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Financial Flow Assessment for Water Supply Optimization in Uzbekistan under Climate Change

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Abstract. The aim of the research was to study the state of the quality of drinking water, drinking water reservoirs over a long-term period to assess the necessary funding to optimize water supply to the population and protect water bodies in Uzbekistan in the face of climate change. The dynamics of the long-term state of water supply systems in a number of regions of the republic is characterized as unfavorable for the health of the population. Over the past ten years, the quality of drinking water has deteriorated by 1.2-10.6% in terms of chemical indicators, and for microbiological indicators - by 0.4-8.9%. Indicators of chemical pollution of water in reservoirs decreased by 11.9-19.8% in Khorezm, Surkhandarya, Andijan and Fergana regions. Water pollution levels increased by 11.9-18.6% in Karakalpakstan, Namangan and Kashkadarya regions. The hygienic state of drinking water supply sources in all regions of the republic is unfavorable due to the fact that the water quality in them does not meet the requirements of the republican standard for centralized drinking water supply sources. Studies have shown that for the base period the amount of financial costs for improving the conditions of drinking water use of the population and the protection of drinking water bodies will amount to 4 286.2 billion sums, and for the adaptation period - 7 665.1 billion sums.

Key words: drinking water, waste water, surface water bodies, water use, population, financial flows, water quality, baseline scenario, adaptation scenario, climate change, water supply optimization.

Introduction. The Republic of Uzbekistan has two large rivers - the Amu Darya in the south and the Syr Darya in the north, which together form the Aral Sea basin. The Amu Darya basin is the main one because provides water resources for 86% of the entire territory of the republic, through which the tributaries of the Surkhandarya, Kashkadarya and Zerafshan flow, originating in Tajikistan [20].

The average annual discharge of the Amu Darya river basin is 78 km3, and depends on the availability of precipitation in the year. About 4.7 km3 or 6% of the total surface resources of rivers is formed from the annual resources on the territory of Uzbekistan [15].

The Syrdarya River covers 14% of the territory of the Republic. The upper course in the Republic of Kyrgyzstan, where the main part of the stream is formed, the middle course in Uzbekistan and Tajikistan, the lower course in Kazakhstan, followed by the flow into the Aral Sea [14,17].

The main streams of the Syrdarya basin are the Karadarya, Naryn, Chirchik and Akhangaran rivers. The average annual water discharge in the Syrdarya river basin is 37 km3 and depends on the water content of the year. About 5 km3 or 13% of the total surface resources of the river are formed from the annual resources on the territory of Uzbekistan [4,5].

The distribution of water resources is controlled by the Interstate Coordination Committee located in Tashkent, which was established by the governments of 5 states (Uzbekistan, Kazakhstan, Tajikistan, Kyrgyzstan and Turkmenistan). The Committee coordinates and monitors compliance with bilateral interstate agreements. In accordance with these agreements, Uzbekistan receives water from

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transboundary rivers originating in Tajikistan and Kyrgyzstan, and also passes transit waters for Kazakhstan, Tajikistan and Turkmenistan [12].

As you know, water resources are a continuous component of industrial and agricultural production, an important means for creating normal conditions and maintaining human health [17, 18]. In Uzbekistan, there are enterprises of the chemical, mining, metallurgical and agricultural industries [19].

On the one hand, stable and safe water supply in Uzbekistan is necessary for the socio-economic development of society, the national economy, industry, agricultural production, meeting the needs of the population for drinking water, food, energy and recreation. On the other hand, the water bodies of the Syrdarya and Amu Darya river basins are the only sources of household, drinking and industrial water supply in this region [13].

These studies are of particular relevance in connection with the solution of one of the most important economic problems - the further development of agro-industrial regions in the republic, accompanied by an intensification of the use of water resources, which can cause negative changes associated with the limitation of the conditions for water use of the population [9].

In recent years, few studies have been carried out characterizing the state of protection of drinking water bodies in Uzbekistan [2,3,4]. Works devoted to the state of centralized water supply to the population were carried out mainly in the basin of the middle reaches of the Syrdarya river [6,7,8].

The purpose of these studies was to study the quality of drinking water, drinking water reservoirs over a long-term period and assess financial flows to optimize water supply to the population in Uzbekistan in the face of climate change.

Material and research methods. Research methods included collection of fund materials on the quality of drinking water and sources of water supply to the population in Uzbekistan in the context of regions for a retrospective period. The quality of drinking water and water supply sources were assessed in accordance with GOST 950: 2011 “Drinking water. Hygienic requirements and quality control "and GOST 951: 2011" Sources of centralized household drinking water supply. Hygienic, technical requirements and selection rules ".

