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Water Balance of the Republic of Uzbekistan Under Conditions of Water Scarcity: Problems and Solutions

Rustam Karshiev¹, Sobir Eshev^{2, a)}, Khurshid Makhmudov³, Umidullo Makhmudov², Alibek Eshev², and Alisher Hazratov²

¹Ministry of Water Resources of the Republic of Uzbekistan, Tashkent, Uzbekistan

²Karshi Engineering Economics Institute, Karshi, Uzbekistan

³Research Institute of Irrigation and Water Problems, Tashkent, Uzbekistan

^{a)}Corresponding author: shakhboz2016@mail.ru

Abstract. Uzbekistan has a severe water shortage issue as a result of the country's rapid economic growth and population rise. Water shortage is mostly caused by inadequate water management, unsustainable water usage in industry and agriculture, and climate change. The annual population growth across the republic, while maintaining the current level of water consumption per capita, leads to a continuous increase in the additional demand for water resources by municipal services. With the current level of water consumption per capita, the annual additional demand for water resources by municipal services increases by 16-20 mln.m³. The development of the industry is also expected to lead to an increase in the demand of this sector. To solve the problem of water scarcity in Uzbekistan, it is necessary to develop comprehensive measures that include improving water resource management, introducing effective technologies in agriculture and industry, increasing public awareness about the rational use of water and promoting international cooperation in the field of water resource management. The above-mentioned data allowed to compile a water balance for the sectors of the national economy of the Republic of Uzbekistan for various scenarios of water supply, with the presence of problems being the subject of research in this study.

Keywords: Water balance, water deficit, water resources, annual limit, water saving, natural ecosystems, main water consumer.

INTRODUCTION

In the Republic of Uzbekistan, one of the main priorities of public policy at all stages of economic reforms is to provide reliable guarantees and measures for the social protection of the population and the environment. Following the chosen course, the Government is focusing on deepening economic reforms through liberalization of this sphere, institutional transformation, development of APP, expansion of rights and economic autonomy of agricultural producers. Society is already aware of the need for radical action to address water problems and mitigate water shortages. There is a rethinking of water management principles and the search for acceptable and adequate measures to overcome established stereotypes in the management of natural resources. It is noteworthy that it is the low water of recent years, when the value of water is felt very acute, forcing everyone to think about what he can do personally to improve the situation, in many ways has ensured a return to the tradition of caring for water. Government programs and planned measures in the field of water management and environmental protection are not confined to the national framework. They envisage integration into regional cooperation strategies, strengthening mutually beneficial partnerships in the joint management of water and energy resources in the Aral Sea basin, taking into account domestic and foreign experiences [1, 3].

The changes to come by 2050 could be significant as a result of increased food production to meet the needs of an increasing population (9 billion), as well as the reduction in the sustainability of natural ecosystems. On continents, the demand for water for food (through irrigation development or improved beech production) is expected to more than triple in Africa and more than double in Asia. The changes may also extend to industrialized countries, which are expected to be able to engage in virtual water exports, i.e. produce more products for export to developing countries with water shortages. The extent to which future water needs will be met through the development of irrigation or the crop-by-crop system, the expansion of arable land or the increase in virtual water for imported products will vary significantly from region to region on the planet. Estimates of increasing water needs to feed the world's population clearly show the scale of future challenges of integrated management of water and land resources and ecosystems and

the need to be well prepared for "living in a changing world". In order for humanity to adapt to changing conditions, it is necessary to consider the dynamics of natural processes simultaneously with social, interacting with the environment, for example, the joint evolution of social and ecological processes. It has been found that human reactions to habitat change are less pronounced than those of other living species, and society must be aware of the changes before it consciously responds to them [4,5,6,7].

Agriculture in the Central African countries is the main consumer of water. Agriculture occupies 73.5% of the territory of the region. According to the report, in 2020, 79% of the water in Central Asia was spent on irrigation. Irrigation farming remains not only the basis of agriculture, but also the basis for the region's food security [8,9,10].

