# Investment and Financial Flows (I&FF) Assessment Report

## Assessment of investment and financial flows to address climate change mitigation in the sector Water

**REPORT**
**to assess investment and financial flows to address climate change in the sector "Water Management"**

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CONTENTS

# 1. Introduction

Turkmenistan is located in Central Asia between 35° 08' and 42° 48' N and 52° 27' and 66° 41' E deep in the Eurasian continent at nearly equidistant from the Atlantic and Pacific Oceans. The country is the 50th largest in the world, with a total area of 491.2 $km^2$, stretches from north to south - 650 km from west to east - 1100 km .. In the north Turkmenistan borders with Kazakhstan and Uzbekistan in the east - with Uzbekistan and Afghanistan in the south - with Afghanistan and Iran to the west of the Caspian - from Azerbaijan. The total length of its borders is 5646 km [1914].

By administrative-territorial division Turkmenistan is a 5 provinces: Akhal, Balkan, Dashoguz, Lebap, Mary.

The capital of the country - the city of Ashgabat - is the administrative, political and economic center.

The total water resources of Turkmenistan in the year of average water availability is estimated at 25 km3, which consists of surface runoff of the Amu Darya, Murghab Tejen, Etrek, small streams north-eastern slopes of the Kopet Dag, and minor amounts of groundwater and drainage waters. Of the total surface water resources 22 billion $m^3$, or 88%, falls on the Amu Darya. The remainder are: River Murghab - 1.631 billion $m^3$ (6,5%), river Tedjen - 0.869 billion $m^3$ (3,5%), river Etrek, Sumbar and Chandyr - 0.354 billion $m^3$ (1,4%), and small rivers - 0.15 billion $m^3$ (0,6%).

All the rivers in Turkmenistan, except small streams north-eastern slopes of Kopet Dag, are cross-border - 95% of surface waters are formed outside the country.

Water quality of rivers is mainly formed in the mountainous part of it. Here the rivers, the water quality depends entirely on man-made factors.

The most important role in the economy of Turkmenistan is the **Amu Darya river** - the-water river in Central Asia, where the average annual runoff of 63 km3.

Amu Darya River basin covers an extensive area - about 1,327 $km^2$, of which the Central Asian States has 1,018.6 $km^2$ (Turkmenistan-488.1; the Republic of Uzbekistan - 388.2; Tajikistan -131; Kyrgyz Republic - 11 3). Part of the spillway basin is located on the territory of Afghanistan and Iran. Boundaries of the basin are: the in the east - Sarykol the ridge to the west - coast of the Aral and Caspian seas in the north - Alai, Turkestan and Nurata ridges in the south - the Hindu Kush mountain ranges, and Paropamiz Kopetdag.

Of the total runoff of the Amu Darya in the share of Turkmenistan, in accordance with the interstate division in the alignment Atamurat, is 22 km3, of which (12-13 km3) diverted the Karakum River. Irrigation systems Lebap region are taken from 3 to 5 km 3, and Dashoguz - from 4.5 to 7.5 km3.

The second largest river is the volume of runoff **Murghab**. The actual catchment area of 46900 $km^2$, the length of the river - 978 km, including in Turkmenistan - 516 km.

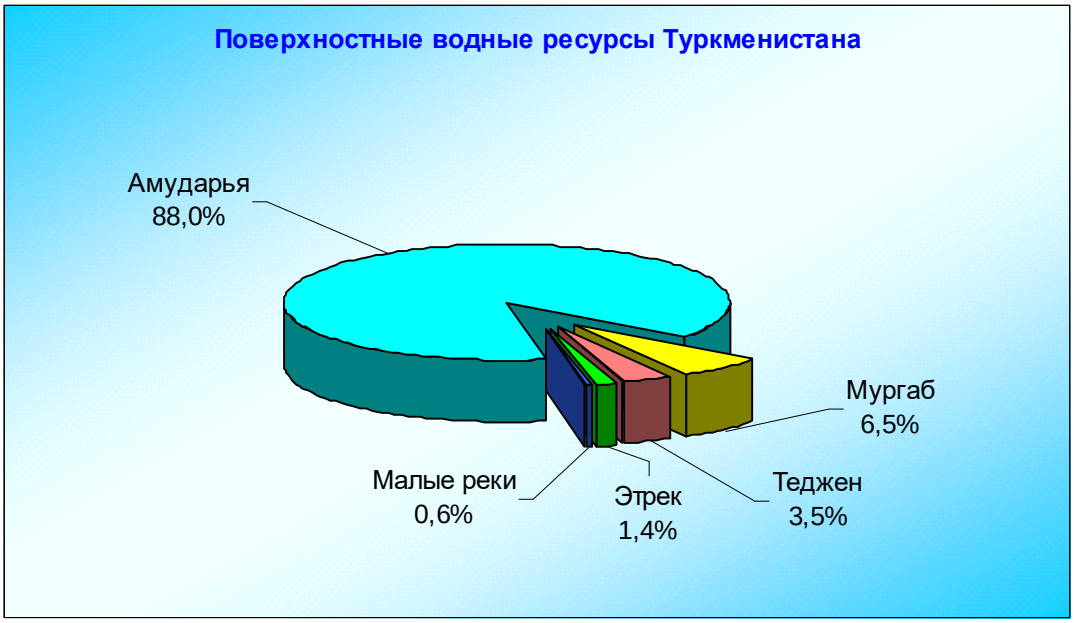
**Tejen River** runs west of the Murghab. Its length is 1150 km and catchment area of more than 70 tys. $km^2$. River basin is located in three countries: Afghanistan, Iran and Turkmenistan. Distribution of river unevenly and negatively for irrigation: 80-85% of the runoff accounts for the period March-May and in July-August, when the need for irrigation water, the maximum, the river is almost dry.

In some years the river Tedzhen are significant flooding, which may take place from February to June. Cost and waste water supply are 0.01% 2192 $m^3$/s and 7559 million $m^3$, and at 0.1% - 1759 $m^3$/s and 5843 $m^3$. The average turbidity of the river in 1915 kg/$m^3$, the maximum value - 190 kg/$m^3$.

**River Etrek**, like all other rivers, is not only a cross-border, but over 150 km - Border. The drainage basin of the total area of 27.3 $km^2$, of which the territory of Iran for about 20 tys. $km^2$, where a main

flow of the river, and the remaining 7.3 tys. km$^2$ located on the territory of Turkmenistan. At the border area of the river flow is divided for 50 to 50 among Turkmenistan and Iran. The water of the river Etrek intensively taken for irrigation in the upper and lower reaches. In order to make full use of river in its lower reaches Etrek built reservoir Kızılay, Mamedkuliyev, shared a total capacity of 45 million m3 and Adzhiyabskoe spawning capacity of 19.3 million m$^3$.

The main feature of all of the above surface water resources is the fact that their stock is fully dismantled, or partially adjusted, and then used for drinking water supply, irrigation, municipal and other needs of the population.




If we consider the use of water in terms of customer water, 91.1% of the total falls in agriculture, 6.3% - in industry, 1.9% - on municipal needs, 0.1% - on fisheries and 0.6% - for other needs.

In the country, more than 130 explored deposits of underground waters, which are now partly used to meet domestic and drinking needs of the population. The overall selection of ground water varies from year to year within mln. m$^3$/god 470-670. At the same time, more than 45% of this amount is used for domestic water supply, about 30% - for irrigation, the rest - for other needs (pastures, balneology).


Approved reserves of groundwater in the whole of Turkmenistan is 3.4 mln. $m^3$/sutki, explored - 6 mln. $m^3$/sutki and forecasting - 9 mln. $m^3$/sutki. In the water balance of the share of groundwater used is 2.0-2.5%.

The hot, dry climate, low precipitation, complex geological and tectonic structure of the territory contributed to the accumulation of highly predominantly groundwater. Fresh groundwater is mainly formed mainly in the mountainous areas of the country where the main falls, rainfall, and a minimum of water is lost by evaporation.