Basic scenario - takes into account the fact that the natural sources of water supply for the industry, population and agriculture of Uzbekistan is a national property that plays a large role in the socio-economic development of the republic. However, due to various conditions, such as the current economic situation of the republic, the state of the international food market, the state of agriculture, population growth, the development of free economic zones, the construction of agricultural and industrial enterprises, this program for the development of water supply in the republic is often adjusted. When adjusting the program, priority measures are established, and usually, the condition for maintaining the average level of development of the water management complex is accepted. The last revised plan is 100% financed from the budget of the republic and is always implemented in full. This circumstance is the basis for the baseline scenario. Therefore, the methodological approach of the baseline scenario until 2025 is based on the average indicators of the development of the “Drinking water and natural sources of water supply” industry. Thus, the scale and growth rates of investment, financial investments and operating expenses until 2025 will grow in the same dynamics as in the historical period 2006-2014.

Adaptation scenario takes into account the position at which there is a change in the Earth's climate in the direction of its increase. At the same time, the shortage of water resources is increasing. The number of the population in Uzbekistan is also growing. Uzbekistan has no additional sources of surface water. In such conditions, providing the population with safe drinking water, optimizing natural sources of water supply, efficient functioning of centralized water supply systems, improving water use conditions and providing the national economy of Uzbekistan with sufficient water resources, are important economic tasks that require cardinal efforts from the state. As part of this work, we calculated a

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possible shortage of water resources in connection with climate change in Uzbekistan and proposed possible adaptation measures to cover this deficit. This scenario assumes a higher rate of development of the "Drinking water and natural sources of water supply" industry, taking into account climate change. We selected the following indicators: water pipelines, water supply networks, wells, water towers, reservoirs, pumping stations, chlorination plants.

To assess the cost of adaptation measures for the future until 2025, not actual, but required (normative) specific indicators were used. This applies to both investment and operating expenses. Calculations of financial and investment flows to optimize drinking water supply to the population for the expected period were carried out in accordance with the "Methodological guide for assessing investment and financial receipts for solving problems associated with climate change" [10].

Research results. Uzbekistan is the largest state in terms of population in Central Asia. As of 01.01.2020, the population was 33,905,800 thousand people. Most of the population is urban - 17122429 thousand people (50.5%), and rural - 16783371 thousand people (49.5%).

The Republic of Uzbekistan includes the following administrative territories: the Republic of Karakalpakstan and 12 regions with 119 cities, 1085 urban-type settlements, 168 districts and 11012 rural settlements (Table 1).

Table 1 - Administrative units of regions

Regions	**Regional cities**	**districts**	**cities of district subordination**	**villages**
Republic Karakalpakstan	2	14	10	1 128
areas:				
Andijan	2	14	9	456
Bukhara	2	11	9	1 469
Jizzakh	1	12	5	519
Kashkadarya	1	13	11	1 045
Navoinskaya	2	8	4	577
Namangan	1	11	7	403
Samarkand	2	14	9	1 829
Surkhandarya	1	13	7	865
Syrdarya	3	8	2	257
Tashkent	4	14	11	885
Fergana	4	15	5	1 020
Khorezm	1	10	2	559
Tashkent		11		
By Republic, total:	**26**	**168**	**91**	**11012**

The coverage of the population in the republic with centralized water supply systems in 2017 reached approximately 80.2% (Table 2).

The highest percentage of coverage with centralized water supply services was noted in the city of Tashkent (99.5%), as well as in the cities of Samarkand, Fergana and Andijan regions (about 93-98%). The lowest percentage of population coverage in urban areas is observed in Jizzakh region (75%).

As for the rural population, the highest percentage of coverage is noted in the Fergana and Andijan regions (80-87%), and the lowest among the rural population of Bukhara and Khorezm regions (42.4% and 56.8%, respectively), which clearly reflects scarcity of fresh surface and groundwater resources in these two areas. 8910 out of 11012 rural settlements have centralized water supply.

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Table 2 - Coverage of the population with centralized water supply systems (in%)

Regions	as of 01.01.2018			as of 01.01.2019		
	Total	**in urban areas**	**in the countryside**	**Total**	**in urban areas**	**in the countryside**
The Republic of Uzbekistan	**81,4**	**89,9**	**71,1**	**80,2**	**89,3**	**69,3**
Republic of Karakalpakstan *regions:*	67,7	73,3	61,3	66,6	72,0	60,5
Andijan	91,9	94,2	89,6	90,4	93,3	87,2
Bukhara	57,7	83,7	43,4	56,6	82,9	42,4
Jizzakh	70,3	75,8	65,9	68,9	74,9	64,2
Kashkadarya	73,9	86,6	62,9	72,8	85,7	61,7
Navoi	80,1	84,2	73,3	78,7	83,8	70,2
Namangan	77,5	85,4	66,8	76,1	85,0	64,5
Samarkand	86,6	98,1	77,3	85,8	98,1	75,9
Surkhandarya	80,5	84,4	78,1	78,5	83,3	75,5
Syrdarya	82,4	80,0	84,2	81,6	79,7	83,1
Tashkent	78,8	85,2	70,9	77,7	84,8	69,0
Fergana	89,8	94,2	83,3	88,8	93,9	1,5
Khorezm	67,5	83,5	58,2	66,3	82,9	56,8
Tashkent	100,0	100,0	-	99,5	99,5	-

