Improvement of water resources management in Syrdarya basin

Cite as: AIP Conference Proceedings **2612**, 020007 (2023); https://doi.org/10.1063/5.0125343
Published Online: 15 March 2023

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Improvement of Water Resources Management in Syrdarya Basin

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Abstract. The paper describes the status of Syrdarya river basin water management. The problems related to the transboundary character of Syrdarya are analysed. Ways of further development in water resources are proposed. Syrdarya was formed by the merger of Naryn and Karadarya in the Fergana region. The average annual flow of the Syrdarya basin is 38.8 cub. km, with the probability of high-water and low-water years (5% and 95% probability), the flow is 54 and 21 cubic km, respectively. The water resources of the Syrdarya are formed by melting snow and glaciers. About 80% of the flow is formed in the period from March to September. For centuries, the peoples inhabiting the Syrdarya river basin have traditionally been engaged in farming, for the needs of which small-scale irrigation systems were created. These systems, as a rule, included in their structure water intake from a river, the main canal of the short extent, and several outlets to the fields. Their operation did not cause serious damage to the environment, was quite effective since the natural flow regime of the Syrdarya river completely coincided with the vegetative regime of crops.

INTRODUCTION

In the Soviet period, the traditional system was replaced by large-scale water management systems, the planning, and management of which was carried out centrally. Beginning in 1939, the goal was to build engineering water intakes on the Naryn, Karadarya, and Syrdarya rivers and a network of canals connecting the basins of the Syrdarya tributaries and simultaneously equalizing the water availability of all irrigated land. The Great Fergana, Northern Fergana, Great Namangan channels, the Sawai channel, the name of Akhunbabaev, and others were built. As a result of the work done, the area of irrigated land in the Fergana region amounted to 1 375.9 thousand hectares in 2000 or more than twice the area of 1930 (675 thousand hectares). In this regard, starting from 1970, the natural hydrological regime of rivers ceased to meet the increased irrigation needs, and there was a need to regulate flow. To this end, a reservoir system was constructed in the Syrdarya basin: Toktogul, Kayrakkum, Chardara, Charvak, Andijan, and other reservoirs with 34.5 billion cubic meters. (useful capacity of all reservoirs 24.1 billion cubic meters). The cascade of reservoirs, sharply violating the natural regime of the Syrdarya River, at the same time made it possible to increase the irrigated area of the Union republics of the Central Asian region [1–4]. From the middle of 1970, with almost complete overregulation (93%) of the Syrdarya runoff, water deficit appeared in dry years. To optimize the management of the water sector, a project was developed for the Automated Water Resources Management System (the Syrdarya automated project control system) of the Naryn, Karadarya, Chirchik, and Syrdarya rivers with reservoirs, large river waterworks, and water intake facilities[5–10].

The Syrdarya River is an example of a transboundary basin with conflicting requirements for water use between its upstream and downstream. Since the winter of 1992–1993, the operation mode of the upper Toktogul reservoir on the Naryn River - the main tributary of the Syr Darya - switched from irrigation to a hydropower regime. This significantly increased winter runoff and reduced summer runoff downstream of the reservoir. As a result, the Syrdarya basin water users - Tajikistan, Uzbekistan, and Kazakhstan have experienced water shortages during the growing season. A lot of scientific research has been done to solve this problem. For example, A. Karimov's and et al. [11]. Made a scientific Water 'banking' in Fergana valley aquifers-A solution to water allocation in the Syrdarya river basin? The article proposes collecting a certain amount of water flowing in the Syrdarya in the winter in the

The Third International Scientific Conference Construction Mechanics, Hydraulics and Water Resources Engineering (CONMECHYDRO 2021 AS)
AIP Conf. Proc. 2612, 020007-1–020007-5; https://doi.org/10.1063/5.0125343
Published by AIP Publishing. 978-0-7354-4337-2/$30.00

