The Future of the Amu Darya Basin in the context of Climate Change

Summary

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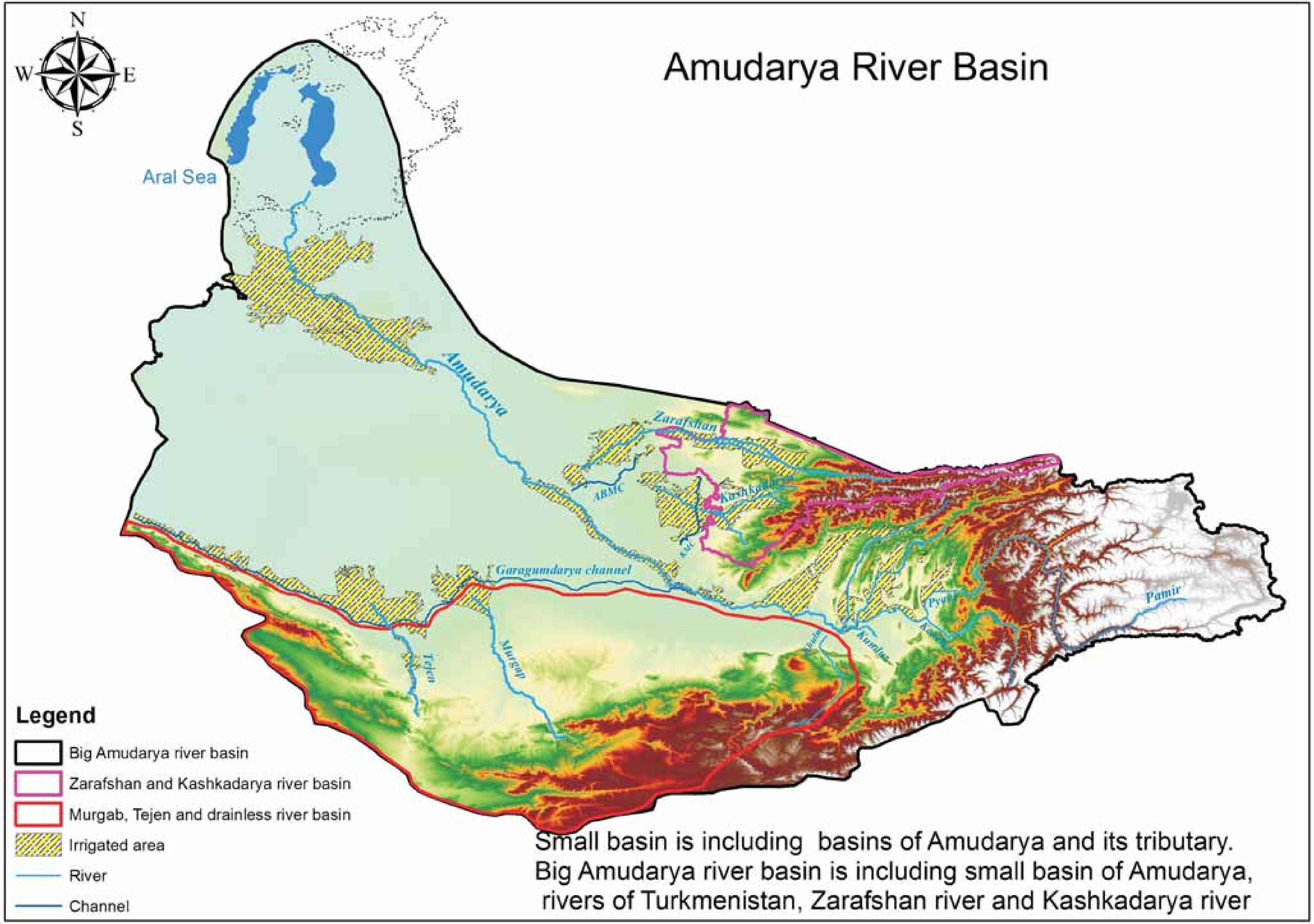
Tashkent 2018


Amudarya River Basin
N
W
E
S
Aral Sea
Amudarya
Zarafshan
ABMC
Garagumdarya channel
Tejen
Murgap
Pyanj
Kunduz
Pamir
Legend
Big Amudarya river basin
Zarafshan and Kashkadarya river basin
Murgab, Tejen and drainless river basin
Irrigated area
River
Channel
Small basin is including basins of Amudarya and its tributary.
Big Amudarya river basin is including small basin of Amudarya,
rivers of Turkmenistan, Zarafshan river and Kashkadarya river