The dynamics of changes in the quality of drinking water in the Republic of Uzbekistan over the past ten years is characterized by the fact that in a number of regions there is a tendency to improve the quality of supplied water by 2017 compared to 2006, and in other regions it is deteriorating. In 2017, compared to 2006, there is a dynamics of deterioration in the quality of drinking water in terms of chemical indicators (Figure 1):

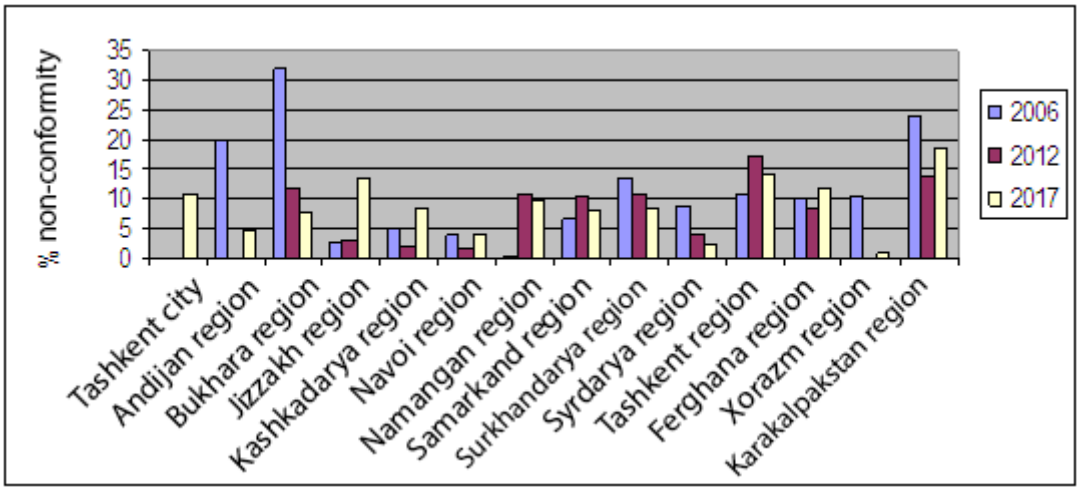

Figure 1 - Dynamics of changes in the quality of drinking water by chemical indicators

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Analysis of the quality of drinking water in the republic for 2006-2017 indicates that the highest level of the percentage of non-compliance with the quality of drinking water in terms of **chemical indicators** was established in Jizzakh region - 10.6%, in Namangan region - 9.4% and in Tashkent region - 3.4%. In the Fergana region, this figure was 1.9%, and in the Samarkand region - 1.2%.

Analysis of long-term water supply materials in the republic showed that by 2017, in some regions of Uzbekistan, the quality of drinking water in terms of **microbiological indicators** deteriorated compared to 2006, while in others it improved. Thus, the deterioration of the quality of drinking water in terms of microbiological indicators in descending order was observed in Surkhandarya region by 8.9%, in Jizzakh region by 3.9%, Fergana region by 1.0%, Syrdarya region by 0.8%, in Kashkadarya and Bukhara region by 0.4%, respectively (Figure 2).

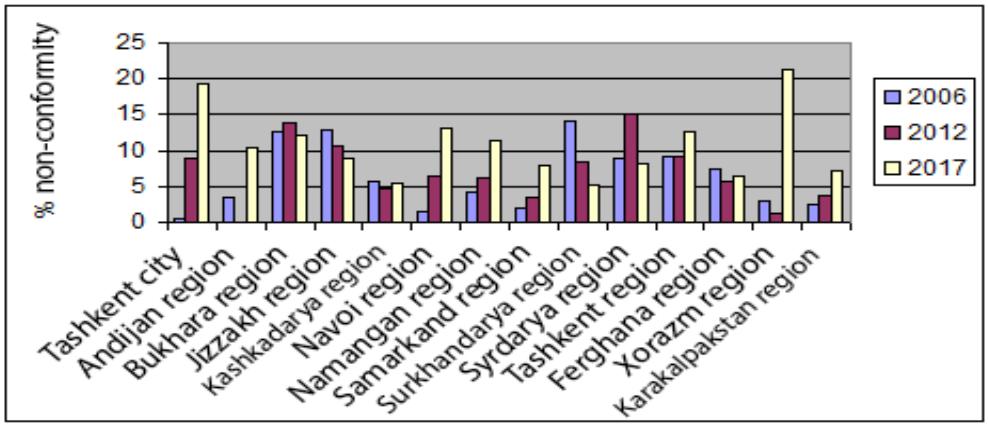

Рисунок 2 - Динамика изменения качества питьевой воды по микробиологическим показателям

Analysis of the current state of drinking water use in the republic in terms of regions in terms of **microbiological indicators** showed that in 2017, an unfavorable situation developed in almost all regions. The minimum deviation of the quality of drinking water in terms of microbiological indicators from sanitary requirements is 5.2%, and the maximum is 21.3%. The average annual indicator for 2017 of bacterial contamination of drinking water in rural water pipelines in the republic is 8.7%.