Fergana Valley reservoirs and using them during the growing season. A.Sorg and et al. [12] researched How to Cope with Changing Water Resources in the Syrdarya Basin in Central Asia. The article highlights the number of water shortages in the region during the growing season and the damage it causes to agriculture in connection with the transition of transboundary waters in the Syrdarya basin to hydropower. V.A. Dukhovny and et al. [13] researched Integrated Water Resources Management in Central Asia as a way of survival in conditions of water scarcity. The article devoted to the distribution of transboundary water resources of the Syrdarya, which contains proposals that take into account the interests of all republics located in the region. Besides, several researchers have also dealt with the problems in the distribution of transboundary water resources in the Syrdarya.

METHODOLOGY

The implementation of the first stage of the automated system of water management complex of the river Syrdarya basin began in the middle 1980 years. It was interrupted due to the collapse of the USSR. Under this Project, in particular, a dispatching automated complex was organized in Tashkent and dispatch centers in the territorial offices in Andijan, Khujand, Chirchik, and Gulistan. The automated complex in 1987 changed to Water Resources Management of Syrdarya river (Water Management "Syrdarya") with the responsibility to control water withdrawals from the river basin to the channels of the republics. Water management was supposed to help reduce water shortages that occurred at that time in the southern regions of the Republic of Kazakhstan and eliminate obstacles when running water to the lower reaches of the Syrdarya and the Aral Sea.

But the effectiveness of Water Resources Management was insignificant because, often, the control functions, when it was impossible to influence the work of the facilities under the jurisdiction of the Union republics, did not allow for the timely detection of deficiencies. Therefore, in early 1988, with the consent of all the region's republics, the Syrdarya Basin Water Organization was established (Fig. 1). 198 buildings were transferred to Basin Water-Management Association. These 21 water intake facilities are directly located on the main trunk of the Naryn, Karadarya, Chirchik, and Syrdarya rivers (from Toktogul to the Chardara reservoir over 650 km) and 151 water intake facilities on the inter-republic Dustlik channels and the Great Fergana cannel [7,14–16].

The association was supposed to operate these facilities, ensure water supply to water-consuming states following approved water withdrawal limits, carry out justification, design, and implementation of the Naryn-Syrdarya cascade of reservoirs, as well as run water to the Republic of Kazakhstan or ensure a well-known inflow volume to the Chardara reservoir. In the very first years of the operation of the Basin Water-Management Association "Syrdarya", it was able to restore order in water allocation, limiting the volumes of water taken in and accounting for river water [17].