In mountain fresh and brackish water are also in the Kara Kum desert in the form of lenses, floating on the salty waters. The nature of their formation differs. In the cultural area, either permanently or regularly under the existing irrigation canals also form lenses of fresh and brackish groundwater, are of interest for the drinking, industrial and agricultural water supply.

The largest volumes of groundwater suitable for drinking, explored in the Central Kopet Dagh and presented as subsand lenses. General statistics reserves are estimated at 70-80 km 3.

Currently, within Turkmenistan, on the basis of the State Corporation Turkmengeologiya hydrogeological work, found 187 deposits of fresh groundwater. In 75 of them operating reserves approved by the SRC in the number of 3367 tys. $m^3$/sutki, forecast operating reserves reach tys. $m^3$/sutki 8782. A significant number of groundwater deposits with the approved operating reserves explored near the centers of provinces and districts, and rural settlements.

Return flow is formed mainly by drainage water from irrigated land and a small amount due to industrial and municipal and domestic waste. The total collector-drainage than 6 km 3 / year, and industrial and municipal and domestic waste water - the order of 0.25-0.30 km 3 / year. In this regard, only a small part of the collector-drainage runoff in dry years (about 50 mln. $m^3$/god, representing 0.2% of the total water resources) is used for irrigation.

In accordance with the Constitution of Turkmenistan, the state water management exercised by the Cabinet of Ministers.

In 2004, adopted the Code of Turkmenistan "On Water" and the Code of Turkmenistan "On the ground" - the basic laws governing water and land relations in the country.

Interstate level of water resources management provides the Interstate Commission for Water Coordination (ICWC).

State level of government to the Ministry of Water Resources and Ministry of Nature Protection; basin management level - BWO "Amu".

With regard to the territorial level of government, this responsibility falls to the production association velayats (PO Ahalsuvhodzhalyk "ON" Balkansuvhodzhalyk "ON" Dashoguzsuvhodzhalyk "ON" Lebapsuvhodzhalyk "ON" Marysuvhodzhalyk "), and in each etrap created etrap Production Management (PU).

Anticipated increase in air temperature and decrease in annual rainfall due to climate change primarily reflected in reduced runoff and changes in the hydrograph of the rivers, increased evaporation from water surface, which ultimately affect the availability of irrigation water, which is based on agriculture. Preliminary calculation shows that the flow of local rivers will decline by more than 30%. In the water balance of Turkmenistan on the Amu Darya is about 90% of the total. According to specialists of the Republic of Uzbekistan of the Amu Darya runoff may decrease by 10-15%, which significantly affect the total water resources of Turkmenistan.

**The main objective of this work** - the analysis of investment and financial flows in the sector "Water management" in connection with the alleged climate change for sustainable development of Turkmenistan's economy.

## 1.1 Objective

To achieve this goal in the process will be solved the following tasks:

- Delimitation of the sector;
- Identification of adaptation measures in the sector;
- Assessment of investment and financial flows in the historical period (2000-2008 years);
- Identification of scenarios for the sector (both baseline and adaptation scenarios);
- Identification of investment and financial flows for baseline and adaptation scenarios (2009-2030 Gg.)
- A comparative analysis of indicators of baseline and adaptation scenarios;
- Assess the feasibility of implementing adaptation measures in the sector.

## 1.2. Background

### 1.2.1 The previous analyses conducted

In this paper we use different materials of international environmental conferences, seminars and meetings, as well as results of international and national projects. Including:

1. Nukus Declaration of Central Asian states and international organizations on issues of sustainable development of the Aral Sea (September 1995), signed by the heads of all five countries where in particular states: ***"We reiterate our full support for international agreements, in particular, the Declaration on the Sustainable Development (Rio de Janeiro, 1992), World Charter for Nature, the international convention to combat desertification, global climate change, conservation of biological diversity and the protection of transboundary waters. In addition, we believe it necessary to establish an international convention on Sustainable Development in the Aral Sea. Issues of joint water and unification of environmental standards and related legislation should take priority in her position."***
2. "First National Communication under UN Framework Convention on Climate Change",
3. Preliminary results of the Second National Communication under UN Framework Convention on Climate Change, "where was the analysis of the vulnerability of critical

sectors of the economy and ecosystems, and make recommendations for the implementation of preparatory measures to adapt to possible climate change.
4. "National Plan of Action of the President of Turkmenistan on the environment.
5. Water vision basin Aralskogo Sea for 2025. UNESCO
6. Glance MG, Zonn IS The Aral Sea: water problems, climate and environmental change in Central Asia. WMO, 2005
7. Assessment reports on priority environmental issues in Central Asia. Ashgabat, 2006
8. Integrated Environmental Assessment in Central Asia. Ashgabat, 2006.
9. Official documents and materials of the Ministry of Water Resources.
10. Official documents and project materials institute "Turkmensuvylymtaslama.

In preparing the First and Second national communications have been used various approaches for constructing climate scenarios. In the first national communication were used following atmospheric general circulation model: GISS, CCCM, UK89, GFDL-R-30. The Second National Communication was used software package recommended by the IPCC MAGICS / SCENGEN, based on the results of 17 general circulation models of the atmosphere and ocean, was selected the most suitable model for the territory of Turkmenistan and used the averaged data obtained from these models, as the calculation was performed for two greenhouse gas emissions scenarios: B1 and A1FI. Both approaches have shown a possible increase in air temperature and decrease in precipitation in the territory of Turkmenistan.

Priority analysis of investment and financial flows, "Water sector" due to the fact that planned for the near future agricultural policy Turkmenistan [11] provides:

- Providing a stable high rate of growth of agricultural production;
- More efficient development of industries through the development of plant breeding and seed production, increase crop yields and livestock productivity;
- Improve the agricultural structure of the country, bringing it closer to the consumer market, the introduction of evidence-based crop rotations for sustainable improvement of soil fertility;
- Deepen the degree and quality of agricultural raw materials;
- Rapid development of industries whose products will enhance the export capacity;
- The radical renewal of the material and technical base;
- Improvement of specialization and spatial distribution of agricultural production.

Achieving these goals depends largely on the availability of the national economy of water resources due to irrigated agriculture in Turkmenistan. Therefore, issues of sustainable agriculture and the need to meet the growing needs of the population in food products show relevance consideration of issues the effect of possible climate change on water management.

Therefore, all adaptation activities that are considered in this paper, aimed at water conservation in the country in connection with the alleged climate change that will guarantee the sustainable development of water sector and to guarantee the necessary agricultural water resources.

In this work the first time in Turkmenistan, an attempt was made to estimate the financial cost, to determine their direction of application for full attainment of the growing needs of the economy of water resources in connection with the alleged climate change. This is proposed to undertake the following adaptation activities in the sector "Water management":

- Improving water resources management (transition to integrated water resources management - IWRM);
- Optimizing the distribution of agricultural production with due regard for the needs of the country in need of agricultural products and minimize the use of water resources (here a need to consider the development of economic and mathematical model to optimize distribution of agricultural production);
- Activities that increase efficiency of irrigation systems;
- The introduction of advanced irrigation methods (drip, sprinkler irrigation) and the improvement of existing (traditional);

- Implementation of a comprehensive reconstruction of irrigated land (Krause);
- Implementation of measures to improve the reclamation of land used (DRF);
- Construction of additional reservoirs;
- Reconstruction of existing and construction of new hydraulic structures that reduce waste and water management, etc.
- Implementation of breeding work on the cultivation of drought resistant crops;
- Involvement of the possibility of additional water (slightly saline drainage water, underground water and sewage) and their quantitative capabilities.

### 1.2.2. Institutional arrangements and collaboration

The institutional issues and cooperation between various departments were also discussed at the beginning of this project, which was organized by the intersectoral meeting with the participation of key government ministries and departments of Turkmenistan, in particular, the Ministry of Water Resources, Ministry of Agriculture, the National Committee for Hydrometeorology at the Cabinet of Ministers of Turkmenistan Ministry of Oil and Gas, etc.

In a project on "Water sector" was attended by representatives of the Ministry of Water Resources of Turkmenistan and its provincial industrial associations for Water Management and Research and Project Research Institute "Turkmensuvylymtaslama".