The improvement in the quality of drinking water in 2017 compared to 2006 in terms of bacteriological indicators in the Khorezm region is 18.3%, in the Navoi region - 11.5%, in the Namangan region - 7.3%, in the Andijan region - 6.8%, in the Samarkand region - 6.0%, in the Republic of Karakalpakstan - 4.8% and in the Tashkent region - 3.6%, respectively.

The analysis of the results obtained for 2017 indicates that the percentage of non-compliance of drinking water quality with chemical indicators, both in urban and rural water pipelines, is the same (9.3%), while the drinking water of the rural population is more contaminated by microbiological indicators. So, if in urban water pipelines the discrepancy in the quality of drinking water is 6.9%, then in rural water pipelines this figure is 8.7%.

The available materials for 2006-2017 were analyzed on the quality of water sources used for household and drinking water supply to the population of the Republic of Uzbekistan in the context of all regions.

It was found that in 2017, compared to 2006, the water quality of water sources in the republic improved in some regions, and, conversely, deteriorated in others. For example, in Khorezm, Surkhandarya, Andijan and Fergana, there is a decrease in the degree of pollution of water sources by **chemical indicators** by 19.8%, 19.7%, 18.2% and 12.0%, respectively (Figure 3).

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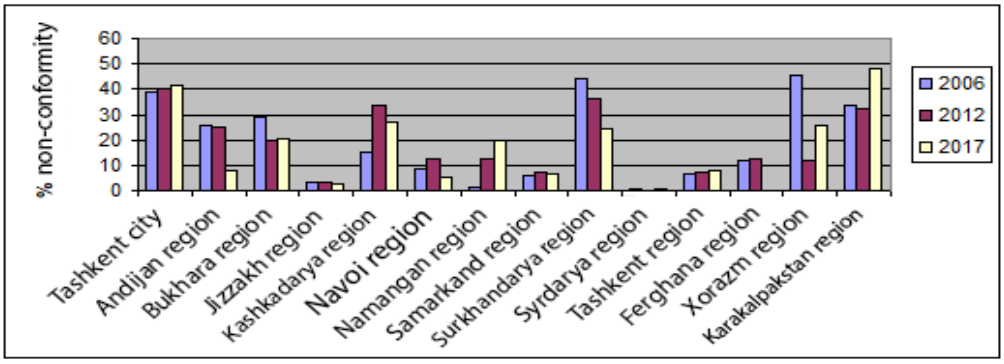

Figure 3 - Water quality of water supply sources by chemical indicators

In the Namangan region, on the contrary, a deterioration in the quality of water of water supply sources in 2017 compared to 2006 was established by 18.6%, and in Kashkadarya and Navoi regions, respectively, by 11.9 and 3.3%.

The dynamics of the water quality of water supply sources in 2017 compared to 2006 is characterized by a decrease in chemical pollution in the Khorezm region by 19.8%, in the Surkhandarya region by 19.7%, in the Andijan region by 18.2% and in the Fergana region by 12. 0%.

At the same time, there is an increase in the degree of chemical pollution of water in the Namangan region (18.6%), the Republic of Karakalpakstan (14.0%), and the Kashkadarya region (11.9%). In the republic, there is a positive trend in reducing the chemical pollution of water (0.6%).

Analysis of materials from the study of water quality of water sources in the regions of the republic in 2017 showed that the percentage of water quality discrepancy in terms of chemical indicators with the requirements is distributed unevenly:

- in the Republic of Karakalpakstan - 47.9%,
- in the Kashchkadarya region 27.1%,
- in the Khorezm region - 25.8%,
- in Surkhandarya region - 24.2%,
- in Bukhara region - 20.7%,
- in Namangan region - 19.9%,
- in the Tashkent region - 8.1%,
- in Andijan region - 7.8,
- in the Samarkand region - 6.4%,
- in Navoi region - 5.6%,
- in Jizzakh region - 2.7%,
- in the Syrdarya region - 0.4%.

Only in Fergana region the quality of water supply sources fully meets the requirements of GOST 951: 2011 “Sources of centralized household drinking water supply. Hygienic, technical requirements and selection rules ”.

The above results indicate that the current state of drinking water supply sources in the republic is of great concern to specialists, since in almost all regions, except for Fergana, water quality does not meet hygienic requirements.

Consequently, the current state of sources of drinking water supply in terms of chemical indicators is characterized by its inconsistency with the requirements in all regions of the republic with the exception of the Fergana region. In the Republic of Karakalpakstan, the inconsistency percentage is 47.9%, and in Kashkadarya and Khorezm regions, 27.1% and 25.8%, respectively. In the republic as a whole, the percentage of non-compliance with water quality standards in terms of chemical indicators of water supply sources in 2017 is 16.8%.