International Fund for Saving the Aral Sea

Interstate Commission for Water Coordination in Central Asia

Scientific-Information Center

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SUMMARY

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Introduction

The history of Central Asia (CA) is inextricably connected with the Amu Darya River. Various state entities, such as Bactria, Gurganj, Kesh, and Marakanda evolved along this ancient river, which formerly was known as Tanasis for ancient Greeks, Ariana for Persians, Jayhoun (furious) for local residents. At all times, the states and their people relied on fertile lands in the basin of this river. With the development of the Great Silk Road, the river helped traders to find their way for the gold treasure of Bukhara, silk of China, alfalfa seeds of Karakalpakstan, and wonderful architecture of Samarkand. In 18-19 centuries, the river was mentioned only in hydrological studies as one among such rivers as Indus, Mississippi, and Yellow River that carry a large amount of sediments. In the 20th century the river became known in connection with disappearance of the Aral Sea - once the fourth world’s largest freshwater body - that it fed along with the Syr Darya River. The modern history of Amu Darya associates with getting over of the bitter legacy and securing of welfare and wellbeing for five riparian nations: Afghanistan, Kyrgyz Republic, Tajikistan, Turkmenistan, and Uzbekistan.

Currently, only four states, excluding Afghanistan, are involved in interstate management of water resources in the Amu Darya River Basin. Since the collapse of the Soviet Union, Kyrgyzstan, Tajikistan Turkmenistan, and Uzbekistan has agreed to adhere “the existing structure and principles of water allocation” in the Amu Darya River basin (Agreement on Cooperation in the Field of Joint Management of the Use and Conservation of Water Resources in Interstate Sources, Almaty, 1992). Thus, the guiding documents that set the structure and principles of Amu Darya River water allocation are the Soviet documents, namely Protocol 566 of the meeting of the Scientific-Technological Council at the USSR Ministry of Land Reclamation and Water Resources (Minvodkhoz) of September 10, 1987, which was approved on December 3, 1987 by the Minister Mr. N.F.Vasiliev (hereinafter Protocol 566). This Protocol approved the “Revised Master Plan for comprehensive use and conservation of water resources in the Amu Darya River.”

Those documents set that the sphere of interstate water management and distribution in the Amu Darya basin, including the Amu Darya River and its major tributaries, the Vakhsh, the Panj, the Kafirnigan (small Amu Darya basin). The water allocation is set considering that the total river water withdrawal is 61.5 km^3, minus diversion of water by Afghanistan (2.10 km^3/year) at the following ratio: Kyrgyzstan – 0.6%; Tajikistan – 15.4%; Uzbekistan – 48.2%; and, Turkmenistan – 35.8%.

The Interstate Commission for Water Coordination (ICWC) in Central Asia established in 1992 among the heads of CA country water agencies is a body responsible for determination of regional water policy, as well as for elaboration and approval of water withdrawal limits for the countries, river delta, and the Aral Sea. Routine management and allocation of water per se are assigned to Basin Water Organization “Amu Darya” (BWO Amu Darya), which has four territorial divisions in Kurgan-Tyube (Republic of Tajikistan), Turkmenabad (Turkmenistan), Urgench (Republic of Uzbekistan) and Takhiatash (Republic of Karakalpakstan). BWO has 170 gauging stations to control allocation of water according to the schedules approved at ICWC meetings that are held four times a year.

Currently, water allocation is conflict-free mainly and shows good fitting of planned and actual values of water delivery to the countries during non-growing season and somewhat worse fitting during growing season (3.8– 5.5% and 12.9–14.0%, respectively over last 10 years). Water management becomes problematic in dry years (2000, 2001, 2008), when downstream zones stay disadvantaged as against the midstream.

However, in the future, the situation related to water management in this basin and environmental balance in Eastern bowl of the Aral Sea is expected to become worse due to demographic pressure, climate change, and growing water demands in Afghanistan.

The need for in-depth study of the current situation and future challenges to take informed and timely actions for water management adaptation in the basin to new conditions was the starting point of the Project “Transboundary Water Management Adaptation in the Amu Darya Basin to Climate Change Uncertainties”. And the main project results are discussed in this publication.

Research Aim and Objectives

The research project “Transboundary Water Management Adaptation in the Amu Darya Basin to Climate Change Uncertainties” was implemented by the SIC ICWC of Central Asia, BWO Amu Darya and the Analytical Agency “Ynanch-Vepa” (Turkmenistan) as part of the program called Partnerships for Enhanced Engagement in Research (PEER) supported by the U.S. Agency for International Development (USAID).