"Fertilized land accounts for almost 66% of gross agricultural output in value terms: about 100% in Turkmenistan, 87% in Uzbekistan, 85% in Kyrgyzstan, 82% in Tajikistan and 40% in Kazakhstan. The solution to the problem of water shortage and efficiency of water use in the region should be sought primarily in irrigation," experts of the Eurasian Development Bank believe.

MATERIALS AND METHODS

Meanwhile, Central Asia is losing its irrigation potential because of the high-water burden. This was also pointed out by the President of RU Shavkat Mirziyoyev in September 2020 at the meeting of the Council of Heads of State founders of the International Rescue Fund for Aral in Dushanbe. The Head of Uzbekistan noted that in some regions of Central Asia by 2040 the burden on water resources will triple. Moreover, the economic damage is already felt: according to the UN, the countries of the region lose up to \$2 billion annually due to the shortage and inefficient use of water resources.

To preserve the potential of irrigated land, to ensure food and water security in the region will help only the transition to water conservation. This is due not only to climate change and rising water requirements, but also to the expected decrease in the flow of Amudarya from Afghanistan.

Afghanistan, with the help of international donors and consultants, has prepared projects for the construction of new GHGs and large irrigation systems. The largest of these is the construction of the Kosh-Tepa Canal on the Punjab River (fusing with the Vakhsh River, forming Amudarya), which began in 2022, the report clarifies [15,16,17,18].

It is expected that the drainage of water from Panja up to 10 cubic kilometers will affect the interests of Uzbekistan. Experts predict that this will result in an uncoverable water shortage in the Upper Panja in the middle and lower Amudarya. This, in turn, "will cause water stress for all sectors of the economy of Uzbekistan".

According to experts, the Kosh-Tepa canal threatens to violate the existing water management arrangements and agreements on the sharing of water resources between the countries of the Central African Republic. They specify that, in particular, Uzbekistan is at risk of losing the sustainability of agriculture and related sectors of the economy, including foreign economic activities.

Uzbekistan is ranked in the top 30 countries with high water stress, ranking 25th out of 164 countries. According to experts, the shortage of fresh water in Uzbekistan by 2030 can reach 7 billion cubic meters - this is the volume of four Charvak reservoirs or almost two Tuzkan lakes. The deficit will double by 2050 [14,15]

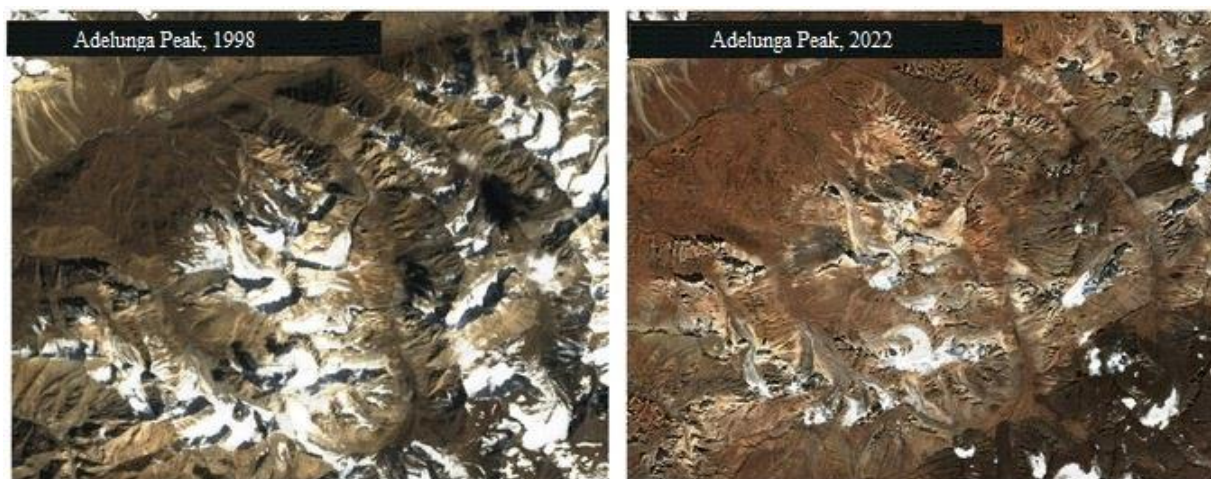


FIGURE 1. Glaciers at the Peak of Adelunga, 4301 m.

