FUTURE CLIMATE RESILIENCE STRATEGY FOR IRRIGATED AGRICULTURE IN AMU DARYA RIVER BASIN OF UZBEKISTAN AMID THE QOSH TEPA CANAL PROJECT IN AFGHANISTAN.

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Keywords: *Climate resilience, irrigated agriculture, Amu Darya River Basin, Qosh Tepa Canal, water management, water loss, transboundary cooperation, market based mechanisms.*

Abstract: *Uzbekistan's irrigated agriculture faces growing risks from climate change and Afghanistan's Qosh Tepa Canal, potentially reducing Amu Darya water flow by 30% by 2050. This paper assesses the economic and social impacts of reduced water supply, including significant losses in agricultural output and employment. While national strategies address efficiency, they lack a long-term climate-resilience framework. The study proposes five key measures, including infrastructure upgrades, regional cooperation, and economic diversification, to enhance water security and align with climate commitments.*

INTRODUCTION

Freshwater is one of the most important natural resources for maintaining life and sustainable development on our planet, and it plays a significant role in many human activities, including domestic household use, agriculture, and industry (Falkenmark and Rockstrom, 2004). Moreover, water has a range of other essential functions, such as supporting socioeconomic movements, sustaining natural ecosystems, supporting recreational activities, and providing habitat for fish and other aquatic species (Wada, Wisser & Bierkens, 2014). Water therefore plays an enormous role in our lives in terms of the economy, society, and the environment. However, water resources on our planet are becoming extremely limited due to several factors such as population growth, economic activities, changes in land use, the overexploitation of groundwater resources, and different development projects (Pour et al., 2020). Another big threat to water resources is climate change, particularly decrease in precipitation and temperature increases. Water engineers and politicians are concerned that the negative impacts of climate change will be even stronger in arid and semi-arid countries (Ahmed et al., 2019). If climate change couples with different agricultural projects which affects the natural flow and availability of water resources, it can cause serious difficulties. In such cases, the countries should establish their long-term climate resilient plans to avoid future disastrous effects.

Uzbekistan is considered as one of the arid places in Central Asia where the reduce in water supply has been an issue due to global warming and upstream hydropower projects (Bekchanov et al., 2018). Uzbekistan is home to almost half of the Central Asian population

and irrigated agriculture plays an essential role for the livelihoods of rural population in the country (Aleksandrova et al., 2014). Despite the shrinkage of the glaciers in upstream countries due to the climate change might increase annual runoff in rivers in the short term, the runoff in Central Asia is expected to decrease by approximately 10 percent in 2050 (Sorg et al., 2014). The annual runoff decrease will be even higher in the Amu Darya Basin (10-15 %) than in the Syr Darya Basin (6-10 %) which will affect irrigated agriculture negatively in the southern regions of Uzbekistan. On top of the climate change impacts, neighboring Afghanistan started building an enormous canal to divert water from the Amu Darya River which will affect the water availability situation in Uzbekistan (The Economist, 2023). Thus, Uzbekistan must plan its climate resilient strategic plan for irrigated agriculture sector in Amu Darya River basin. This essay tries to explore a future climate resilience strategy for Uzbekistan in Amu Darya River basin in response to future climate change threats and the Qosh Tepa canal project.

Overview of the Qosh Tepa canal project and its impact.

In 2021, the Taliban took over the government in Afghanistan but has not been recognized by any countries internationally. Therefore, they are trying to increase the dialogue with other countries and implement some domestic policies to strengthen their administrative presence and the Qosh Tepa Canal Project is an important start for the Taliban (Kizilay, 2023).

According to Osmankhil and Osmankhil (2023), in March of 2022, the Taliban announced that Qosh Tepa Canal Project to use the Amu Darya River's water had begun. It starts in the Balkh province's Kaldar district and concludes in the Faryab province's Andhoy district and the project is known to be 285 km length, 100 m width, and 8.5 m depth. The project's total cost is expected to be about 680 million US dollars or 60 billion Afs (TOLOnews, 2022). According to News Central Asia (2023), 550 thousand hectares of land in Balkh, Jawzjan, and Faryab could be irrigated when the canal is finished, and it helps to solve the water problems in those regions. Moreover, the canal will carry 650 cusecs (cubic meters per second) of water and is planned to be completed in 2028 (Seerat, 2022). This project is expected to significantly boost the variety and volume of agricultural products produced in Afghanistan and gives the nation will be able to export grain while also being self-sufficient in agricultural products (Umirdinov, 2022). Thus, the canal project is crucial for both internal development and external growth of the country.