The general aim of implemented work was to build resilience to the impacts of climate change on transboundary water management in the Amu Darya Basin countries. To this end, a study in a holistic manner was carried out of transboundary water management issues in the Amudarya Basin for the long run under conditions of climatic and other changes along with the national plans on irrigated agriculture and hydropower development. Particularly, the following objectives were reached:

- Estimated plausible deviations in hydrological regime and in future water consumption rates as a result of climate change;
- Studied scenarios of the impacts of multiyear flow regulation by a system of large reservoirs on hydrology of rivers and available water supply for irrigated land and aquatic ecosystems in the basin;
- Evaluated irrigated crop water requirements in the basin under an array of future climate change and river flow regulation, based on national agriculture and hydropower development plans and with account of technological innovations and water conservation technologies as adaptive measures;
- Elaborated possible tradeoffs between national priorities and requirements at the basin level inter alia on the basis of legal and institutional analysis focused on global water conventions, such as 1997 UN Convention and 1992 UNECE Convention;
- Drafted recommendations for decision makers.

Methodology

This research project relies on the concept of Integrated Water Resources Management (IWRM) for coordination of interstate & intersectoral interests and achievement of equal, equitable and well-grounded distribution of water and efficient water use through technological innovations, new institutional structures, and public participation. This approach allows adapting to changes caused by climate variations and other destabilizing factors (population growth, socio-economic changes, cultural shifts, increased water use by Afghanistan, altered flow regimes for hydropower).

Hydrologic and economic processes were modeled and actions aimed at adapting to dynamic changes were predicted on the basis of GAMS (The General Algebraic Modeling System), in which the team of executors had substantial experience. In particular, the ASBmm was written in GAMS as a set of optimization and simulation models for the basin, including the planning zone model that allows assessing the impacts of various factors on productivity of the water sector under the array of specific future scenarios (climate, water, agricultural, and economic).

The legal and institutional framework was analyzed in terms of its adaptability to current changes. Applied to water resources management, the adaptive approach ensures timely and appropriate response to the changes in process. Adaptive management implies rules and procedures that are flexible enough to make decisions in unusual situations or under changing conditions but also clear and specific to ensure that those decisions are made in a timely and non-confrontational manner.

Broadly, the scientific merits of the project are:

- the modeling tool that allows for assessment of climate change impacts in combination with various scenarios of water, socio-economic, agricultural, environmental, & energy development in the basin countries;
- approaches which aim at reducing water inputs in irrigated agriculture; to be enriched by the relevant US experience (WaterSmart, etc.);
- harvesting positive impacts of climate change in the basin by making use of shorter crop growing period, modeling of which will give lower figures of water requirements;
- assessment of adaptability of the legal and institutional framework underlying transboundary water management in the Amu Darya Basin to continuously changing conditions that was made for the first time.

Content of publication

Given publication describes the results of the comprehensive research. Section 1 provides general information about the Amu Darya Basin (geography, population, climate, water resources, key water uses) and analyzes the current state of interstate water management in the basin, including legal, institutional, and technical aspects. Key achievements and future tasks for more adaptive and effective water management in the basin are summarized in the final chapter of this Section.

Forecasts and recommendations for future development in the Amu Darya Basin until 2050 are discussed in Section 2.

Broad conclusions and recommendations are provided in the final section of the publication. Additionally, the key research conclusions regarding the future of the Amu Darya are stated below.

Future of Amu Darya: Key Conclusions

The future of the Amu Darya depends on dynamics of water resources available for all the countries and on growth of their demands. The interests of the riparian countries differ and the current agreements fail to ensure appropriate regulation of all existing concerns. There exist a number of agreements between Kyrgyzstan, Tajikistan, and Uzbekistan that set only an order of annual water use in these countries and lack provisions for future potential changes. The annual and daily management is supported by the interstate organization – BWO Amu Darya – and analyzed in details in this publication. Besides, there is an agreement between Turkmenistan and Uzbekistan that sets the rules for equal water distribution at Kelif section. Implementation of this agreement is ensured through regular meetings of the Turkmen-Uzbek Commission that tries to keep to variations of river flow regime by quick and timely actions in response. Finally, there are Soviet-time agreements that contain no tough rules for water allocation and use but, at the same time, determine certain procedural obligations that are still effective for all post-Soviet countries.