Due to climate and anthropogenic changes over the last 50 years, the country's key rivers, Sirdarya and Amudarya, have lost 20% of their volume. This leads to dust storms and droughts, which exacerbate the problem of water shortages [2,11,12,13].

When the average temperature rises by 2 °C, Uzbekistan's ice reserves will decrease by 50%, and when the temperature increases by 4 °C – by 78%. By 2100, the average temperature in the region is expected to rise by 5-6 °C.

To demand an increase in the volume of water flowing into Uzbekistan at the expense of other countries is little prospective. Water is limited worldwide, and climate factors affect other countries just as much as we do.

The main consumer of fresh water in the country is the agricultural sector, which accounts for 90% of the volume of water used. At the same time, the agricultural sector is one of the leading in the economy of Uzbekistan. In 2019, its contribution to the country's GDP was around 28%.

RESULTS AND DISCUSSIONS

A year ago, the government approved measures to ensure the irrigation of crops in the event of expected water shortages, setting a limit for water consumption of 28.2 billion cubic meters per month from April to September. However, monitoring of water consumption efficiency in agriculture has not been achieved.

For agriculture, an annual limit of water intake from sources has been set at 55 km³/year. With the transition to limited water use over the past ten years in the republic, the total water intake per one complex hectare has decreased from 13 thousand m³/ha to 10.4-12.2 thousand m³/ha, including during the growing season from 10.7-11 thousand m³/ha to 8.8-9.6 thousand m³/ha, while in the non-growing season it averaged between 2.4-2.7 thousand m³/ha.

The annual limit of the communal and domestic sector of the economy is 2.65 billion m³, which is 4.35% of the total water consumption in the republic. Centralized water supply for urban population on average in the republic is 85.9%, and for rural population - 61.9%. The actual average daily water consumption per capita is 137 and 75 liters respectively.

At the same time, due to the low level of technical condition and the use of capacities of the water supply network, losses in this system on average throughout the republic amount to about 24.9%.

The total annual water intake limit for fish farms with artificial ponds is 0.6 billion m³, of which 30-32% is fresh water. The main volume of water consumption by fish farms is accounted for by natural water bodies, such as the Arnasay depression, the Aral Sea region, and others. For the sustainable development of fish farming and environmental protection in the Arnasay depression, it is necessary to supply about 1.5 billion m³ of water annually, and for the Aral Sea region - 3 billion m³ of fresh water.

For the technical water supply of thermal power plants, a water limit of 4.1 billion m³ is provided, of which the volume of irrecoverable water losses is 0.153 billion m³ or 4% of the water consumption volume of the energy sector.

In the republic, there are about 400 industrial and other enterprises and organizations with a total annual limit of 0.9 billion m³. At the same time, the volume of wastewater discharge from industrial facilities is over 0.45 billion m³. Due to the imperfections of the water treatment system in industrial enterprises, around 0.172 billion m³ of polluted wastewater are discharged into open sources.

The annual population growth in the republic averages 350,000 people. With the current level of water consumption per capita maintained, the annual additional demand for communal services on water resources increases by 16-20 million m³. Due to the development of the industry, an increase in the demand of this sector is also expected. The growth in water consumption of these sectors should primarily be covered by reducing operational losses in these sectors, as well as reducing the limit of water intake by agriculture.

The above-mentioned data allowed to compile a water balance (Fig. 2 and 3) for the sectors of the national economy of the Republic of Uzbekistan under various scenarios of water supply.