The water quality of water supply sources for the population in Uzbekistan for many years is characterized by a decrease in microbial pollution in 2017 compared to 2006. In the Syrdarya region, the

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improvement in water quality is 14.0%, in the Kashkadarya region - 10.0%, in the Bukhara and Khorezm regions - 6.1%, in the Tashkent region - 5.7%, in the Jizzakh region - 5.0%, in the Samarkand region 4 , 2% and in the Surkhandarya region 4.0% (Figure 4).

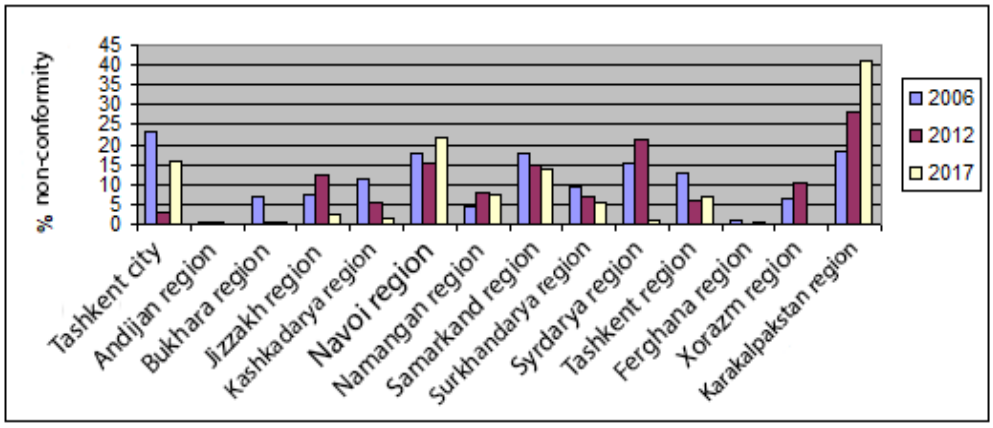

Figure 4 - Water quality of water supply sources according to microbiological indicators

However, in 2017 compared to 2006, there is a deterioration in water quality in terms of microbiological indicators in the Republic of Karakalpakstan by 22.3%, in Navoi region by 4.0% and in Namangan region by 2.9%.

Thus, microbial contamination of drinking water sources over the past ten years has decreased in all regions of the republic with the exception of the Republic of Karakalpakstan, Navoi and Namangan regions. The highest levels of bacterial contamination of water supply sources in 2017 were found in the Republic of Karakalpakstan (40.9%), in the Navoi region (21.6%) and in the Samarkand region (13.8%). The above materials give reason to believe that the state of the sources drinking water supply in all regions of the republic in 2017 is unfavorable due to the fact that the water quality in them does not meet the hygienic requirements.

In this work, for the first time in Uzbekistan, an attempt is made to assess financial revenues, to determine their direction to fully meet the growing needs of the population, agriculture and national economy of the republic with water resources in connection with the expected climate change.

The climatic conditions of Uzbekistan are one of the determining factors in the formation of the hydrological network and have a significant impact on the conditions of water use by the population of them [1].

Uzbekistan is located in the steppe zone and is characterized by a sharply continental arid climate, which is due to the remoteness of the territory from large bodies of water, free available dry air of the deserts of Central Asia in the warm season and moisture-poor Arctic air in the cold half of the year. Winter is short, cold with unstable snow cover, significant wind speeds, last from mid-December to February. Summer is long with high temperatures and dry air.

In the long-term cycle, the amount of precipitation varied within wide limits. Over a long-term period, three peaks were noted when the amount of precipitation exceeded 250 mm. The uneven dynamics of cloudiness has led to a significant duration of sunshine, which averaged 4600 hours per year. The main share of insolation hours falls on the summer months, when its duration reaches 82.2-87.4% of the total duration of the sun's standing over the horizon.

Natural conditions and geographic processes in Uzbekistan are also largely determined by the nature of the relief. Orographically, it is clearly divided into two parts: the large western one, in which the Turanian plain prevails, and the eastern one, occupied by the Tien Shan and Pamir mountain systems. A

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significant part of the plains with different relief lies on average at an altitude of 100-300 m above sea level.

In accordance with the data obtained, it has been established that an increase in the temperature of atmospheric air throughout the territory of Uzbekistan is expected, as well as a decrease in precipitation. However, the rate of change in temperature and precipitation can be different in different years, depending on the duration of the forecast. Calculations show that an increase in temperature by 2025 on the territory of Uzbekistan may average 1.5–20C relative to the base rate [11, 21, 22].

In Uzbekistan, as you know, almost all surface and ground water bodies are used to provide the population with household and drinking water supply, and at the same time, today 72% of the urban and only 61% of the rural population are provided with drinking water. We have selected the following indicator indicators: investment and financial flows for the construction and repair of water pipelines, water supply networks, wells, water towers, reservoirs, pumping stations, chlorination plants and fences.