The future, which given publication mainly addresses, also will require better legal framework. As is well-known, one of weak points of the existing Master Plans that set the current order of water allocation along the Amu Darya is the share of Afghanistan, which is estimated as 2.10 km^3/year based on available irrigated land area. Now, this statement is subjected to strong disputes in works of Afghan scholars and policy makers supported by western analysts as “regulations behind the times”. Moreover, this is stated by scholars who virtually have never dealt directly with Afghanistan’s river hydrology but who have used materials of someone else’s research, characterized by variable degree of reliability (McKinney, 2004, King and Sturtewagen B. 2010, Rahaman 2014, Yildiz 2015, Habib 2014), mainly of Soviet and Afghan authors, and indicated widely varying values of recharge of the Amu Darya from Afghanistan’s territory and demand of the country.

The future of the Amu Darya also depends on the use of hydropower potential of this river and its two major tributaries – the Vakhsh and the Panj. The hydroschemes planned or under construction, such as Roghun, can have an impact on river flow comparable with the effects of climate change and population growth as early as at stage of filling. Their operation modes can cause even more uncertainty if no clear coordination mechanisms are in place.

In the Soviet period, all agreements between the republics, e.g. the inter-republican operation commencement act of the Nurek or Toktogul hydroschemes stated that the primary goal of the constructed hydroschemes was multipurpose flow regulation, first of all, for irrigation needs, with accompanying energy generation. Since independence, the situation has changed for all hydroschemes operated by powermen. Hence, the Nurek hydroscheme, which in the Soviet period reduced summer water releases to the benefit of winter releases by 2 km^3 a year only, regularly had withdrawn not less than 4.2 km^3 from summer releases in the post-Soviet period. Currently, this figure is fixed in the design operation mode of the Vakhsh cascade as developed in the documents of the Impact Assessment for Roghun Hydro Power Plant made with the support of the World Bank (similar situation occurred along the Syr Darya River, see de Schutter J. and Dukhovniy V., 2011).

Thus, we have to seek solutions under an array of future challenges:

- **population growth and changed water demand** due to such growth and socio-economic development;
- **climate change,** with consequently altered runoff and water demands;
- **irrigation development in Afghanistan** and increased demand of the latter;
- potential changes caused by **hydropower construction.**

Rates and focus of **socio-economic progress,** which is specific for different countries and zones in the region, will be determined by structure and orientation of economy, especially agriculture and its principle part in terms of water – irrigated farming, with wide range of alternatives shown in relevant section (Sh.Muminov). Besides three different scenarios of cropping patterns oriented towards either business as usual or food security or export, innovations in both irrigation and agricultural production and degree of agricultural processing will be also very important. According to direction set by the President Sh.M.Mirziyoyev in the textile industry, Uzbekistan will orient towards complete processing of all agricultural raw materials. This again will demand additional water inputs.

Among other factors contributing to tightened water balance in the basin one should expect increased withdrawal of water by Afghanistan within 6 km^3 by 2035-2045. This is twice as high as the current water withdrawal from the Amu Darya channel and its current tributaries. Finally, actions that are obligatory but not yet certain in terms of size and content of hydraulic structures as stipulated in the long-term plans of Afghanistan and Tajikistan for development of their hydropower potential along the rivers Panj, Vakhsh, and Amu Darya itself may seriously alter the water balance in the basin. At least, in the immediate future delineated by the project, one may expect completion of Roghun and several other hydropower plants along the Vakhsh and possible construction of one of two key hydroschemes – Dashtijum dam in the Panj or even Upper Amu Darya dam in the Amu Darya. Certainly, everything will depend on good will of the riparian states sharing water of the Amu Darya and their wish to support the initiative of President Mirziyoyev concerning joint development of water sector potential in the Aral Sea basin. In any case, hydropower development progress will be connected with the inputs for filling of related reservoirs, and the higher degree of cooperation between the countries, the more acceptable are such inputs will be. Another uncertainty aspect in terms of future arises in the context of the Chinese initiative "One Belt, One Road", which may offer a broader perspective for cooperation in the region by making use technical and investment capacities of the two member-states of the Shanghai Cooperation Organization, namely China and Russia.

With the existing knowledge and the current degree of cooperation among the riparian countries, for the average long-term available water supply, water resources in the basin will be decreased minimum by 2.6 km^3 as a result of climate change and by 3 km^3 due to water withdrawal by Afghanistan from the Amu Darya by 2040. More than 1 km^3 will be needed additionally given an increase of population by, at least, 10 million, and the same amount is necessary to ensure industrial and service sectors growth for employment of this growing population. Even if regimes of filling of new reservoirs as proposed by Tajikistan for filling of Roghun in form of withdrawal of their underused limit in the amount of 2 km^3 are clearly coordinated, the total water shortage for average year would be as high as **9.6-10 km^3.** But if we account flow variations in the small Amu Darya Basin within 51-73 km^3 over 2010–2017, water shortage in the Amu Darya may reach **20 km^3** in some years.