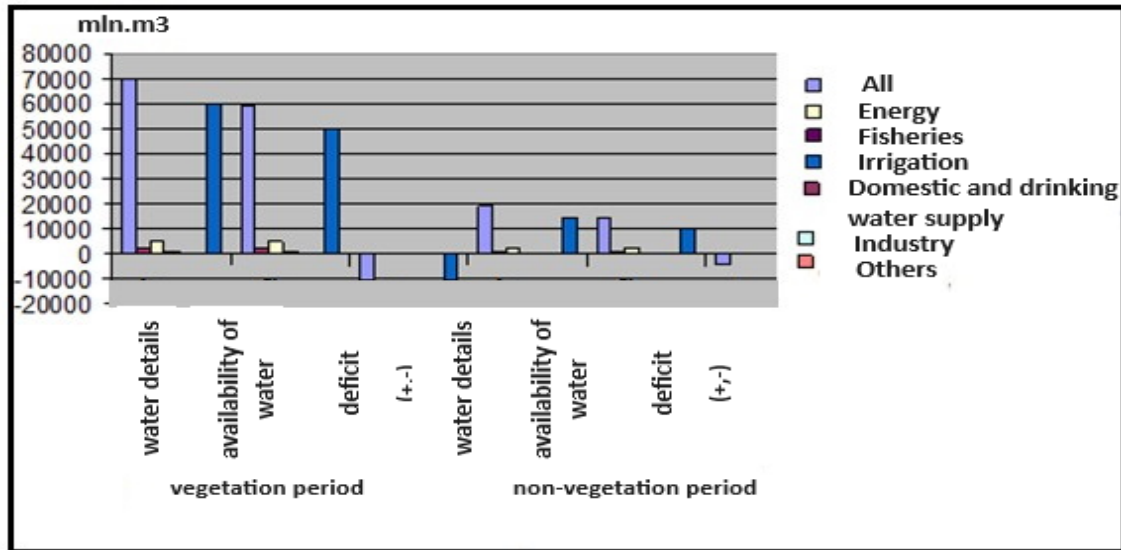


FIGURE 2. Water balance by sectors of the national economy of the Republic of Uzbekistan, million m³ with 100% water resources limit coverage.

The water balance gives reason to believe that with the preservation of existing equipment, technologies, and management organization for the use of water resources by the sectors of the economy of the country, even with the availability of water resources at 100% of the limit (fig.2.), a deficit of water resources will be felt within the range of up to 10 km³ per year.

If the provision reaches 80% (fig.3.), the water resources deficit for the country's economy will reach up to 14 km³ per year. According to the calculations of the Ministry of Water Resources and Agriculture, under the conditions of maintaining the efficiency of water management systems and irrigation networks, to meet the biological needs of agricultural crops, as well as the demand of other sectors of the economy, the water resources requirements for the republic amount to about 69.4 billion m³, including 59.9 billion m³ for agriculture. Based on the above, in the case of water availability at 80% of the water resources limit (59.3 billion m³), a water deficit of up to 14.3 billion m³ can occur, and with 100% water availability, a water deficit of 10.1 billion m³ is expected, while irrigation of agricultural crops on irrigated lands may decrease.