The project will be completed in three phases (News Central Asia, 2023):

1. The 108 km long first phase of the project starts from the Amu Darya River and ends in the Balkh province's Dawlatabad district.

2. The second stage is 177 km long and begins in Dawlatabad district, goes along Aqchi district in Jawzjan province, and ends in Andhoy district in Faryab province.

3. The construction of sub-channels to land used for agriculture is the last step.

Due to the high importance of the project for the Taliban government, they are trying to complete and implement the canal as soon as possible. Therefore, there are currently

5500 individuals operating at 120 places at the same time to speed up the process and the number of machines in use exceeds 3300 Furthermore, over 200 local businesses are employed as subcontractors by the Afghanistan National Development Company for this project (Kizilay, 2023). New Central Asia (2023) states that the Taliban used their own funds to fund the project's initial phase, which cost 91 million dollars and the money will be generated by selling of mines in the country such as The Dar-e-Souph to complete the next two phases. The first phase of the canal was supposed to be done by June 2023 which is two months ahead of schedule and this also demonstrates how important the project is for the Taliban government.

When the canal is complete, it could mean that Uzbekistan will receive 15 % less of water from Amu Darya for irrigation (Charles, 2023). Moreover, the low water levels caused by climate change could drastically reduce the annual flow of Amu Darya which will cause serious water availability for the irrigated agricultural sector of Uzbekistan. Besides the water availability issues, the canal project also can lead to new tensions between parties in the region and potential conflicts over water. Because no agreement was reached between Afghanistan and the Central Asian countries about the Amu Darya River after the fall of the Soviet Union in 1991 (Charles, 2023). To sum up, with the ongoing climate change crisis and the Qosh Tepa Canal Project in Afghanistan the water availability in Central Asian especially in Uzbekistan may change soon, which should rise awareness among Uzbek policymakers to prepare climate resilient strategies for the irrigated agriculture in Amu Darya River basin.

The consequences of reduced irrigation water availability for Uzbekistan.

In Uzbekistan, irrigated agriculture plays an essential role in the livelihood of majority people living in the rural areas since their main source of income is agriculture. Moreover, the agricultural sector accounts for around 20 % of the country’s Gross Domestic Product (GDP) and approximately 25 % of total employment (Bekchanov and Bhaduri, 2013). Thus, the reduced water availability will affect the country's entire economy and jeopardize the environment and ecosystem in the lower parts of the basin.

Bekchanov and Lamers (2016) assessed the economic impacts of reduced water supplies in Uzbekistan by adopting the Computable General Equilibrium (CGE) model developed by the International Food Policy Research Institute (IFPRI; Lofgren, Harris & Robinson, 2002). They created a cause-effect relationship model for the study and numerical assessments of the analysis were also included in their paper. According to Bekchanov and Lamers’ (2016) cause-effect relationship model, following are the potential effects might occur in the case of reduced water supplies in Uzbekistan:

1. The impacts from irrigation water supply decrease are following:
   a. Land abandonment;
   b. Reduction in agricultural production;
   c. High consequent marginal value of irrigation water.
2. Production reduces in agriculture will lead to:

a. Demand reduction for labor and capital resources;

b. Price increase in agricultural markets.

3. Due to restricted water use and consequent production reductions will lead to decrease in the agricultural value added despite increased agricultural product prices may increase the agricultural income or value added.

4. The productivity of agroprocessing sector which includes cotton, food processing and light industry will decline due to the agricultural production reduction.

5. The decrease in demand for machinery outputs and chemical engineering industries will eventually cause reductions in demand for the services sector.

6. Due to unemployment rate increase and lower wages, private consumption and household incomes will decline.

7. The production decrease will lower the tax base and revenues from tax while the export revenue from agriculture will also decline. In that case, the government may increase the export and the production of industrial goods such as metals, gas, and oil to raise budget revenues and maintain the activities of the public services sector. However, the overall negative impacts of reduced water supply could only partly be outweighed by such sectoral changes.

8. Thus, the overall income loss caused by reduced agricultural water supply will eventually lead to GDP decrease in the country. (Bekchanov and Lamers, 2016).

Above mentioned changes in sector-specific water and land uses, unemployment rate and value added because of irrigation water supply reduce in Uzbekistan, confirmed by the CEG model. Those changes in the resources use will eventually impact income distribution, consumption patterns, and other macroeconomic indicators such as the national income, exports, and imports. According to numerical results of the model, if assuming that no action is taken to respond to those changes, 10-20 % assumed reductions in irrigated water supply will reduce the irrigated areas by 6,3-9,7 % (241,000–374,000 hectares) and the demand for workforce by 7,9–9,6 % (712–868,000 people). Moreover, the value added in the agriculture sector would decrease by 4,6–7,0 %, which will lead to a 4,2–5,8 % total farm income reduction and a 3,7–4,6 % loss in household incomes. Overall, total loss for the country from the reduced water supply would be 3,6-4,3 % of the national income. (Bekchanov and Lamers, 2016).