This is due to the fact that these organizations are the sole owners of the necessary information on water economy of Turkmenistan and all accounting information for the historical period and the program for the future focus of these organizations. In addition, the institute "Turkmensuvylymtaslama is the sole developer of projects in water sector and has extensive experience in designing water resources projects, which are included in the list of adaptation measures discussed in this document. Also note that many of the indicators relating to investment income, are taken on draft-analogues, developed by the institute "Turkmensuvylymtaslama.

In addition, to determine the value of prospective investments following materials were used, enjoyed by design institutes of the country:

- «Cconsolidated standards of the specific capital investments for the construction of the reconstruction of reclamation systems and facilities"
- Stan 33-2.1.03-85. Moscow - in 1986, consolidated standards of specific capital investment in rural construction and development of reclaimed land. Stan 33-2.1.04-85. Moscow - 1986
- Specific work projects on the comprehensive reconstruction of the irrigated lands of reclamation improvement, construction, drip irrigation systems, etc.

### 1.2.3. The basic methodology and key terms

In this work, has been used extensively prepared by UNDP "Methodology to assess Investment and Financial Flows to Address Climate Change"

To determine the aggregated unit of capital investments for construction and reconstruction of reclamation systems were used normative data obtained from Stan 33-2.1.03-85 and projects analogues, made the institute "Turkmensuvylymtaslama.

We also used the following official documents:

- «Strategy of economic, political and cultural development of Turkmenistan until 2020", which presents the main indicators of economic sectors by 2020;
- «National Action Plan for Environmental Protection (NEAP) - here are some basic measures to ensure ecological safety of the country in the future;
- «Initial National Communication on UN Framework Convention on Climate Change";
- Statistical reports on Turkmenistan, which shows evidence of socio-economic development for the years 2000-2008.;

- Reports of various Ministries and agencies, especially the Ministry of Water Resources of Turkmenistan, where were taken evidence of the branch for the years 2000-2008.

In the development of baseline and adaptation scenarios used the results obtained during the development of the Second National Communication under UN Framework Convention on Climate Change, especially information about water balance, namely, the proposed modification of river runoff, evaporation from reservoirs and raising standards for agricultural irrigation cultures. For their calculation were used the obtained values of temperature and rainfall corresponding to different climate scenarios and statistical modeling techniques - regression analysis.

At the same time to assess the global and regional temperature and precipitation was used recommended by the IPCC (IPCC) and the National Communications Support Programme (NCSP) software package MAGICC / SCENGEN version 4.1. The calculations were performed with two general circulation models of the atmosphere and ocean: Had300 and ECH498, most suitable for the conditions of Turkmenistan.

Construction of climate scenarios were carried out for two scenarios of greenhouse gas emissions, taking into account the influence of sulfate aerosols: A1FI - pessimistic (economic priorities) and B1 - optimistic (environmental priorities) and with a choice of high climate sensitivity to increased concentrations of greenhouse gases in the atmosphere.

Under both scenarios (A1FI and B1) is expected to increase in temperature throughout the territory of Turkmenistan, as well as reduction in rainfall. However, the rate of change in temperature and precipitation in the A1FI scenario are much higher. Calculations show the temperature increase by 2100 of 2-3 degrees (optimistic scenario) to 6.7 degrees (pessimistic scenario) on the basic rules.

Tables 1-2 present the results of calculations of air temperature and annual precipitation for the stations used as reference for the agricultural zoning for the period 2020-2100 years. For the development of adaptation scenarios used the results of the scenario A1FI.

**The average annual temperature scenario A1FI, °C**

| Name | 1961-1990 | 2020 | 2040 | 2060 | 2080 | 2100 |
|---|---|---|---|---|---|---|
| Ashgabat | 16,4 | 17,5 | 18,5 | 20,3 | 22,2 | 23,5 |
| Bayramali | 16,6 | 17,6 | 18,7 | 20,4 | 22,3 | 23,6 |
| Turkmenabat (lizard) | 15,5 | 16,6 | 17,6 | 19,4 | 21,3 | 22,7 |
| Kunyaurgench | 12,0 | 13,1 | 14,2 | 16,0 | 17,9 | 19,3 |
| Serdar (Kizylarvat) | 16,1 | 17,2 | 18,2 | 19,9 | 21,8 | 23,1 |

**Annual precipitation scenario A1FI, mm / year**

| Name | 1961-1990 | 2020 | 2040 | 2060 | 2080 | 2100 |
|---|---|---|---|---|---|---|
| Ashgabat | 242 | 243 | 238 | 221 | 210 | 202 |
| Bayramali | 183 | 189 | 187 | 167 | 154 | 146 |
| Turkmenabat (lizard) | 130 | 135 | 134 | 122 | 115 | 110 |
| Kunyaurgench | 118 | 119 | 117 | 110 | 105 | 102 |
| Serdar (Kizylarvat) | 206 | 206 | 202 | 191 | 183 | 178 |

The analysis revealed the following that by 2030:

- Reduced flow of rivers - Amu Darya - by 7-12%, Murghab Tejen and Etrek - by 5-8%.♣ Especially important in this case is that against the background of 5-15% reduction in the annual flow of local rivers, runoff during the growing period may be reduced by 30%. Tejen - 30%, Etrek - 50% [5]. The total value of reducing the flow of the order of 2400 million $m^3$;
- Increase evaporation from the surface reservoirs. The difference in the amount of evaporation from the current $ 150 million $m^3$ [5];

- Irrigation norm for major crops already in 2030 increased by 13% [5]. From this it follows that for crop irrigation will require an additional 3000 $m^3$.

In general, the need for additional water resources will be about 5.5 billion $m^3$.

**The baseline scenario** - mindful of the fact that the water management system of Turkmenistan is a national sector, providing water management not only for the purposes of irrigation. Irrigation canals and reservoirs on them as sources of industrial and drinking, and cultural and community water supply is used for watering livestock and pastures, to fisheries, water, industrial, energy and transport, recreational purposes and to many other economic problems. The water here has always been insufficient. Therefore, the Turkmen government to ensure equitable distribution of available water resources between users in different regions and between different owners take control water complex and planning for further development of the complex is fully itself with the view to fully meet the needs of the economy in water and free water in Turkmenistan.

The water sector is developing in accordance with its program development. However, due to various conditions, such as the country's economic situation, state of the international market of food products, state of the country's agricultural sector and population growth, this program is often adjusted. When adjusting the program stand out the most important events and have always accepted the condition of maintaining the average level of development of the complex. Last corrected plan 100% funded from the budget of the country and is always satisfied in full. This laid the basis of the baseline scenario.

Therefore, the methodological approach of the baseline scenario to 2030 is based on averages for the development of water sector. Ie size and growth of investment, financial investment and operating costs through 2030 will grow in the same dynamics as in the historical period 2000-2008.

**Adaptation scenario** - assumes the Earth's climate is changing. Water scarcity is increasing. Increasing the number of the population in Turkmenistan. Additional sources of surface water Turkmenistan does not have. In such conditions, ensuring food security and ensuring the national economy of Turkmenistan water in sufficient quantities, are important economic problems that require drastic efforts by the state. In implementing this project the experts have calculated the possible shortage of water resources due to climate change in Turkmenistan and suggested possible adaptation measures to cover this deficit. In the adaptation scenario, the size of investment, financial flows and transaction costs of the project is estimated by experts as the minimum required level for the national economy of Turkmenistan water in sufficient quantity to climate change. This scenario assumes a more accelerated rate of development of the water sector for being prepared to change the climate.

Although the event in adaptation and baseline scenarios are similar, but they differ in scope and pace of their implementation.

The development of the **Adaptation scenario** was carried out following the methodological approach. The calculation showed that if climate change water deficit will be about 5 billion $m^3$ of water (this is if the irrigated area will remain the same as now). Accordingly, the specific actions called for in the adaptation scenario was to increase their performance, compared with the baseline scenario. For example, in the baseline scenario provides an integrated reconstruction of irrigated land (Krause), an area of 143 hectares, and the script adaptation - it is the same event is supposed to be an area of 357 hectares, in the baseline area of land which will be introduced drip irrigation to 38 ha, and the script adaptation - 96 ha The same approach was used for other activities. Such activities as the improvement of water management, optimization of distribution of agricultural production are the same cost in both scenarios, since they provide the same effect (the transition to integrated water resources management, development of optimization model of distribution of agricultural production).