The relevance of solving problems related to the need to improve drinking water in the Republic of Uzbekistan is also due to the following factors:

-providing the population with centralized water supply systems will actually eliminate the problems of social and environmental tension in the republic;

-more than 20% of water resources are used specifically for industrial and drinking water supply to the population;

-adaptation measures carried out in this industry will make it possible to provide the population with safe drinking water, rationally use natural water resources and reduce the intensive morbidity rates associated with the water factor;

-social and economic development and food security of Uzbekistan largely depends on the ecological state of natural water sources and the quality of drinking water.

Large volumes of capital investments are allocated for the development of water infrastructure: own funds of the Ministry of Housing and Utilities Services, the Ministry of Agriculture, the Ministry of Water Resources, funds from the state budget, the State Monetary Fund, the State Committee on Ecology and Environmental Protection and other state structures of Uzbekistan.

The methodological approach in the baseline scenario is based on the level of the cost growth rate for the period from 2006 to 2014, and on their basis (in the same dynamics) the calculation was carried out until 2025. A feature of the development of the "Drinking water and natural sources of water supply" industry in Uzbekistan is the implementation of all investments from the state budget. This circumstance was taken as the basis for the assumption that in the future this provision will remain unchanged. However, maintaining the investment growth rates until 2025 will not be able to ensure the cost of adaptation measures that guarantee full one hundred percent coverage of the population with centralized domestic drinking water supply systems and safe conditions for water use in the event of predicted climate change.

Based on this, an adaptation scenario was calculated, in which the methodological approach was based on the implementation of specific measures until 2025 that will reduce the negative impact of climate increase on natural sources of water supply and drinking water. This served as the basis for determining the required size of investments and financial flows required for their implementation. In the absence of data on the number of investment and financial flows for some indicator indicators for 2021-2025, we used medium-term forecasting methods.

An analytical description of the dependencies between the variables is performed at the stage of retrospection (historical period), assessment of the current state of the system (base period) and is subsequently used for calculating investment flows for the period of the target scenario (adaptation period).

Historical data on financial flows are presented:

• from the materials of research work (grants) carried out during the historical period;

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• costs for the development of various programs on computers and office equipment;
• expenses for the development of new research methods in the field of protection of water bodies and drinking water;
• business trips made in the near and far abroad during the specified period of time;
• held seminars on drinking water issues;
• advertising and propaganda of literature in the field of protection of water bodies and drinking water use of the population;
• based on expert assessments.

In the last years of the Historical Period, there has been an increase in investment. This situation can be explained by the desire of the government of the republic to improve the conditions for water use of the population and a general increase in the welfare of the republic's economy as a whole. It should be noted that for the entire historical period for the construction of water pipelines, the total cost (in million sums) was 92.5; water supply networks - 40.0; wells - 72.8; water towers - 951; reservoirs - 59.7; pumping stations - 51.1; chlorination plants - 88.2. The total amount of financial receipts for the entire "historical period" is 499.4 million sums. At the same time, of the total amount, the percentage of costs for the construction of water pipelines was 18.5%, for water supply networks - 8.2%, wells - 14.5%, water towers - 19%, reservoirs - 12%, pumping stations - 10.2% and chlorination plants - 17.6% (Figure 5).

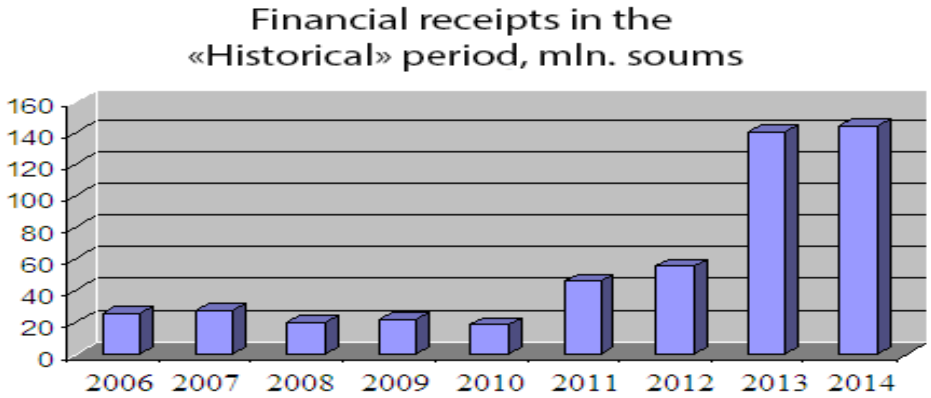

Figure 5 - Financial receipts in the "Historical period", million sums.

Basic scenario. The analysis of financial receipts showed that the implementation of adaptation measures according to the baseline scenario will eliminate the problems associated with improving the functioning of drinking water supply systems and the quality of drinking water by 2025 by no more than 40%. At the same time, the total amount of financial receipts for the period 2015-2025. calculated on the basis of the current actual expenditures will be about 4 286.2 billion sums. (table 3).

