Policy brief – April 2022

Water resources and water security in Central Asia

Main Findings

- Adaptation to expected water shortage and increasing water demand has to be undertaken to achieve water security in the future
- In-depth studies on the quantification of climate change impact on water resources should be considered
- Optimization of water management practices should consider the best economic value between Central Asian countries
- Decision making process on water management should be supported with more scientific knowledge
- Capacity building measures on the assessment of water availability in times of climate change should be improved

Introduction

This policy brief reviews the water resources and water security in Central Asia (CA), which requires increased attention in times of climate change. The long- and short-term water availabilities in CA are addressed in this policy brief that is now widely recognized as a threat in the region. Due to ongoing climate change, the drought frequency, as well as the frequency of flood events, are increasing. Moreover, the melting out of glaciers is a serious threat in CA, especially in the summer months, when the demand is high. In this policy brief, certain recommendations are given to be considered in the future to adapt to expected hydrological changes.

History and geographical setting of the region

Central Asia's food security, energy and environment are inseparably linked to water resources. Two main rivers that feed the region with water resources are the Amu Darya and the Syr Darya. Both are crossing the whole region and provide 90% of the surface water in CA. Since the 1960s, vast Central Asian desert areas are heavily irrigated due to the extension of agricultural production. Reservoirs, pumping stations and drainage networks were built to satisfy the high-water demand of cotton crops. The heavy toll of intensive and unsustainable irrigation was paid for by the drying up of the Aral Sea.

Until 1991, five countries in Central Asia were part of the Soviet Union and the water resources were managed centrally. Upstream countries provided water for irrigation to downstream countries and in return received resources for heating and electricity in the winter. After the Soviet era, the dynamic has changed. New independent countries shifted their national interests in using water resources. Kyrgyzstan and Tajikistan have large hydroelectricity potential and already 90% of the total energy comes from hydropower. Both countries have their interest to replenish the reservoirs during the summertime to be prepared for winter energy production, whereas the countries Kazakhstan, Turkmenistan and Uzbekistan have their focus on summer when the demand is highest for agricultural production. The sixth country of CA, Afghanistan, with its prime upstream location, for the time being, is not overusing the water from the Amu Darya, but if the agriculture in this area develops, the demand for water in the region will further increase.

Climate change and water situation in Central Asia

Earth's climate is changing, and with it, the hydrological cycles too. The climate of CA is mainly arid or semi-arid, intensified extreme weather conditions were observed in recent decades. Droughts are already becoming quite common in the region and they are likely to

become more frequent. Another issue is the rapid melting of glaciers since the Amu Darya and the Syr Darya are mainly filled with glacier meltwater in the late summer period when demand for agricultural production is high. Climate studies are indicating that global warming will accelerate the melting of glaciers, but at which rate and how that will affect the region's water security is still debatable.

Policy Issues

Three policy issues that are important to tackle when dealing with water resources and water security in Central Asia are identified. The first two issues regarding water resources are: (1) the increasing frequency of droughts and (2) the rapid melting of glaciers. Both are directly related to climate change. The third issue is: (3) data availability is a necessity for the indication of water-related problems.

Increasing drought frequency

Most climate models predict that dry regions of the world will only become drier. The deficit of water in river basins or aquifers is driving regional droughts. Severe droughts in CA are causing mass displacement of the population. In 2018, the majority of Afghanistan was hit by a drought and more than 300,000 people had to relocate due to food insecurity. In 2021, the massive Toktogul Reservoir which is located on the largest hydropower plant in Kyrgyzstan, which is providing 40% of the electricity in this country, had again an alarmingly low water level. Toktogul is filled by the Naryn River which flows into the Syr Darya.

Droughts in 2021 were a cause of massive livestock deaths in Kazakhstan. Shortages of water for irrigation ignited protests among farmers in Kyrgyzstan. In Turkmenistan, last year was recorded as the driest in the last 13 years, triggering a reduction in food production for the livestock due to the low harvests of pasture fields. In Uzbekistan, the drought caused a loss in harvest and higher prices for seasonal vegetables. The low water level of the Zarafshan river led to water shortages of drinking water in the capital Samarkand and set limited consumption by the Uzbekistan authorities in June 2021. In the Syr Darya River Basin, as seen in Fig. 1, the general trend of water level is steadily decreasing, indicating potentially more droughts in the upcoming years.