To estimate the cost of adaptation measures in the future to 2030 are used instead of actual and desired (normative) specific indicators. This includes investment and operating costs. In addition,

to evaluate future investment in specific activities of materials were used government programs and plans for the development of water sector projects and analog developed and successfully implemented in the present. Among them:

1. "The program of agricultural development of Turkmenistan until 2030. The system of water management,
2. "Concepts of Water Resources of Turkmenistan until 2030",
3. "Proposal for the development of water resources in Turkmenistan until 2030" and other works, which define the basic objects and parameters for the development of water sector of Turkmenistan.

In evaluating the financial return when the official data on the cost of implementation of training, seminars, meetings, etc. zatrudneny.byli were used peer review and having the experience of the staff of the organizations.

**Key terms:**

**"Investment Flow" (IF)** - a capital cost of new real assets with a lifetime of more than one year, for instance, capital expenditure on new agricultural irrigation system;

**"Financial Flow (FF)** - is the operational costs associated with program activities, financial income includes expenses other than those which relate to the expansion or introduction of new real assets. Examples of revenue may be the cost of training tenants, workshops, dissemination of popular literature, etc.

**"Investment entity** - an entity that is responsible for the investment. These are entities that make decisions about investing projects.

**Sources of I&FF means "**- this is the origins of the funds invested by institutional investors such as domestic capital, foreign debt, domestic subsidies, foreign aid.

**"Operation and maintenance cost" (O&M)** - as we understand it is operating (operating) costs, ie expenses, which include:

- Wages or salaries of staff
- The cost of fuel, such as energy and / or fuel for operations, fuel production
- Utilities, such as telephone service, Internet connectivity, etc.
- Raw Materials
- Operating expenses and / or leasing of equipment
- Office supplies and consumables
- Advertising
- Licence or equivalent duties (for example, the annual registration fee for corporations), levied by the Government
- The cost of property, including:
    - Rental or lease payments
    - Premises
    - Furniture and equipment
    - Property taxes and tax equivalent
    - Maintenance fees, such as fees charged to carriers for transport, road pricing, and manufacturing or operating fees
    - Insurance
    - Damage due to losses in the absence of insurance, accidents, sabotage, terrorism, negligence.

# 2. The scope, the input data and scenarios

## 2.1. Scope of the sector

Due to the fact that in Turkmenistan for more than 90% of the total water resources are related to irrigated agriculture, this project in its scope includes water used for irrigation.

Irrigated agriculture - is irrigated agriculture, which includes the construction and operation of irrigation and drainage networks, waterworks, reservoirs, water distribution sites, land reclamation.

Background review of irrigated agriculture is also due to the following factors:

- Solving problems in irrigated agriculture would effectively eliminate the problem of water scarcity;
- More than 90% of water is used in this sector;
- Adaptation activities undertaken in this sector would really save a substantial amount of water and to guaranteeing economic sectors of water resources and ensure sustainable development of water sector and the economy as a whole;
- The share of agriculture in the national gross domestic product reaches about 20% and ensuring food security of the country, and therefore the importance of this sector is beyond doubt.

Of course, you must carry out certain measures to ensure the economical and efficient use of water in the household sector (1,9% of total), industry (6,3% of total), etc. However, this does not yield significant savings in water, therefore, these components in this study were not considered.

With regard to investment entities, **it should be noted that the only source of water sector investments in Turkmenistan is the government.**

For the development of water infrastructure are allocated large amounts of capital investment: equity Minvodhoza Turkmenistan, the state budget, the State Monetary Fund, the State Fund for the oil and gas industry and mineral resources and other public structures.

In the historical period and is currently been allocated some funds to undertake research, conduct workshops on the project, backed by international organizations (UNDP, UNEP, USAID, GEF, etc.) - financial flows. However, the actual funds that were spent on these activities are not available. These costs in the table "historical data" are given in the form of peer review.

## 2.2. The input data and scenarios

### 2.2.1. The assessment period and the parameters of cost accounting

Assessment carried out before 2030. Historical period before the figures for 2000-2008. The data were presented by the Ministry of Water Resources of Turkmenistan and the Research and design institute "Turkmensuvylymtaslama.

Depending on the level of their external economic relations, the methods of obtaining public funding, the level of self-financing relationships in the industry, on the economic status of related industries, from the historical method of planning the industry's various sectors of Turkmenistan's economy, with financial planning, use different currencies. In the industry "Water management" adopted financial plan in U.S. dollars and translated formulated plans for state policy in the national currency for domestic use. Thus, financial plans in the sector in the U.S. dollar does not change with the change of the national currency.

In the period from 2000 to 2005 the official exchange rate of national currency was 1manat = 1, / 5200 USD. Historical Financial Data in national currency (2000 -2008) in the organization of water

complex were identified for this course. In this connection, in this paper as the base year adopted in 2005.

In accordance with the existing practice of designing the discount rate adopted at the 10% level.

### 2.2.2. Analytical approach

The methodical approach to the baseline scenario is based on the level of the growth rate of expenditure for the period 2000 to 2008, and based on them (in the same dynamics) calculation was performed until 2030. As mentioned above, **particularly the development of water management system in Turkmenistan is that all investments made from the state budget**. This was the basis of assumptions that in the future this situation will remain unchanged. However, preservation of investment growth until 2030 will not be able to provide for the holding cost of adaptation measures to guarantee the shortfall water (even without the increase in irrigated area - about 5.5 billion $m^3$), which may arise in the case of projected climate change.

From this perspective, was designed adaptation scenario in which a methodological approach was based on identifying specific activities that will completely eliminate the deficit of water resources. It serves as a basis for determining the required size of investment and financial flows needed for their implementation.

The main objects and parameters of development of water sector have been identified by the Ministry of Water Resources and the Institute "Turkmensuvylymtaslama" in such documents as the Programme for Development of Agriculture of Turkmenistan until 2030. Water management system "," The concept of water resources development of Turkmenistan until 2030 "and" Proposals for the development of water resources in Turkmenistan until 2030 "and others, with their help in this work, the experts determined the list of adaptation measures with a view to ensuring sustainable development of water sector, as well as the anticipated climate change and increasing scarcity of water resources on which to execute the investment and financial analysis.

### 2.2.3. Historical IF, FF and O&M data, as well as subsidies

Historical data on the investment returns (2000-2008 years.) - Presented according to the annual reports of the Ministry of Water Resources and the design institute "Turkmensuvylymtaslama for the following events:

- Construction of reservoirs - Zeidskoe, Hauzhanskoe, Dostluk, Tagtinskoe etc. Such reservoirs as Zeidskoe, Dostluk were built before the historical period, which is represented in this project;
- Measures to improve the reclamation of land used - Turkmen Lake of the Golden Age, construction and reconstruction of individual intereconomic reservoirs such as Lake, Daryalyk, Yapach-Narazym and other Turkmen Lake of the Golden Age included in this list due to the fact that its main purpose - amelioration of irrigated lands.

Historical data on the financial income provided by peer review.

