid and donor programmes to align programmes, reduce duplication of efforts and siloed projects, employ local knowledge to tailor projects to national needs, develop a database of previous projects' successes and shortcomings, and increase regional cooperation around project implementation.
- investing in human resources development to provide the basis for the introduction and implementation of innovative solutions for effective and rational water management.
- raising public awareness around the value and importance of water to revive an understanding of water's importance and value to will aid efforts to achieve water sustainability and development under conditions of water scarcity and climate change and may nurture a new generation that is more aware of scarcity problems and the value of water.

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The balance between the use of water for irrigation and water for energy is central to the water management discussion in Central Asia. Competition between the two sectors makes it difficult to balance while adhering to flow regimes that cater to both needs and incomplete water resource monitoring and evaluation throughout the region, preventing efficient management. The unequal division of water resources between upstream and downstream countries, and the divergence of national priorities, complicates regional cooperation. Improved governance frameworks are needed to mutually compensate water resources during dry and wet periods and to undertake national and regional water monitoring in order to better understand water resource availability and use. They would also offer benefits to improve water management and leverage economic gains, delivering the social and environmental benefits of reliable water resources management to improve the livelihoods of Central Asian citizens.

This Policy Perspectives discusses recent progress and status of the use of water resources in Central Asia, making recommendations to support the long-term sustainable management of the region's precious water resources.

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