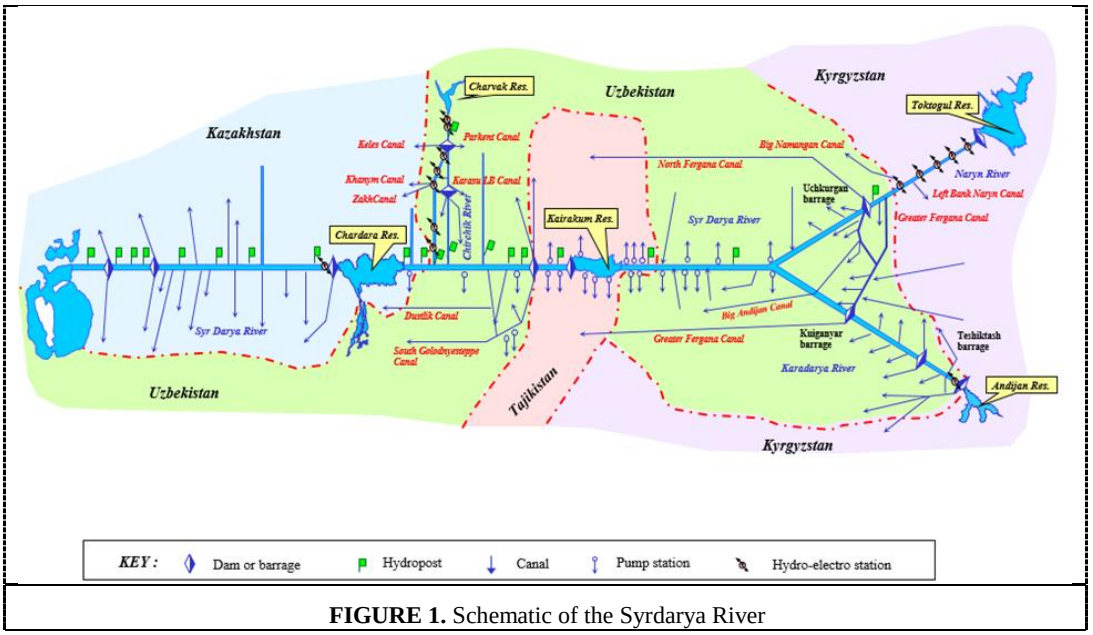

FIGURE 1. Schematic of the Syrdarya River

As a result, a noticeable increase in the efficiency of transboundary water management in the basin was noted. With the operational management level of the river basin's water increasing above all, the Naryn-Syrdarya cascade of reservoirs became more regular. Water users' republics regularly received volumes of water provided for by water intake limits. The required inflow to the Chardara reservoir was ensured, and thanks to the measures taken by the Association, in 1988-1989, water losses in the amount of about one cubic meter were reduced.

After the collapse of the Soviet Union on February 18, 1992, the Agreement of the Central Asian states of the region was signed. The Interstate Coordination Commission was created, which entrusted with managing the water resources of the Aral basin. Basin Water-Management Association "Syrdarya" became one of the executive bodies of the Interstate Coordination Commission. Despite this, in the new conditions of the formation of independent states, the issues of rational use of the water and energy resources of the Syrdarya River in all sectors of the economy, as it was carried out within the framework of a single state, became much more complicated. The fact is that the differences in the current priorities of the economic development of the region's states have formed contradictions of interests regarding the schedule for passing water from the Toktogul reservoir. Kazakhstan and Uzbekistan are interested in the irrigation regime of the reservoir. Kyrgyzstan and partly Tajikistan - in the energy sector. In this regard, starting from 1993, the Toktogul cascade operation mode changed in the direction of a sharp increase in water accumulation in the summer and releases in the winter period in the interests of hydropower production by Kyrgyzstan. For example, releases from the Toktogul reservoir before 1991 averaged 3.53 km^3 in winter, in the summer - 7.93 km^3 after 1992, the corresponding values are 7.59 and 5.73 km^3[18–20].

By that time, the Basin Water-Management Association had lost some of its powers: the ability to set the operating mode of the Naryn-Syrdarya reservoir cascade; control water intakes to channels located in Kyrgyzstan (non-destructive testing laboratory, on-board navigation complex, pumping stations on the Naryn River). Between the republics began to arise friction and mutual reproaches in the shortage of water during the growing season, especially aggravated in some years (1995, 1999, and 2000). This is connected with low water and the shortfall in interstate agreements on compensatory energy supplies to Kyrgyzstan. Naturally, disputes and contradictions lay mainly on the Basin Water-Management Association of Syrdarya River [7,9,16,21].

To get out of this situation, the efforts of the Basin Water-Management Association of Syrdarya River were focused on upgrading the infrastructure in the direction of improving the means of water accounting and control (monitoring), as well as creating a management information base using modern technologies[22–24].

The measures taken to establish water accounting led to the fact that in 2001 the water intake from the Naryn, Karadarya, Syrdarya, and Chirchik rivers was controlled by 430 points, including 187 on the Basin Water-Management Association balance, 243 which 157 are temporary pumping stations and 49 stationary pumping stations.

The measures taken made it possible to significantly increase the amount of information necessary for management, which, in turn, required an expansion of its storage and processing base. Until 1991, all incoming information was processed on an EC-1045 electronic computer, which required a lot of manual labour and time for its maintenance and preliminary data processing. With the transition in 1992 to the use of personal computers, it became possible to reduce these costs and raise the management process to a new qualitative level.