**Historical data on the type of investment, million U.S. $**
**Category Investment Entity - Government;**
**Sources of I&FF funds - Internal budgetary funds**

| | Improving the management of water resources allocation | | | Optimization of agricultural production | | | Implementation of activities that increase efficiency of irrigation systems | | | Introduction of advanced irrigation methods | | | Implementation of breeding work on the cultivation of drought resistant crops | | | Involvement of additional water resources | | | Construction of additional reservoirs | | | Other Investments | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | IF | FF | O&M | IF | FF | O&M | IF | FF | O&M | IF | FF | O&M | IF | FF | O&M | IF | FF | O&M | IF | FF | O&M | IF | FF | O&M |
| **2000** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 7,7 | 0,0 | 0,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 2,3 | 0,0 | 0,2 | 0,2 | 0,0 | 0,0 |
| **2001** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 22,6 | 0,0 | 1,6 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 6,0 | 0,1 | 0,4 | 1,4 | 0,0 | 0,0 |
| **2002** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 28,5 | 0,0 | 2,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 6,3 | 0,1 | 0,4 | 0,7 | 0,0 | 0,0 |
| **2003** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 30,8 | 0,0 | 2,2 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 12,4 | 0,1 | 0,9 | 5,1 | 0,0 | 0,0 |
| **2004** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 32,3 | 0,0 | 2,3 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 19,9 | 0,2 | 1,4 | 1,2 | 0,0 | 0,0 |
| **2005** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 53,0 | 0,0 | 3,7 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 10,8 | 0,1 | 0,8 | 5,7 | 0,0 | 0,0 |
| **2006** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 60,4 | 0,0 | 4,2 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 12,2 | 0,1 | 0,9 | 14,0 | 0,0 | 0,0 |
| **2007** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 91,4 | 0,0 | 6,4 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 13,1 | 0,1 | 0,9 | 3,3 | 0,0 | 0,0 |
| **2008** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 108,5 | 0,0 | 7,6 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 16,0 | 0,2 | 1,1 | 28,4 | 0,0 | 0,0 |
| **Total** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 435,3 | 0,0 | 30,5 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 99,0 | 1,0 | 6,9 | 59,9 | 0,0 | 0,0 |

**Improving water management includes:**

- Transition from the administrative district of the principle of water management in the management of irrigation systems - IWRM;
- Study and implementation experience of water user associations and farmers associations
- Gradual introduction of paid water use.

**Optimization of the distribution of agricultural production includes:**

- Development of the optimization of economic and mathematical models;
- Re-specialization of agricultural production in the zones of the country.

**Implementation of measures that increase efficiency of irrigation systems, includes:**

- Implementation of a comprehensive reconstruction of irrigated land (Krause);
- Implementation of measures to improve the reclamation of land used (DRF);
- Reconstruction of existing and construction of new hydraulic structures that reduce waste and water management, etc.

Growth in investment in recent years "historical" period is observed because of the large volume of work on the comprehensive reconstruction of irrigated land, reclamation of land improvement and reconstruction of existing and construction of new waterworks.

**The introduction of advanced irrigation methods include:**

- Improvement of existing (traditional) methods of irrigation;
- Drip irrigation;
- Sprinkler irrigation.

**Implementation of the breeding work on the cultivation of drought resistant crops include:**

- Breeding work on the cultivation of drought-and salt-tolerant crops;
- Zoning of new varieties in the country.

**The involvement of additional water resources include:**

- A significant increase in the use of brackish drainage water for irrigation;
- Groundwater;
- The use of wastewater.

**Construction of additional reservoirs includes:**

- Construction of new and increase capacity of existing reservoirs.

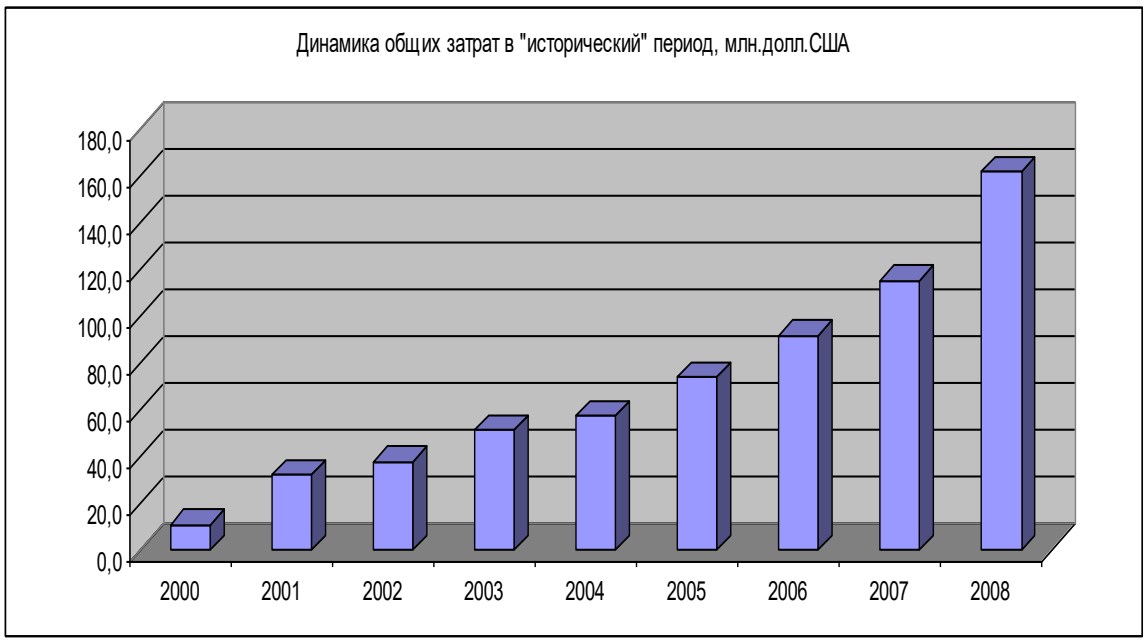
**Other investments include:**

- The investments that are not included in the list of adaptation, for example, development of new lands, increasing the capacity of existing canals, etc.

**Historical data, the overall costs, million $ U.S.**
**Category Investment Entity - Government;**
**Sources of I&FF funds - Internal budgetary funds**

| | Improving the management of water resources allocation | Optimization of agricultural production | Implementation of activities that increase efficiency of irrigation systems | Introduction of advanced irrigation methods | Implementation of breeding work on the cultivation of drought resistant crops | Involvement of additional water resources | Construction of additional reservoirs | Other Investments |
|---|---|---|---|---|---|---|---|---|
| | IF+FF+O&M | IF+FF+O&M | IF+FF+O&M | IF+FF+O&M | IF+FF+O&M | IF+FF+O&M | IF+FF+O&M1 | IF+FF+O&M |
| **2000** | 0,0 | 0,0 | 8,2 | 0,0 | 0,0 | 0,0 | 2,5 | 0,2 |
| **2001** | 0,0 | 0,0 | 24,2 | 0,0 | 0,0 | 0,0 | 6,5 | 1,4 |
| **2002** | 0,0 | 0,0 | 30,5 | 0,0 | 0,0 | 0,0 | 6,8 | 0,7 |
| **2003** | 0,0 | 0,0 | 33,0 | 0,0 | 0,0 | 0,0 | 13,4 | 5,1 |
| **2004** | 0,0 | 0,0 | 34,6 | 0,0 | 0,0 | 0,0 | 21,5 | 1,2 |
| **2005** | 0,0 | 0,0 | 56,7 | 0,0 | 0,0 | 0,0 | 11,6 | 5,7 |
| **2006** | 0,0 | 0,0 | 64,6 | 0,0 | 0,0 | 0,0 | 13,2 | 14,0 |
| **2007** | 0,0 | 0,0 | 97,8 | 0,0 | 0,0 | 0,0 | 14,2 | 3,3 |
| **2008** | 0,0 | 0,0 | 116,1 | 0,0 | 0,0 | 0,0 | 17,3 | 28,4 |
| **Total** | 0,0 | 0,0 | 465,7 | 0,0 | 0,0 | 0,0 | 106,9 | 59,9 |

Significant growth in investment on the position of the Implementation of the activities that increase efficiency of irrigation systems "due to the fact that between 2005 and 2008, significant funds were invested in the construction of the Turkmen Lake of the Golden Age, which aims to amelioration of irrigated lands are used. Substantial funds were invested in a "historical" period for the construction of large Zeidskogo reservoir, as well as small reservoirs on small rivers. All funds for those activities funded from the state budget.