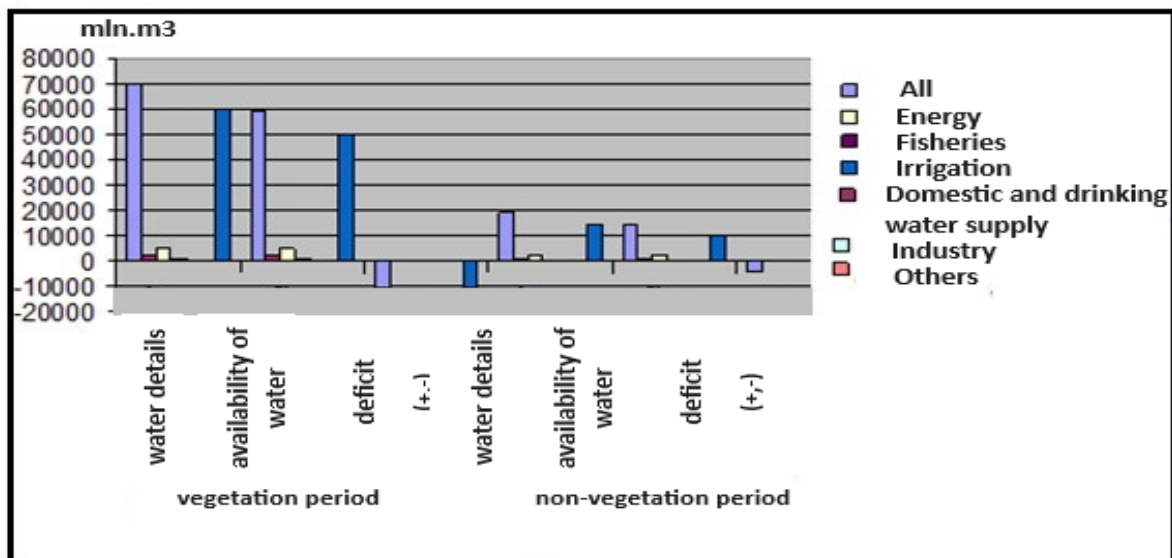


FIGURE 3. Water balance by sectors of the national economy of the Republic of Uzbekistan, million m³ with water resource limit coverage at 80% and below, low-water year.

Agriculture. Annual water intake limit of 55 km³ per year has been set for agriculture. With the transition to limited water use over the past decade in the republic, the total water intake per one integrated hectare has decreased from 13 thousand m³/ha to 10.4-12.2 thousand m³/ha, including during the growing season from 10.7-11 thousand m³/ha to 8.8-9.6 thousand m³/ha, while during the non-growing season it averaged between 2.4-2.7 thousand m³/ha.

The annual limit of the communal and domestic sector of the economy is equal to 2.65 billion m³, which is 4.35% of the total water consumption in the republic. Centralized water supply for urban population on average in the republic is 85.9%, and for rural population - 61.9%, the actual average daily water consumption per capita is 137 and 75 liters respectively.

At the same time, due to the low level of technical condition and the use of capacities of the water supply network, losses in this system average about 24.9% across the republic.

The total annual water intake limit for fish farms with artificial ponds is 0.6 billion m³, of which 30-32% is freshwater. The main volume of water consumption for fish farms is from natural water bodies, such as the Arnasay depression, the Aral Sea region, etc. Sustainable development of fish farming and environmental protection in the Arnasay depression requires an annual supply of about 1.5 billion m³, and for the Aral Sea region - 3 billion m³ of freshwater.

For technical water supply of thermal power plants, a water limit of 4.1 billion m³ is provided, including a volume of non-recoverable water losses of 0.153 billion m³, which is 4% of the energy industry's water consumption volume.

In connection with the development of the industry, an increase in the demand of this sector is also expected. There are about 400 industrial and other enterprises and organizations in the republic, with a total annual limit of 0.9 billion m³. At the same time, the volume of wastewater from industrial facilities is over 0.45 billion m³. Due to the imperfection of the water treatment system in industrial enterprises, about 0.172 billion m³ of polluted wastewater are discharged into open sources.

Maintaining today's level of water consumption per capita, the annual additional demand for water resources by the utilities due to a four percent increase in population is 16-20 million m³.

In order to maintain the efficiency of water management systems and irrigation networks, to meet the biological needs of agricultural crops, as well as the demand of other sectors of the economy, the water resource requirement in the republic is estimated at about 69.4 billion m³, including 59.9 billion m³ for agriculture.

CONCLUSIONS

The water balance gives reason to believe that even with the preservation of existing equipment, technologies, and management organization of water resource use by the country's economy, a water resource deficit will be felt within the range of up to 10 km³/year with 100% water resource limit, and if the availability is 80%, the water resource deficit for the country's economy will reach up to 14 km³/year of water.

The solution to the problem of water resource scarcity is water conservation not only in irrigated agriculture, but also in all sectors of the country's economy.

In addressing existing problems, it is proposed to use international experience. First and foremost, irrigation infrastructure needs to be upgraded by attracting investment (including public-private partnerships) and water-saving technologies to be applied everywhere. According to the experts of EABD, all this will enable the countries of Central Asia not only to provide basic food products to their own market, but also to expand the export of food goods.

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