An important link in water basin management in the basin was the BWM Syrdarya information database, developed and implemented with the support of USAID, containing complete information on the availability and use of water resources over many years. The basis of the information in it is the actual data on daily expenses and water levels for all hydraulic structures and water volumes in the reservoirs of the Naryn-Syrdarya cascade. The natural inflow to the three reservoirs of the Naryn-Syrdarya cascade has been presented along the Toktogul reservoir since 1911, Andijan since 1925, and Charvak (along three rivers) since 1932. The lateral inflow to the trunk of the Syrdarya and its main tributaries has been taken into account since 1948. Information is replenished regularly as the central control room of the BWO in Tashkent receives operational data from the field during the day.

DISCUSSION

The structure of the BWM of Syrdarya Database is represented by the following main blocks:

1. Regulatory and reference block including passport data on structures and channels, regulatory data, and inflow forecasts;
2. Dispatch unit with a cipher log of structures, daily data on the hydraulic mode of objects, certificates of water intake, cumulative list, and functions of multi-year data processing and the dynamics of their change.

3. Analysing unit for tracking the implementation of water withdrawal limits, water balances, making forecasts for water resources management;

4. Archive block, which stores all the long-term information on the water intake republics.

The base allows:

- track current information on water supply both in the republics as a whole and in individual structures and channels, automatically comparing it with the established limits;
- in the shortest time to make calculations of the local channel and general water balances for any interesting interval of time;
- quickly identify the reasons for the discrepancy in the balance and take appropriate management decisions to eliminate deviations in water supply schedules;
- document received information in tabular and graphical form.

The next step in improving the information system was the development of a special database program, "Forecast of the Naryn-Syrdarya reservoir cascade," for calculating the work of reservoirs based on the approved limits and established limits. To calculate the forecast, it is enough to set the initial conditions - year, period of the year, limits, set the recommended data and restrictions, and then, by pressing only one button, almost instantly get interesting results in the form of a table or report.

At the same time, the efficiency of water distribution increases, and higher accuracy of water supply and water accounting efficiency are achieved compared to the traditional "manual" methods used. Considering that, as a rule, the objects of management - waterworks and water outlets are removed at significant distances from control rooms, which makes them difficult to manage, the implementation of these projects significantly improves the quality and efficiency of the water allocation process between the republics. In addition, water accounting, based on modern electronic means of receiving, storing, and transmitting information, virtually eliminates doubts about the accuracy of water sharing among water users' water management organizations.

From 2000 to 2004, with technical assistance from foreign donors, BWM Syrdarya rendered significant assistance in introducing advanced world technologies in the water sector. Automated head structures of the Dustlik cannel (Canadian engineering company UMA), SGC and Yukorichirchik waterworks (American Agency USAID), Uchkurgan waterworks (Swiss International Agency), Kuyganyarskiy waterworks, and others. The introduction of these systems greatly facilitates the work of operational personnel in managing the gates of structures, regulating water levels and flow rates. It contributes to improving the accuracy of water accounting according to both gauging stations and control algorithms for opening gates and water pressure.

CONCLUSIONS

Reliable water metering in channels, rivers, water intake structures, large waterworks, and transboundary gauging stations is the basis for quality water management. For its organization, it is planned to equip it with modern means of monitoring and transmitting hydrometric information to control stations in the field and the BWM of Syrdarya for several hydraulic structures and several pumping stations. It should be noted that the mere replacement of equipment, both at cross-border posts and at points of internal water accounting, solves only a part of the problems. BWM "Syrdarya", which is essentially an international organization, does not have access to information from hydrometric transboundary posts in real time. This, in turn, does not allow for the prompt and effective management of water resources. Therefore, the priority work outlines the organization of this monitoring in conjunction with the automation of individual hydraulic structures.

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