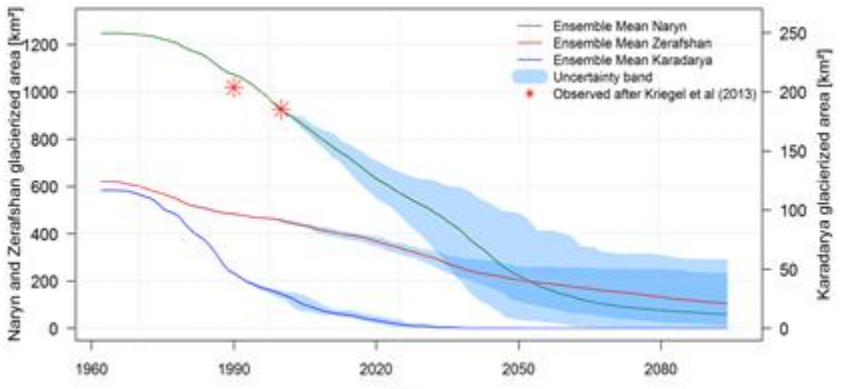

Figure 1: Simulated glacier area evolution until the end of the 21st century for the Naryn, Karadarya and Zerafshan river basins (Gafurov et al., 2017).

The retreat of the glaciers

The Tien Shan and Pamir Mountains are called the "water towers" of Central Asia. The glacial and snow-melt in these mountains is the main source of water for the major CA rivers. Climate change is causing rapid warming and affecting the snow cover and glacial melt. Snow is shifting to rain and almost 98% of Tien Shan glaciers are showing a retreating trend due to a change in the snow cover duration. Snow cover is decreasing the Earth's albedo by reflecting the radiation from the Sun, and like that protecting glaciers from melting. However, higher temperatures in spring and winter are melting the snow and thus, exposing the glaciers. Additionally, higher temperatures in spring and summer are influencing the seasonality of river flow where earlier snowmelt could trigger flood events

during spring when water becomes abundant. The simulation of glacier area evolution until the end of the 21st century in the Naryn, Karadarya and Zerafshan Rivers shows (Fig. 1) a significant decrease in glacier area by then. This is of serious threat to Central Asia that leads to water shortages in the summer months when the demand is highest.

Data availability issue

The efficient use of water requires knowledge about the available resources. Primary water supplies for irrigation and drinking water are groundwater and surface storage. Comprehensive monitoring, especially of the changes in water volumes or levels in reservoirs and lakes is necessary not only to effectively regulate the usage of water but also to be able to model and predict the changes. Moreover, the river discharge monitoring of the main rivers and their tributaries is indispensable for water management. Contradictory to the increasing need, many of the hydro posts and meteorological stations stopped operation after the collapse of the Soviet Union. For the operational stations often, data is not available for public use. Hydrological and statistical models depend on streamflow observations, and if these observations are not available or contain gaps, it is impossible to perform model validation and calibration. In addition, lack of spatial information or additional factors that are influencing streamflow conditions, such as anthropogenic factors like irrigation usage or reservoir level is challenging for drought and flood modelling.

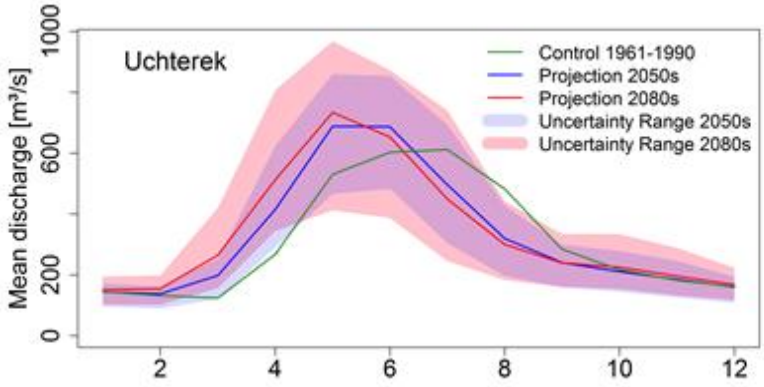

Fig. 2 Expected change in hydrological regime due to climate change until the end of the 21st century (Gafurov et al., 2017)

Policy options

Improvement of drought forecasting methodologies

There are several challenges in modelling and predicting droughts such as data availability, human-water interaction, process understanding and event definition.