So, how can the riparian countries cover that shortage?

1. **Lowering of flow losses in the river channel** is one of largest reserves for water. Currently, water losses in the river channel vary from **5.756 km^3** in dry year to **16.2 km^3** in wet year, given that the standard losses are set by ICWC's protocol at **9.03-9.23 km^3**. If things are put right in water accounting at the interstate level by continuous flow recording through implementation of the SCADA system, similar to what was done in upper and middle (partially) reaches of the Syr Darya River, we will be able to improve accuracy of recording of water withdrawals from the river by 8% on average, i.e. reduce deviations from ±10 to ± 2%!!! This would allow catching at least **3-4.4 km^3** a year, with the approximate cost of investments of $M23, given that the average cost of one cubic meter of saved water is about 0.5 cents!!!

2. **Putting things right** and improving **accuracy of water accounting in main and inter-farm canals** in each country and each of planning zone may provide considerable reserves for compensation of water shortage. As the data of water balances of planning zones and main canals shows, values of losses and discrepancies of water balance over average year lead to actual water losses of **19.475 km^3** a year. If coefficient of performance of that type of irrigation

network is improved to its standard of 0.7, **3.7 km^3** of water will be saved additionally.

3. Shifting to multiyear flow regulation upon completion of Roghun and coordinating operation modes of existing intra-system reservoirs with those of in-stream reservoirs may lead to stable operation of the whole water system and fill the gaps in dry years, at least, **half** of observed deviations. Better long-term forecasts, and, first of all, annual forecasts, both climatic and hydrological, are prerequisite for such approach.

4. Shifting from energy (maximal energy generation in autumn-winter) **to energy-irrigation** (maximal generation throughout the year) **mode of operation of the Nurek HPP** will provide growth of annual energy generation for Tajikistan and reduce/prevent water shortages in irrigated agriculture in Turkmenistan and Uzbekistan. Such shift to energy-irrigation mode is feasible in case of organization of seasonal transfers of energy between the countries (within single energy market in CA) to prevent winter energy shortage through summer energy excess.

5. Harvesting positive effects of climate change on plant growth and potential shortening of plant development phases open a broad perspective for revision of production technology and watering depths for various crops. Implementation of such an approach will require better equipping of basin administrations at provincial level with climate stations (approximately one station per 10,000-12,000 ha covering 2-3 WUAs) and with a special extension service for forecasting of water requirements to capture fluctuations in climate and timely inform farmers for appropriate actions to be taken. From experience of implementation of similar service in the Fergana Valley, potential water saving through revision of water use norms and crop irrigation regimes is 12-15 % of net water requirements or approx. 700-800 m^3/ha. Establishment of such extension service even on 200,000 ha of irrigated land may lower required water delivery by **1.4 -1.6 km^3.**

6. Increased use of agricultural wastewater and collector-drainage water is one of simplest and most affordable areas of additional water reserves. Totally, 14 km^3 of return water is formed in the basin. Out of this amount of return water 7.39 km^3 are discharged into lakes and 4.94 km^3 flow into the Amu Darya channel. Thus, at least, about 2 km^3 can be used in their pure form if salinity is less than 2 g/l or in mixture with irrigation water if salinity is more than 2 g/l.

7. Creating a water conservation platform as a means of social movement for survival in the light of imminent water shortage should help to involve widely water users and consumers and, hence, the society as a whole in the efforts aimed to achieve needed, socially perceived and recognized objectives of water saving. Available experience in establishment of Basin community councils comprised of representatives of all user-organizations is to be used as a basis for involvement of large water using entities in planning and control of flow regulation and river water distribution.

8. Enhancing adaptability and effectiveness of the legal and institutional framework of cooperation in the context of climate change and other sensitive factors is critical for peaceful and wise use of Amu Darya water resources in the future. A high degree of adaptability means that it is possible to change rules and procedures to account for new circumstances, data and knowledge and to modify the management methods under changing conditions. Comprehensive and systemic efforts are needed in three directions: (i) improve existing agreements and ensure their enforcement; (ii) take part actively, consciously and competently in lawmaking and law enforcement and avoid behavior that runs counter to norms and principles of international law; (iii) increase legal awareness and legal culture. If those efforts are successfully made, the effectiveness of legal regulation in the Amu Darya Basin will be actually judged from formation of legal relations that allow for evolutionarily development and improvement of legal framework in response to changing needs and circumstances rather than from the total quantity of signed agreements, protocols and declarations.

Project "Transboundary water management adaptation in the Amudarya basin to climate change uncertainties“

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