Although the analysis conducted by Bekchanov and Lamers (2016) covers the whole country, it demonstrates how drastic can be the impact from the reduction in water supply for the economy of Uzbekistan. Since the water supply from Amu Darya River accounts for 67 % of the overall annual flow from all rivers in Uzbekistan, the water supply reduction from only Amu Darya will extremely impact the economy of the country. As mentioned earlier, the annual runoff from Amu Darya River will decrease by 10-15 % by 2050 and the Qosh Tepa canal project will add another 15 % reduction when it is completed. In that case, the estimated water loss for irrigation will be around 25-30% for Uzbekistan by 2050. Thus, to avoid the expected national income loss, Uzbekistan should implement climate

resilient water allocation strategies which consider 25-30 % water supply loss for irrigation by 2050.

Does Uzbekistan have existing climate adaptation or resilience plan?

Before moving on to the climate vulnerability assessment and adaptation and resilience plan, I decided to analyze the current water management strategy of Uzbekistan and the climate aspects covered in that strategy. Thus, I analyzed decree of “The concept of development of water management sector of the republic of Uzbekistan for 2020-2030" approved by the President of the Republic of Uzbekistan (MINISTRY OF WATER RESOURCES OF THE REPUBLIC OF UZBEKISTAN, 2020).

First, the decree contains information on climate challenges for water management and transboundary relations but there was not any neither short-term nor long-term strategic plan to overcome those climate related challenges. Moreover, the document also demonstrates the commitment of Uzbekistan towards the Sustainable Development Goals (SDG) which are related to water management (SDG6). However, SDG 6 tasks set for 2030 do not provide any climate related development goal for the country. Those SDG goals only cover the tasks which aim to achieve access to safe and affordable drinking water, access to adequate sanitation and hygiene, improved water quality, and water-use efficiency increase, yet the decree does not provide any strategic plans to achieve those goals either.

Nevertheless, there have been several tasks with clear targeted indicators which can help to respond to the reduced water supply in the future and be part of the climate resilience plan. Such indicators which should be achieved by 2030 include:

a. Enhancing the irrigation system efficiency by 0,1 to 0,73;

b. Reducing the irrigated fields by 370 thousand hectares;

c. Implementing water-saving irrigation technologies for irrigation of agricultural crops up to 2,0 million hectares from 127,5 thousand hectares;

d. Increasing the share of areas with drip irrigation technologies implemented up to 500 thousand hectares;

e. Increasing the number of water facilities up to 1000 where “Smart Water”, automated system for measuring and controlling water, has been installed;

f. Modernizing the primary and inter-farm canals and increasing share of canals with lining up to 13 175,7 km. (MINISTRY OF WATER RESOURCES OF THE REPUBLIC OF UZBEKISTAN, 2020).

Although above mentioned indicators do not directly tackle the climate change impacts of water resources in Uzbekistan, they are going to help to avoid non-revenue water losses due to the outdated and worn-out irrigation infrastructure in the country.

To conclude, Uzbekistan aims to reach rational use of water resources by implementing several water-saving technologies, modernizing the canals and irrigation techniques, and reducing some irrigated fields. Although those indicators might not be a systematic climate resilience plan, they help to decrease the negative effects from reduced

water supply caused by climate change and the development projects in neighboring countries.

Climate resilient strategy for irrigated agriculture in Amu Darya River basin in Uzbekistan.

As discussed earlier, the estimated water loss for irrigation from Amu Darya River will be around 25-30 % by 2050 due to the climate related impacts and Qosh Tepa Canal Project of Afghanistan. Thus, Uzbekistan should develop its long-term climate resilience plan. To avoid the potential negative impacts of irrigation water supply reduction by 25-30 % from Amu Darya River, following climate resilience actions should be taken:

I.The government should implement modern water management, water use systems, and modernize outdated irrigation and hydraulic systems to gain zero non-revenue water loss by 2028.

II. Uzbekistan should improve its interstate relations with riparian countries in Amu Darya River basin including Afghanistan.

III.The share of the agricultural sector in GDP should be below 10 % percent by 2050 and the export of agricultural products should be increased step by step.

IV.The government should adopt market-based mechanisms for water management, water delivery and water use.

V. Uzbekistan should support global climate actions according to the Paris agreement.

Above mentioned five strategic plans should be implemented to avoid potential national income loss from the reduced water supply from Amu Darya River.