As an alternative to limited observational data, *new data sources* should be exploited. Remote sensed data are provided with consistent spatial coverage and data in transboundary water basins. The disadvantage with this data is a relatively short record and sampling frequency of time series, depending on the satellite mission parameters. *Improvement of data-sharing* of existent observational records is needed to improve regional drought modelling. An establishment of a unique database for the whole CA where each country would equally participate, regularly update and make it publicly available would be an advantage. Drought modelling can be improved by considering the influence of *human factors*. However, to be able to include factors such as reservoir levels, it is necessary to have access to this data, and that there exist clear regulations and communication on how much water can be or is released from them seasonally.

Another improvement in drought modelling is clear communication on the *drought type* and the identification of a variable that is causing the drought. For example, streamflow, water level and groundwater level are causing a *hydrological drought*, and these variables can be monitored with GRACE missions, while a *meteorological drought* relies on precipitation, which could be monitored by some of the existing global precipitation datasets that are combining various satellite products and in-situ observations. When variables that are responsible for the droughts are clear, then threshold values can be set, and in that way,

drought events can be identified and the tools for early warning can be developed.

Analysis of water availability until the end of the 21st century

Considering glacier retreat in the region in the next decades, it is expected that water resources availability in the summer months will become limited in the future. Model predictions suggest that in late summer (July, August) the river flow will gradually decrease over the next few decades (Fig. 2). Climate change also has an impact on the frequency of floods or mudflows in the region as there is expected to be more water influx that can translate to fast overland flow and consequently to a flood event.

Policy recommendations

This policy brief outlined the main issues in water security and availability in Central Asia. As a recommendation for the improvement of water security in the region, it is important to:

- consider the increase in extreme weather conditions
- prepare agriculture and food sectors for possible future scenarios of water shortage
- improve transboundary political and technical cooperation in water management
- reduce negative impacts on water, food and energy security
- develop new tools and methods to better assess short- and long-term water availability in CA

References

Chen, Y., Li, W., Deng, H. *et al.* Changes in Central Asia's Water Tower: Past, Present and Future. *Sci Rep* **6,** 35458 (2016). DOI: 10.1038/srep35458

Brunner, MI, Slater, L, Tallaksen, LM, Clark, M. Challenges in modelling and predicting floods and droughts: A review. WIREs Water. (2021) DOI: 10.1002/wat2.1520

Famiglietti James S. and Rodell Matthew, Water in the Balance, Science, vol. 340, (2013), DOI: 10.1126/science.1236460

Haoyu Deng, Yunhe Yin and Xiang Han, Vulnerability of vegetation activities to drought in Central Asia, Environmental Research Letters, (2020) DOI: 10.1088/1748-9326/ab93fa

Pohl, B.; Kramer, A.; Hull, W.; Blumstein, S.; Abdullaev, I.; Kazbekov, J.; Reznikova, T.; Strikeleva, E.; Interwies, R. and Görlitz, S.: Rethinking Water in Central Asia: The costs of inaction and benefits of water cooperation -A policy brief (2017) https://carececo.org/en/main/news/news/publication-rethinking-water-in-central-asia/

Radio Free Europe, Central Asian Heat Wave and Drought Creating Water Shortages, Crop Failures, https://www.rferl.org/a/central-asian-drought-water-shortages/31324012.html - Accessed 15.02.2022

The Water, Peace and Security (WPS) Team, Water and (in-)Security in Afghanistan as the Taliban Take Over, https://www.newsecuritybeat.org/2021/08/water-in-security-afghanistan-taliban/- Accessed 15.02.2022

Water Security in Central Asia: an overview, https://nu.edu.kz/news/water-security-in-central-asia-an-overview - Accessed 16.02.2022

Gafurov, A., Duethmann, D., Kriegel, D., Unger-Shayesteh, K., Huss, M., Farinotti, D., Vorogushyn, S.: Climate impact assessment on water resources and glacierization in the Naryn, Karadarya and Zerafshan basins, Central Asia, (Geophysical Research Abstracts Vol. 19, EGU2017-15122), General Assembly European Geosciences Union (Vienna 2017).

Authors

Abror Gafurov, GFZ German Research Centre for Geosciences

Milena Latinović, GFZ German Research Centre for Geosciences

Larissa Kogutenko, Kazakh-German University

Tilo Schöne, GFZ German Research Centre for Geosciences

Please cite this Policy Brief as:

Gafurov, A., Latinović, M., Kogutenko, L., Schöne, T.: Water resources and water security in Central Asia. Policy Briefs of the Green Central Asia Initiative. DOI: 10.48440/GCA.2022.003