### 2.2.4. Baseline scenario

As mentioned above, investment income for the historical period (2000-2008 years.) Included in the baseline scenario are given according to the Ministry of Water Resources of Turkmenistan. Cost analysis showed that the implementation of adaptation measures in the baseline scenario will eliminate water scarcity by 2030 no more than 50%, and that the total value of expenditure for the period 2009-2030 years. calculated on real costs currently prevailing in the order of 10.5 billion dollars., including:

**Improving the management of water resources - 4,1 million, of which:**

The transition to integrated water resources management will entail some changes in the patterns of water management - may reduce the operating staff. In addition, the transition to integrated water resources management involves the reconstruction of existing hydraulic structures.

According to specialists improve the structure of water management and reconstruction of existing hydraulic structures will allow annual savings of about 10-20% water. Reconstruction of the existing hydraulic structures will additionally have at least 10% water savings.

Total expenditure for the implementation of measures to "Improving the management of water resources" are divided into:

- The transition from administrative district of the principle of water management at the management of irrigation systems - IWRM - 2,6 million. Part of these funds is related to investments - 2,02 mln. (Minor renovation of existing hydraulic structures, such as water distribution sites, and the other part - the financial income (the study of experiences, the development of specific projects, workshops, etc.) - 0,48 mln. Hereinafter financial flows are for peer review. The value of operating costs taken at 3% of the value of investments.
- Study and implementation experience of water user associations and associations of farmers - 0,4 mln. Here, all costs attributable to the financial income.
- Gradual introduction of paid water use - 1.2 million dollars. Some of these funds is related to investments (construction of facilities that provide commercial water metering) - 0,96 mln. And the other part - to the financial income (the study and dissemination of experience) and operating costs - 0,2 million. The value of operating expenses adopted at the level of 1-3% of the value of investments. This is due to the simplicity of technical installations that take into account water consumption (eg, fixed bed, etc.)

The foregoing suggests that these activities can provide water savings in the order of 3.2 billion $m^3$ of water.

**Optimization of the distribution of agricultural production - 18,5 million dollars.**

Implementation of measures to optimize the distribution of agricultural production - estimated at 18,5 million dollars. Investment income here will relate to the need to re-specialization of agricultural production. For example, the area where there is need for re-specialization would require some reorganization of the irrigation network, etc.

Financial income - is the cost required to develop an optimization of economic and mathematical models. As an optimization criterion in this model is expected to use the maximum profit. As constraints - financial opportunities for specific activities, the volume of water resources and quality (level of fertility), soil, etc.

This will take into account the irrigation standards for major crops, depending on the location of their production (the production of the same crops the irrigation rate varies according to the agro-climatic zones).

Calculations show that the implementation of this exercise will greatly improve the utilization of water resources in the country, improve the utilization of land resources, which resulted in the growth of productivity, and reduce the cost of the redistribution of agricultural products between the zones.

Implementation of these measures can provide water savings in the order of 1,0-1,5 billion $m^3$ of water. Given that these savings will be achieved against a background of increased yields and lower costs for redistribution of agricultural products between the zones, it will be very important.

**Implementation of measures to ensure higher efficiency irrigation systems - 6505 million, including:**

**Implementation of a comprehensive reconstruction of irrigated land (Krause)**, an area of 143 ha - 1075 million. (About 7 thousand U.S. dollars / ha). The dynamics of investment income for the period to 2030 is based on prevailing in the "historical period" growth capital investments aimed at Krause. The structure of work "complex reconstruction of irrigated land" includes works such as reconstruction of irrigation systems and waterworks, the capital planning of land, the reconstruction of drainage networks, etc. implementation of these measures will save about 20% of water used for irrigation.

Implementation of a comprehensive reconstruction of irrigated land in the area of 143 hectares would save about 0,2-0,3 billion $m^3$ of water. Contributing factor in this exercise is to increase crop yields by 15-30%.

**Implementation of measures to improve the reclamation of land used (DRF)** on the area 214 ha - 4155 million. (About 2.3 thousand U.S. dollars / ha). The dynamics of investment income for the period to 2030 is based on prevailing in the "historical period" growth capital investments aimed at IAPSO.

One feature of the calculation of investment for this event is a total investment includes the cost for the construction of the Turkmen lake Golden Age. This is due to the fact that one of the main purposes of construction of this lake is the reclamation of land used improvement.

Improvement of Reclamation of land used is the reconstruction of the existing drainage network and the construction of the missing.

Implementation of reclamation of land used Advancement (DRF) on the area 214 ha would save about 0,2-0,3 billion $m^3$ of water. Primarily this is achieved by eliminating the necessary flushing of irrigation on saline lands.

Contributing factor in this exercise is to increase crop yields not less than 15%.

**Reconstruction of existing and construction of new hydraulic structures that reduce waste and water management and so on** - 850 million dollars. The dynamics of investment income for the period to 2030 is based on prevailing in the "historical period" growth capital investments to measures relating to rehabilitation and construction of new waterworks.

Implementation of these measures will save about 0,1-0,2 billion $m^3$ of water.

**Introduction of progressive methods of irrigation - 1,775 million, including:**

**Improvement of existing (traditional) methods of irrigation** on the area of 385 hectares - 6,6 mln. (About 20 dollars / ha). The essence of the improvement of existing (traditional) methods of irrigation is widespread use of siphons, tubes, irrigation of crops in the furrows. Conserving water thus reaches about 10% and, moreover, watering becomes more efficient due to the gradual (over a slow and uniform) soil moisture.

This event will save about 0,3-0,4 billion $m^3$ of water.

**Drip irrigation** in the area of 38 hectares - 844 million dollars. (About 17,3 tys.doll. / ha). The introduction of drip irrigation on the area of 38 ha would save about 0,1-0,3 billion $m^3$ of water.

According to numerous literary sources of the introduction of drip irrigation leads to increased yields of up to 40%.

Drip irrigation in Turkmenistan, in the first place should be implemented in the area occupied by orchards and vineyards. Experience of implementing drip irrigation in these cultures in Turkmenistan is already available.

**Sprinkler** on the area of 69 hectares - 924 million dollars. (About 8,7 tys.doll. / ha).

The introduction of sprinkling in the base scenario assumed an area of 69 hectares, which will save about 0,1-0,2 billion $m^3$ of water.

Sprinkler irrigation in Turkmenistan can be implemented in the production of fodder and grain crops.

**Implementation of the breeding work on the cultivation of drought resistant varieties of crops - 46 million dollars.**

Turkmenistan, and is currently characterized by high temperatures. In the case of projected warming, the situation will get worse. In this regard, a priority of research scientists and plant breeders should be informed by research on the cultivation of drought resistant crops and zoning.

**The involvement of additional water resources - 796 million dollars, among them:**

- Slightly saline drainage water (to bring the volume of up to 650 million $m^3$) - 374 million dollars.
- Ground water (to bring the volume of up to 470 million $m^3$) - 243 million dollars.
- Waste water (to bring the volume of up to 410 million $m^3$) - 179 million dollars.

The total additional water resources amount to 1.5 billion $m^3$.

**Construction of additional reservoirs and increasing capacity of existing reservoirs - 793 million dollars.** Among the priority - Zeidskoe reservoir Hauzhanskoe, Saryyazynskoe.

The dynamics of investment income for the period to 2030 is based on prevailing in the "historical period" growth capital investments aimed at the construction and reconstruction (increased capacity) reservoirs.

