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*Editorial*

# The Future of Water Management in Central Asia

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**Abstract:** Central Asia is an increasingly important strategic geopolitical region. During the latest decades, the region has often been identified as close to potential conflict regarding water usage. This includes the sharing of water from the Syr Darya and the Amu Darya in the Aral Sea Basin. The Aral Sea disaster has exposed a complex picture of water needs and potential political conflict. Rapid population increase together with climate change impacts are likely to further aggravate the short- and long-term future precarious situation for water management in the region. This Special Issue focuses on present and future water management issues in Central Asia in view of future climate changes and how these will affect socioeconomic development. Central Asia is, in general, water rich; however, exercising efficient and fair water management will be important in view of future population increase and climate change. At the same time, water and natural resource development is a cornerstone in all the Central Asian republics. Especially, water resources are, to a great extent, shared between all five republics. A common ground for water-sharing is, therefore, of utmost importance.

**Keywords:** Central Asia; water management; water conflict; hydropolitics; climate change; socioeconomic development

## 1. Introduction

Central Asia has been pinpointed as one of the regions with the highest probability for conflicts over water [1]. Central Asian countries are developing under increasing water deficiency resulting in developmental problems. The main reason for this is worsening ecological and socioeconomic conditions together with increasing political tensions [2]. Climate change will increase the water scarcity in the future. Since the 1970s, observed temperature appears to have risen twice as fast in Central Asia compared to global levels [3]. The IPCC (Intergovernmental Panel of Climate Change) projections show an increase in future temperature by 2–4 °C for 2050 and 3–5 °C for 2080 for the major part of the region [4–6].

The Central Asian states became independent in 1991. This meant a breakdown of the economic system, and consequent socioeconomic upheaval [7]. The transition from state planned to market economy meant changing arrangements of basic amenities, such as water supply and sanitation [8]. At the same time, the population of Central Asia is expected to increase from today's 66 to about 86 million by 2040 [9,10]. This will likely, in combination with rural migration to urban areas, result in a massive stress on water supply and sanitation infrastructure. Water supply in Central Asia is a complex issue due to the fact that the region's major rivers, the Syr Darya, Amu Darya, and Irtysh are transboundary. This has been the region's major water resources conflict problem since the downfall of the Soviet Union [11]. It has been estimated that about 70% of developmental problems in the region are caused by freshwater shortage [7]. A typical example of this is the drying out of the Aral Sea,

the fourth largest lake in the world [12]. The reason for the ecological disaster was the doubling of irrigated agricultural area from 4.3 to 8.2 million ha. The changed ecology damaged several hundred thousand square kilometers with a population of several million [13,14].

Due to the strategic geopolitical position, hydropolitics and water management in Central Asia have gained increasing interest during recent years. As mentioned above, the sudden break-up of the Soviet Union and occurrence of the five new sovereign Central Asian states sharing the two major rivers of Syr Darya and Amu Darya exposed a complex picture of water needs and potential political conflict [15–17]. Water resources protection is, thus, a special challenge for all the Central Asian states in view of the fate of the Aral Sea and necessary agricultural expansion due to population increase and a warmer climate. Therefore, the aim of this Special Issue is to disseminate and share findings especially on contemporary knowledge together with water management tools to forecast what the future of water usage might look like in the region, in response to future climate changes, and how this will affect socioeconomic development. Original research papers were selected by a rigorous peer-review process with the aim of rapid, accessible, and wide dissemination of results.

## 2. Contributions

The selected papers presented in the Special Issue are highlighted in this section. They display a wide variety of water management issues including seven original research papers and one review paper. Geographically, they span the area from the Tarim and Ili Rivers in the East to Amu Darya in the South and as well Central Asia as a whole. Two papers deal with tree shelterbelts related to improved water management and sustainability, one paper with fishery related to the nexus of water, energy, and food, one paper with institutional irrigation management in southern Uzbekistan, and the remaining four with general water management and effects of future climate change for Central Asia as a whole.

### *2.1. Tree Shelterbelts to Improve Water Management and Sustainability*

Two articles [18,19] look at the use of tree shelterbelts vs. natural riparian forests in urban areas and tree shelterbelts to improve water management. Missall et al. [18] perform a sustainability assessment of the Kökyar Protection Forest in NW China (Tarim River Basin). This area is prone to dust and sand storms with detrimental effects on human health. The Kökyar Protection Forest was established already in the 1980s with the objective to protect the Aksu City. It is described as a reforestation project to combat desertification with sustainability improvements. This is a part of large-scale reforestation projects performed in many areas in China since the 1950s. The paper finds that the project is economically sustainable with mixed results for social aspects. Environmentally, the project appears to be unsustainable due to the fact that it has a high irrigation demand. It causes downstream desertification due to high upstream water consumption. The second paper, on three shelterbelts by Thevs et al. [19], investigates the reduction in crop water consumption by the use of wind breaks in the form of tree shelterbelts. They show that a number of agricultural crops decrease their water consumption by 10–12% using wind protective tree shelterbelts compared to open field conditions. However, if consumed water for the irrigated shelterbelt is included as a total system, the saving of water appears negligible. The authors suggest further research on the topic.