Table 3 - Basic scenario indicators, million sums.

Indicators	Total cost	Percentage of total cost
Water conduits	807,4	19
Water supply networks	350,0	8,5
Wells	631,8	14,9
Water towers	683,7	15,7
Reservoirs	623,3	14,3
Pumping stations	521,3	12,2
	668,7	15,4
Chlorination plants	4 286,2	100

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It should be noted that some foreign financial organizations have provided for the allocation of investments in the "Drinking water, natural sources of water supply" sector. Such investors are the World Development Bank, Arab Coordination Group, Asian Development Bank, International Development Association (Table 4).

Table 4 - Foreign investments to optimize the quality of drinking water and water supply sources

Years	International Development Association (IDA)	Asian Development Bank (ADB)	Arab Coordination Group (ACG)	World Development Bank (IDB)
2007	2,20	5,80	3,12	18,10
2008	3,00	7,20	3,17	19,20
2009	3,90	7,90	4,20	19,10
2010	3,31	11,20	5,60	25,60
2011	0,00	14,50	11,10	27,30
2012	15,23	17,90	12,70	31,40
2013	28,51	19,10	14,20	34,00
2014	39,76	20,50	16,30	49,50
2015	41,57	23,50	10,78	49,90
2016	73,31	23,85	6,00	50,20
Всего	**210,79**	**131,45**	**87,17**	**323,40**

Adaptation script. *Assumes the implementation of the necessary adaptation measures under the conditions of climate change. As mentioned above, an increase in the climate in Uzbekistan by an average of 1.5 - 2 degrees will lead to a worsening of water use conditions by about 40 percent. This will lead to a malfunction in the centralized drinking water supply systems, the quality of drinking water will deteriorate significantly, and the levels of pollution of drinking water sources will increase. In connection with the above, for specific activities provided for in the adaptation scenario, the volume of their implementation and financing was increased compared to the baseline scenario. The list of the main adaptation measures includes:*

• construction of new reservoirs, accumulation of fresh water in reservoirs (flood waters);
• construction of storage facilities for the accumulation of rainwater;
• introduction of recycling water supply at industrial facilities;
• use of household and collector-drainage wastewater in agricultural irrigated fields;
• introduction of modern methods of industrial wastewater treatment at enterprises of various industries;
• improving monitoring of the quality of drinking water and water supply sources;
• development of measures to prohibit the discharge of industrial wastewater into drinking water bodies, if the wastewater contains chemicals for which hygiene standards are not established.
• reconstruction of existing and construction of new hydraulic structures, ensuring the reduction of losses and rational use of water, etc.
• Possibilities of involving additional water resources (low-mineralized collector-drainage water, groundwater and waste water) and their quantitative potential.
• construction of inter-district and group rural water pipelines.
• Development for 2021-2025 of design and estimate documentation for repair and restoration work at water supply facilities.
• introduction of a system for the use of drinking water by the population in cities and rural

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settlements, based on a differentiated tariff policy (the cost of drinking water), taking into account the recoupment of operating costs.

• development and improvement of existing normative legal documents in the field of sanitary protection of water supply sources and assessment of drinking water quality in accordance with the requirements of international standards, sanitary rules and regulations.

• introduction of progressive methods of irrigation (drip, sprinkling) and improvement of existing (traditional) ones.

The implementation of the measures outlined above on the adaptation scenario by 2025 in the Republic of Uzbekistan will allow:

- to reduce the levels of anthropogenic pollution of natural water sources;
- provide the population with safe drinking water;
-improve the conditions for water use by the population;
- to modernize the centralized drinking water supply systems;
- to provide the population with decentralized water supply systems;
- will reduce the consumption of fresh water for irrigation of crops;
-to optimize agricultural production;
-create new hydraulic structures for water storage;
- to allocate additional funds for the implementation of the FP;
- use non-drinking water resources for agriculture.

The total amount of financial receipts for the period 2015-2025 in the republic under the adaptation scenario will amount to 7,665.1 billion sums. (table 5).

Table 5 - Key indicators of the adaptation scenario, million sums

Indicators	Total cost	Percentage of costs in relation to the baseline scenario
Water conduits	1422,5	75,2
Water supply networks	634,6	81,3
Wells	1123,6	77,8
Water towers	1230,1	79,9
Reservoirs	1092,2	75,2
Pumping stations	922,5	76,9
Chlorination plants	1239,6	85,3
TOTAL:	7 665,1	78,8

An analytical analysis of the above materials shows that the implementation of the action plan for the adaptation scenario will fully eliminate the negative consequences of the expected climate change in the republic. With a total cost of more than 7 billion sums, taking into account possible investments from other sources, for example, foreign financial organizations, it will be possible to expect the provision of the population of Uzbekistan with safe drinking water supply and a satisfactory condition of surface and ground waters in the context of climate change.