Initially, Uzbekistan should lead to 100 % water efficiency by 2028, improving old water management facilities and irrigation systems. According to the report by the Ministry of Water Resources of the Republic of Uzbekistan in 2020, 66 % of the total length (28,400 km) of main and inter-farm canals in the country do not have watertight protection, which they are earth canals. Moreover, out of farm and on-farm network which have a total length of 155,000 km, o18,100 km or 12.1% are flumes and 14.400 km are lined canals and the rest are earth canals too. Furthermore, 12,000km (44%) of main and inter-farm canals require repair, 4,500 km (16%) need reconstruction, and 65,200 km (42%) of farm and on-farm network also require repair and rehabilitation, and more than 10% should be reconstructed. On top of that, among the existing flume networks, most have been used for over 30 years with limited maintenance. Therefore, the technical condition of 70% of the flume network is considered unsatisfactory and requires their reconstruction and replacement. In addition to that, the hydraulic structures in the water management system are physically worn out and obsolete and half existing headworks of hydro-mechanical equipment need to be replaced or modernized, while 5 headworks require a complete reconstruction. More than 60% of pumping equipment has exceeded their lifespan and almost 80% of large, 50% of medium and 30% of small pumping stations were built more than 30 years ago. Currently, those pumping stations are maintained only

with costly and frequent repairs and around 10% (300 km) of the existing pressurized pipelines going from the pumping stations require urgent replacement. Finally, water saving technologies have been introduced on only 3.0% of the irrigated lands (MINISTRY OF WATER RESOURCES OF THE REPUBLIC OF UZBEKISTAN, 2020).

Due to the above-mentioned poor technological capability of water management and irrigation facilities, around 35-40% of water taken from the sources with pumps or by gravity is lost from the irrigation systems. The current water loss rate is extremely critical to implement urgent development strategies and investments to the system. Because in the case of a 25-30% water supply decrease from Amu Darya River, avoiding non-revenue water loss would be particularly important for the country since around 70 % of those losses account for the Amu Darya River Basin. Since Uzbekistan is planning to implement 50 public-private partnership investment projects by 2030, majority of those projects should be directed towards the resolve the technical issues of water management systems and irrigation facilities to achieve 100 % water efficiency and zero non-revenue water loss in the Amu Darya River basin.

Furthermore, 80 % of Uzbekistan's water resources are generated in riparian countries, it is vital to maintain cooperation with the countries in the basin (White, Tanton & Rycroft, 2014). Most importantly, Uzbekistan and Turkmenistan should initiate the agreement on the use of water resources from Amu Darya River between Central Asian countries and Afghanistan since these two countries mostly rely on the river. Because future difficulties may arise after the completion of Qosh Tepa Canal project due to the lack of agreements signed by Central Asian countries and Afghanistan on use and allocation of the Amu Darya's waters. Since Afghanistan contributes 12% of the Amu Darya's total flow and it is excluded from the Almaty Agreement signed by Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan which regulates the allocation of water between those countries (Charles, 2023). Although, the countries did not recognize the Taliban government in Afghanistan, they should consider working with the water ministry in the country. Moreover, the UN Convention on the Law of Non-Navigational Uses of International Water Courses favors the early developers, but it does not take away late developers of their rights (Charles, 2023). Thus, Afghanistan, as a country in the Amu Darya basin, has a full right to use waters of the Amu Darya and Panj, it is vital to include Afghanistan to make the entire regional water management regime complete.

The agricultural sector leads to the development of rural areas, reduction in poverty rate, food security, nutrition, biodiversity, and environmental sustainability. Moreover, the value added from the agricultural sector also would be higher compared to other sectors of the economy (Paz, Benavides & Arias, 2009). However, the agricultural sector share in GDP in developed countries are below 5% compared to the 20 % agriculture share in Uzbekistan. Therefore, continuous reduction of agricultural sector share in GDP will be another solution to reduced water supply especially in Amu Darya River basin. Besides high-water consumption of the sector, the agricultural sector also contributes most of the

pollution in many countries due to the pesticides and other toxic chemicals used in the sector (Nagendran, 2011). Nagendran (2011) also states that the high-yield production systems pollute the air and water, cause soil degradation and contribute to climate change. Thus, Uzbekistan should decrease agricultural production and agriculture share in GDP gradually to achieve below 10 % share by 2050. It will be another response to the reduced water supply from Amu Darya River and it also reduce the water consumption in the country and helps to avoid potential negative impacts which can lead to climate change. Uzbekistan should also try to increase agricultural exports to decrease the agricultural production. Uzbekistan should be interested in investing Qosh Tepa Canal project of Afghanistan which can create beneficial agricultural product source for the country, and it also helps to strengthen water resources management cooperation with Afghanistan.