**The baseline scenario costs by type of investment million U.S. $**
**Category Investment Entity - Government;**
**Sources of I&FF funds - Internal budgetary funds**

| | Improving the management of water resources allocation optimization of agricultural production | | | Implementation of activities that increase efficiency of irrigation systems | | | Introduction of advanced irrigation methods | | | Implementation of breeding work on the cultivation of drought resistant crops | | | Involvement of additional water resources | | | Construction of additional reservoirs | | | Other Investments | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | IF | FF | O&M | IF | FF | O&M | IF | FF | O&M | IF | FF | O&M | IF | FF | O&M | IF | FF | O&M | IF | FF | O&M |
| **2009** | 0,0 | 0,1 | 0,0 | 0,0 | 0,0 | 0,0 | 120,9 | 0,0 | 8,5 | 27,2 | 0,2 | 1,4 | 0,4 | 0,6 | 0,0 | 0,0 | 0,0 | 0,0 | 18,3 | 0,2 | 1,3 |
| **2010** | 0,1 | 0,3 | 0,0 | 0,0 | 0,2 | 0,0 | 134,0 | 0,0 | 9,4 | 29,2 | 0,3 | 1,5 | 0,4 | 0,6 | 0,0 | 19,9 | 0,2 | 1,0 | 19,7 | 0,2 | 1,4 |
| **2011** | 0,4 | 0,1 | 0,0 | 0,0 | 0,4 | 0,0 | 147,2 | 0,0 | 10,3 | 31,4 | 0,3 | 1,6 | 0,8 | 1,2 | 0,0 | 19,2 | 0,2 | 1,0 | 21,1 | 0,2 | 1,5 |
| **2012** | 0,4 | 0,1 | 0,0 | 0,0 | 0,4 | 0,0 | 160,6 | 0,0 | 11,2 | 33,8 | 0,3 | 1,7 | 0,8 | 1,2 | 0,0 | 19,2 | 0,2 | 1,0 | 22,6 | 0,2 | 1,6 |
| **2013** | 0,4 | 0,1 | 0,0 | 0,0 | 0,4 | 0,0 | 174,2 | 0,0 | 12,2 | 36,5 | 0,3 | 1,8 | 0,8 | 1,2 | 0,0 | 19,2 | 0,2 | 1,0 | 24,0 | 0,2 | 1,7 |
| **2014** | 0,4 | 0,1 | 0,0 | 1,0 | 0,0 | 0,0 | 188,0 | 0,0 | 13,2 | 39,4 | 0,3 | 2,0 | 0,8 | 1,2 | 0,0 | 19,2 | 0,2 | 1,0 | 25,5 | 0,3 | 1,8 |
| **2015** | 0,4 | 0,1 | 0,0 | 1,0 | 0,0 | 0,0 | 202,0 | 0,0 | 14,1 | 42,7 | 0,4 | 2,1 | 0,8 | 1,2 | 0,0 | 19,2 | 0,2 | 1,0 | 26,9 | 0,3 | 1,9 |
| **2016** | 0,2 | 0,0 | 0,0 | 1,0 | 0,0 | 0,0 | 216,3 | 0,0 | 15,1 | 46,3 | 0,4 | 2,3 | 1,0 | 1,3 | 0,0 | 32,1 | 0,3 | 1,6 | 28,3 | 0,3 | 2,0 |
| **2017** | 0,2 | 0,0 | 0,0 | 1,0 | 0,0 | 0,0 | 230,8 | 0,0 | 16,2 | 50,3 | 0,4 | 2,5 | 1,0 | 1,3 | 0,0 | 32,1 | 0,3 | 1,6 | 29,8 | 0,3 | 2,1 |
| **2018** | 0,2 | 0,0 | 0,0 | 1,0 | 0,0 | 0,0 | 245,6 | 0,0 | 17,2 | 54,7 | 0,4 | 2,7 | 1,0 | 1,3 | 0,0 | 32,1 | 0,3 | 1,6 | 31,2 | 0,3 | 2,2 |
| **2019** | 0,2 | 0,0 | 0,0 | 1,0 | 0,0 | 0,0 | 260,7 | 0,0 | 18,3 | 59,7 | 0,5 | 3,0 | 1,0 | 1,3 | 0,0 | 32,1 | 0,3 | 1,6 | 32,7 | 0,3 | 2,3 |
| **2020** | 0,2 | 0,0 | 0,0 | 1,0 | 0,0 | 0,0 | 276,2 | 0,0 | 19,3 | 65,3 | 0,5 | 3,3 | 1,0 | 1,3 | 0,0 | 32,1 | 0,3 | 1,6 | 34,1 | 0,3 | 2,4 |
| **2021** | 0,0 | 0,0 | 0,0 | 1,0 | 0,0 | 0,0 | 292,1 | 0,0 | 20,4 | 71,5 | 0,5 | 3,6 | 1,0 | 1,3 | 0,0 | 38,5 | 0,4 | 1,9 | 35,5 | 0,4 | 2,5 |
| **2022** | 0,0 | 0,0 | 0,0 | 1,0 | 0,0 | 0,0 | 308,4 | 0,0 | 21,6 | 78,5 | 0,6 | 3,9 | 1,0 | 1,3 | 0,0 | 38,5 | 0,4 | 1,9 | 37,0 | 0,4 | 2,6 |
| **2023** | 0,0 | 0,0 | 0,0 | 1,0 | 0,0 | 0,0 | 325,2 | 0,0 | 22,8 | 86,3 | 0,6 | 4,3 | 1,0 | 1,3 | 0,0 | 38,5 | 0,4 | 1,9 | 38,4 | 0,4 | 2,7 |
| **2024** | 0,0 | 0,0 | 0,0 | 1,0 | 0,0 | 0,0 | 342,5 | 0,0 | 24,0 | 95,1 | 0,7 | 4,7 | 1,0 | 1,3 | 0,0 | 38,5 | 0,4 | 1,9 | 39,9 | 0,4 | 2,8 |
| **2025** | 0,0 | 0,0 | 0,0 | 1,0 | 0,0 | 0,0 | 360,4 | 0,0 | 25,2 | 105,1 | 0,8 | 5,2 | 1,0 | 1,3 | 0,0 | 38,5 | 0,4 | 1,9 | 41,3 | 0,4 | 2,9 |
| **2026** | 0,0 | 0,0 | 0,0 | 1,0 | 0,0 | 0,0 | 378,9 | 0,0 | 26,5 | 116,3 | 0,8 | 5,8 | 1,0 | 1,3 | 0,0 | 57,7 | 0,6 | 2,9 | 42,7 | 0,4 | 3,0 |
| **2027** | 0,0 | 0,0 | 0,0 | 1,0 | 0,0 | 0,0 | 398,1 | 0,0 | 27,9 | 128,9 | 0,9 | 6,4 | 1,0 | 1,3 | 0,0 | 51,3 | 0,5 | 2,6 | 44,2 | 0,4 | 3,1 |
| **2028** | 0,0 | 0,0 | 0,0 | 1,0 | 0,0 | 0,0 | 418,1 | 0,0 | 29,3 | 143,3 | 1,0 | 7,1 | 1,0 | 1,3 | 0,0 | 57,7 | 0,6 | 2,9 | 45,6 | 0,5 | 3,2 |
| **2029** | 0,0 | 0,0 | 0,0 | 1,0 | 0,0 | 0,0 | 438,9 | 0,0 | 30,7 | 159,5 | 1,1 | 8,0 | 1,0 | 1,3 | 0,0 | 57,7 | 0,6 | 2,9 | 47,1 | 0,5 | 3,3 |
| **2030** | 0,0 | 0,0 | 0,0 | 1,0 | 0,0 | 0,0 | 460,6 | 0,0 | 32,2 | 177,9 | 1,2 | 8,9 | 1,0 | 1,3 | 0,0 | 57,7 | 0,6 | 2,9 | 48,5 | 0,5 | 3,4 |
| **Total** | 3,0 | 0,9 | 0,2 | 16,3 | 1,3 | 0,8 | 6079,7 | 0,0 | 425,6 | 1678,8 | 12,4 | 83,7 | 19,0 | 27,1 | 0,0 | 750,6 | 7,5 | 37,5 | 734,4 | 7,3 | 51, |