### *2.2. Fishery Related to the Nexus of Water, Energy, and Food*

Graham et al. [20] investigate fish capture in the five Central Asian republics. Due to water diversion for energy and agricultural crop production, fish production has dwindled since the Soviet Union's collapse. However, during recent decades, production levels have somewhat recovered in some of the countries. Progress appears most evident in water-deficient Uzbekistan while fish capture in Kazakhstan is still dwindling. The solution to the problem has to be solved regionally by managing the nexus water, energy, and food. The authors are cautiously optimistic about the future regarding the region´s fishery and aquaculture industry.

### *2.3. Institutional Irrigation Management*

Djumaboev et al. [21] present results from a case study on institutional change in irrigation management in Southern Uzbekistan. Even though there is no general water scarcity in Central Asia, Uzbekistan represents the smallest per capita amount of renewable water that can be regarded as economic water scarcity [22]. Irrigation is the major water consumer in Uzbekistan. The introduction of water consumer associations (WCAs) is generally assumed to increase agricultural production to meet the food demand. A problem is that WCAs are not completely capable of organizing collective action or sufficient funding for their obligations. The authors show that outdated irrigation infrastructure, poor governance, and farmer´s non-payment of irrigation service fees obstruct sustainable irrigation water management. They identify greater trust and better communication within the WCAs as a possibility to improve these short-comings.

### *2.4. General Water Management in Central Asia*

In four articles [22–24], water management aspects for Central Asia as a whole are scrutinized. Chatalova et al. [23] investigate development challenges involving water use in agriculture in Central Asia. The authors find that funding from foreign donors and development agencies to support innovative solutions, e.g., in irrigation, is only partially successful. Innovative and apparently useful new technologies, proposed by foreign donors, are rarely or only partially fruitful. A main reason for this appears to be dysfunctional institutions managing the introduced techniques. A common bottleneck in both Soviet and Transitional models of agricultural innovation is related to the encapsulation of new technologies. During the Soviet period, among other things, rural patriarchic values formed a barrier to new technologies by sustaining manual cotton-picking. In the transition period, similar problems seem to be related to the beliefs in water's sacredness hindering water-saving by local farmers. The authors conclude that a better understanding of these limiting factors for new technology calls for more research on the wider institutional repercussions of technology on water use practices in Central Asia.

Zhupankan et al. [22] state that increasing national water needs, water claims by neighboring countries, uncertainties in renewable water amounts, and climate change together with population increase will put increasing strain on future water use in Central Asia. At present, the general power distribution between the republics is three downstream hegemons (Kazakhstan, Turkmenistan, and Uzbekistan) and two upstream much poorer countries with less political influence (Kyrgyzstan and Tajikistan). The hydropower development in Kyrgyzstan and Tajikistan is, however, likely to gradually re-define the hydropolitical map of Central Asia. This may as well bring forward a better collaboration among the Central Asian republics regarding conjunctive water use.

Yapiyev et al. [24] perform a review on endorheic basins and lakes in Central Asia with a view on current and future water resources management. Endorheic basins may be more sensitive to climate change and over-exploitation of water resources. A large portion of the land area of Central Asia is represented by endorheic basins. To some extent, proper technology can help in the saving of water resources in this type of basin. However, these technologies alone are not sufficient. Regional programs, supported by local governments and international donors with proper approaches, are needed for successful climate change adaptations. The authors conclude that there is little time for hesitation and that regional collaboration is of utmost importance.

Climate change presents a range of challenges in a variety of societal sectors and water management. Ta et al. [25] present a comparison of precipitation simulations over Central Asia for the historical period 1986–2005 using 37 GCMs from CMIP5 models. Central Asia is composed by a complex topography and this results in specific problems using these types of models. The study finds that HadCM3, MIROC5, MPI-ESM-LR, MPI-ESM-P, CMCC-CM, and CMCC-CMS were the most reliable models to simulate observed inter-annual precipitation over Central Asia. It is important to continue to monitor precipitation variability depending on topography to improve input to these models.

## 3. Conclusions

Seven original research articles and one review article were selected for this Special Issue. The research findings are novel and timely in informing the hydrological and water resources management communities on up-to-date research and practice. Almost three decades have passed since the downfall of the Soviet Union and the emergence of the five Central Asian republics. The road to independence has been bumpy. Managing transboundary water resources and river basins is a difficult task. However, water resources investigations need to continue, and, where appropriate, water management needs to adapt. It is important that water resources research in Central Asia continues to integrate in the global research community. We hope that the collection of these papers contributes to generating further interest in water resources management in Central Asia and how better quantitative knowledge and data sharing can contribute and be used to address water resources issues such as vulnerability, sustainability, and uncertainty in water resources systems and their management.

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