Uzbekistan should start implementing market-based strategies by establishing new water-storage facilities and water markets. The Ministry of Water Resources of the Republic of Uzbekistan already included following market-based principles in 2020-2030 strategic plan:

a. Water allocation between economic, social and environment sectors through quotas (limits) allocation;

b. Taxation and penalizing system for using water;

c. Water delivery charges;

d. State expenditures for operation and modernization of irrigation assets;

e. State subsidies and tax exemptions in water sector;

f. Transfer of economic functions in water infrastructure management and maintenance to third parties under public-private partnerships and other forms of outsourcing. (MINISTRY OF WATER RESOURCES OF THE REPUBLIC OF UZBEKISTAN, 2020).

On top of those principles, the global successful practices of market-based mechanism also should be implemented. For instance, hydropower facilities in upstream countries of Kyrgyzstan and Tajikistan require massive amounts of water release during winter when the water is not needed for irrigation purposes. Those released water can be stored for irrigation in water stressed summer seasons. The government should give the opportunity for the private companies to build water storage facilities and trade those water resources during the summer months. Moreover, establishment of water markets to facilitate water trading is another method of market-based strategies which allows moving water from lower value use to higher value uses (Wheeler, Loch, Zuo & Bjornlund, 2014). Because “water trading encourages more economically efficient water use patterns because the market-determined price provides a motivation for users to trade water for cash, reallocating water from lower valued uses, such as fodder to higher valued uses such as urban water” (Jiang et al., 2020). If farmers have the water rights to sell or lease, they might be interested in transferring their water rights to industrial use which is a big sector in the Amu Darya River basin especially Bukhara and Navoi regions. In that case, big

farmers can divert their excess water to industrial use which prevents the water resource waste and small farmers can even generate income just from their water rights which reduces agricultural production.

Finally, Uzbekistan should continue to make its contribution to global climate change response according to Paris agreement. Uzbekistan submitted its revised Nationally Determined Contributions (NDC) in 2021 and promised to reduce specific greenhouse gas emissions per unit of GDP by 35% by 2030. Uzbekistan also aims to strengthens adaptation measures, particularly in agriculture and to align its NDC with its strategy for transition to Green Economy by 2030 (Uzbekistan.UNDP Climate Promise, 2023). Those actions will contribute to the global response to climate change's negative impacts.

CONCLUSION

Climate change in the form of precipitation decrease and temperature increases is a big threat to water resources especially in arid and semi-arid countries such as Uzbekistan. The negative impacts of climate change will be even stronger due to different hydropower or agricultural development projects. Qosh Tepa Canal project which was started by Taliban government in 2022 to divert water from the Amu Darya River can be additional challenge to water availability in Uzbekistan besides climate change. This paper tried to give strategic responses to prevent potential economic loss in the case of 25-30 % water supply decrease from Amu Darya River by 2050. After analyzing the current water resources management strategic plan of the country for 2020-2030, some climate resilience responses suggested to be considered in the future.

First, Uzbekistan should resolve the technical issues of water management systems and irrigation facilities to achieve 100 % water efficiency and zero non-revenue water loss in the Amu Darya River basin by 2028. Because Qosh Tepa Canal project is planned to be complete by 2028 which ensures 15 % less water from Amu Darya River for Uzbekistan. Moreover, due to poor technological capability of water management and irrigation facilities, around 35-40% of water taken from the sources with pumps or by gravity is lost from the irrigation systems.

Second, Uzbekistan should enhance water cooperation with riparian countries and should establish an agreement with Afghanistan on the water use from Amu Darya River. Because 80 % of Uzbekistan’s water resources are generated in riparian countries and Afghanistan is excluded from the Almaty Agreement signed by Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan which regulates the allocation of water between those countries although it contributes 12% of the Amu Darya’s total flow.

Third, the role of agricultural sector in the country’s economy should be decreased step by step to achieve 10% or less share by 2050 since it helps to reduce the water consumption in the country and to avoid potential negative impacts which can lead to climate change. Uzbekistan should also try to increase agricultural exports to decrease the agricultural production in the country considering Afghanistan can be a potential producer.

Fourth, the market-based mechanisms in the water sector should be adopted to increase the value of water resources. On top of the principles planned by the Ministry of Water Resources for 2020-2030, the global successful practices of market-based mechanism also should be implemented such as water markets.

Finally, Uzbekistan should contribute to the global response to the threats of climate change by fulfilling its climate promises by reducing specific greenhouse gas emissions per unit of GDP by 35% by 2030 as promised in its NDC.

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