Climate change, as mentioned above, can lead to adverse consequences that will contribute to an increase in the levels of anthropogenic pollution of water supply sources, a deterioration in the quality of drinking water, an increase in the intensive rates of morbidity among the population, a failure in the

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functioning of centralized water supply systems, and a shortage of water resources.

In such conditions, social tension in the republic will significantly increase. This predicted situation necessitated the development of a set of measures for the adaptation period (target scenario) that would help mitigate the negative impact of climate change, eliminate the causes of failure in the functioning of centralized drinking water supply systems and optimize the state of water supply sources.

Financial receipts for the adaptation period are 75.2-85.3% higher than the costs in comparison with the base period. So, if in the base period the total amount of receipts for construction, repair and reconstruction of water pipelines amounted to 807.4 million sums, then during the adaptation period it was equal to 1,422.5 million sums. For the repair, reconstruction and construction of water supply networks, respectively, 350.0 and 634.6 million. For the construction of wells, respectively 631.8 and 11236 million. For the construction of water towers, 683.7 and 1230.1 million. For the construction and repair of reservoirs, respectively 623, 3 and 1092.2 million. For the construction, repair and reconstruction of pumping stations, respectively 521.3 and 922.5, respectively. For the construction of chlorination plants, respectively 668.7 and 1239.6 million. In total, for the base period, financial receipts for a total of 4 billion 286.2 million sums are provided, and for the adaptation period - 7 billion 665.1 million sums. In general, the total amount of financial receipts for the adaptation period will exceed the level of receipts for the base period by 78.8 percent (Figure 6).

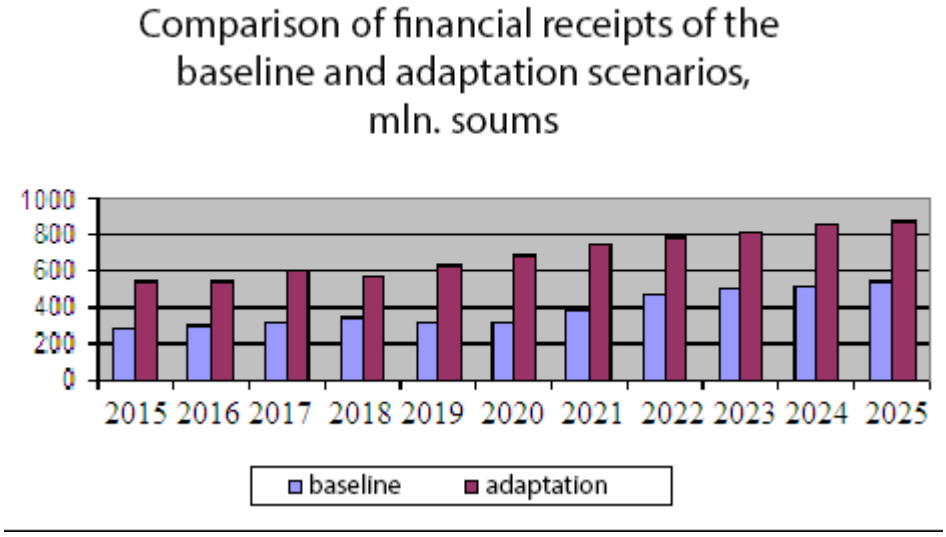

Figure 6 - Comparison of financial receipts of the baseline and adaptation scenarios, mln. sums.

The existing legal framework for water management does not meet modern requirements and require improvement. The administrative-territorial system of water resources management leads to inconsistency of management decisions within a single basin. There is inconsistency in the use and protection of water resources (surface, groundwater, return water), a gap and insufficient coordination between individual links and levels of water resources management, there is no mutual interest between water resource management authorities and water consumers to increase the productivity of water resources use. All this dictates the need for a gradual and consistent implementation of the principles of integrated water resources management in the Republic of Uzbekistan (IWRM).

Conclusions:

1. The dynamics of the long-term state of water supply systems in a number of regions of the republic is characterized as unfavorable for the health of the population. In 2017, the quality of drinking water compared to 2006 deteriorated by 1.2-10.6% in terms of chemical indicators, and in terms of microbiological indicators - by 0.4-8.9%.
2. The drinking water is most polluted in the Khorezm region (21.3% non-compliance with standards), Navoi region (13.0%), Tashkent region (12.7%) and Bukhara region (12.2%).

3. Indicators of chemical water pollution of water supply sources in 2017 compared to 2006 decreased by 11.9-19.8% in Khorezm, Surkhandarya, Andijan and Fergana regions. Water pollution levels increased by 11.9-18.6% in Karakalpakstan, Namangan and Kashkadarya regions.
4. The ecological state of sources of drinking water supply in all regions of the republic in 2017 is unfavorable due to the fact that the quality of water in them does not meet the requirements of the republican standard for sources of centralized drinking water supply.
5. The conducted studies have shown that for the base period the amount of financial costs for improving the conditions of drinking water use of the population and the protection of drinking water bodies will amount to 4,286.2 billion sums, and for the adaptation period - 7,665.1 billion sums..

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