**Baseline Scenario. Total costs, million $ U.S.**
**Category Investment Entity - Government;**
**Sources of I&FF funds - Internal budgetary funds**

| | Improving the management of water resources allocation | Optimization of agricultural production | Implementation of activities that increase efficiency of irrigation systems | Introduction of advanced irrigation methods | Implementation of breeding work on the cultivation of drought resistant crops | Involvement of additional water resources | Construction of additional reservoirs | Other Investments |
|---|---|---|---|---|---|---|---|---|
| | IF+FF+O&M | IF+FF+O&M | IF+FF+O&M | IF+FF+O&M | IF+FF+O&M | IF+FF+O&M | IF+FF+O&M | IF+FF+O&M |
| **2009** | 0,1 | 0,0 | 129,3 | 28,8 | 1,0 | 0,0 | 19,7 | 11,5 |
| **2010** | 0,4 | 0,2 | 143,3 | 30,9 | 1,0 | 21,1 | 21,3 | 14,4 |
| **2011** | 0,5 | 0,4 | 157,5 | 33,2 | 1,9 | 20,4 | 22,8 | 16,3 |
| **2012** | 0,5 | 0,4 | 171,8 | 35,8 | 1,9 | 20,4 | 24,4 | 17,3 |
| **2013** | 0,5 | 0,4 | 186,4 | 38,6 | 1,9 | 20,4 | 25,9 | 18,3 |
| **2014** | 0,5 | 1,0 | 201,2 | 41,7 | 1,9 | 20,4 | 27,5 | 19,2 |
| **2015** | 0,5 | 1,0 | 216,1 | 45,1 | 1,9 | 20,4 | 29,1 | 20,2 |
| **2016** | 0,2 | 1,0 | 231,4 | 49,0 | 2,3 | 34,0 | 30,6 | 21,2 |
| **2017** | 0,2 | 1,0 | 246,9 | 53,2 | 2,3 | 34,0 | 32,2 | 22,1 |
| **2018** | 0,2 | 1,0 | 262,8 | 57,9 | 2,3 | 34,0 | 33,7 | 23,1 |
| **2019** | 0,2 | 1,0 | 279,0 | 63,2 | 2,3 | 34,0 | 35,3 | 24,0 |
| **2020** | 0,2 | 1,0 | 295,6 | 69,0 | 2,3 | 34,0 | 36,8 | 25,0 |
| **2021** | 0,0 | 1,0 | 312,6 | 75,6 | 2,3 | 40,8 | 38,4 | 26,9 |
| **2022** | 0,0 | 1,0 | 330,0 | 83,0 | 2,3 | 40,8 | 39,9 | 27,9 |
| **2023** | 0,0 | 1,0 | 348,0 | 91,3 | 2,3 | 40,8 | 41,5 | 28,8 |
| **2024** | 0,0 | 1,0 | 366,5 | 100,6 | 2,3 | 40,8 | 43,0 | 29,8 |
| **2025** | 0,0 | 1,0 | 385,6 | 111,1 | 2,3 | 40,8 | 44,6 | 30,8 |
| **2026** | 0,0 | 1,0 | 405,4 | 122,9 | 2,3 | 61,2 | 46,2 | 31,7 |
| **2027** | 0,0 | 1,0 | 426,0 | 136,3 | 2,3 | 54,4 | 47,7 | 32,7 |
| **2028** | 0,0 | 1,0 | 447,3 | 151,4 | 2,3 | 61,2 | 49,3 | 33,7 |
| **2029** | 0,0 | 1,0 | 469,6 | 168,5 | 2,3 | 61,2 | 50,8 | 34,6 |
| **2030** | 0,0 | 1,0 | 492,8 | 187,9 | 2,3 | 61,2 | 52,4 | 34,6 |
| **Total** | 4,1 | 18,5 | 6505,3 | 1774,9 | 46,2 | 795,7 | 793,1 | 544,2 |

**Table: Baseline Scenario: Cumulative Discounted IF, FF, and O&M Estimates, By Investment Type, Investment Entity, and Funding Source**

| Category of Investment Entity | Source of I&FF Funds | | Cumulative Discounted IF, FF, & O&M Estimates For Baseline Scenario (million 2005US$) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Investment Type 1 | | | Investment Type 2 | | | Investment Type 3 | | | Investment Type 4 | | | All Investment Types | | |
| | | | IF | FF | O&M costs | IF | FF | O&M costs | IF | FF | O&M costs | IF | FF | O&M costs | IF | FF | O&M costs |
| Households | Domestic | Equity and debt | | | | | | | | | | | | | | | |
| | Total Household Funds (all domestic) | | | | | | | | | | | | | | | | |
| Corporations | Domestic | Domestic equity (including internal cash flow) | | | | | | | | | | | | | | | |
| | | Domestic borrowing (bonds and loans) | | | | | | | | | | | | | | | |
| | | Total Domestic Sources | | | | | | | | | | | | | | | |
| | Foreign | Foreign direct investment (FDI) | | | | | | | | | | | | | | | |
| | | Foreign borrowing (loans) | | | | | | | | | | | | | | | |
| | | Foreign aid (ODA) | | | | | | | | | | | | | | | |
| | | Total Foreign Sources | | | | | | | | | | | | | | | |
| | Total Corporation Funds | | | | | | | | | | | | | | | | |
| Government | Domestic | Domestic funds (budgetary) | | | | | | | | | | | | | | | |
| | Foreign | Foreign borrowing (loans) | | | | | | | | | | | | | | | |
| | | Bilateral foreign aid (bilateral ODA) | | | | | | | | | | | | | | | |
| | | Multilateral foreign aid (multilateral ODA) | | | | | | | | | | | | | | | |
| | | Total Foreign Sources | | | | | | | | | | | | | | | |
| | Total Government Funds | | | | | | | | | | | | | | | | |
| Total | | | | | | | | | | | | | | | | | |

By position "Improving Water Resources Management in the baseline scenario is expected to complete all work by 2020. Implementation of such activities as "Optimizing distribution of agricultural production" and "Implementation of the breeding work on the cultivation of drought resistant crops, and others expected to be implemented gradually over the entire period (2009-2030 years), since these activities require considerable time.

**Key indicators of baseline scenario**

| Activity | The total amount of costs mln | Volume of savings (additional) water, billion $m^3$ |
|---|---|---|
| **Improving water management** | 4,1 | 2-3 |
| **Optimization of the distribution of agricultural production** | 18,5 | 1,0-1,5 |
| **Implementation of measures that increase efficiency of irrigation systems, including** | 6505 | |
| Implementation of a comprehensive reconstruction of irrigated land (Krause), an area of 143 ha | 1075 | 0,2-0,3 |
| Implementation of measures to improve the reclamation of land used (DRF) on the area 214 ha | 4155 | 0,2-0,3 |
| Reconstruction of existing and construction of new hydraulic structures that reduce waste and water management, etc. | 850 | 0,1-0,2 |
| **The introduction of advanced irrigation methods, including** | 1775 | |
| improvement of existing (traditional) methods of irrigation on the area of 385 ha | 6,6 | 0,3-0,4 |
| drip irrigation on the area of 38 ha | 844 | 0,1-0,3 |
| sprinkler on the area of 69 ha | 924 | 0,1-0,2 |
| **The involvement of additional water resources** | 796 | |
| slightly saline drainage water (to bring the volume of up to 650 million $m^3$) - 374 | 374 | 0,65 |
| ground water (to bring the volume of up to 470 million $m^3$ | 243 | 0,47 |
| Waste water (to bring the volume of up to 410 million $m^3$ | 179 | 0,41 |
| **Construction of additional reservoirs and increasing capacity of existing reservoirs** | 793 | 0,5 |
| **Total** | **10482** | **4,2-5,5** |

A special feature of this scenario is that all activities are carried out at a pace which was celebrated in the "historical" period.

The foregoing shows that the implementation activities identified by the baseline scenario, would not adapt fully to the expected climate change. With a total outlay of more than 10 billion dollars deficit of water resources can be covered only by 80%, in addition, there will be no possibility of expanding the irrigated area, which is required in connection with population growth and demand for its main food. Lack of water for irrigation will force reduced irrigation rates, as this will reduce crop yields and, ultimately, to reduce the efficiency of agricultural production and forced the import of basic foodstuffs.

### 2.2.5. Adaptation scenario

Adaptation scenario assumes implementation of the necessary adaptation measures for climate change conditions for sustainable security needs of agriculture in the irrigation water,. As mentioned above, water scarcity can be about 5.5 $km^3$ without the expansion of irrigated area.

Specific indicators for the calculation of investment in specific activities, such as IAPSO, Crozet, introduction of advanced irrigation methods are the same as the baseline. Due to the fact that the implementation of these activities in the adaptation scenario assumes a substantially larger area, their total value has grown. List of key adaptation measures as defined by experts, includes:

- Improving water resources management (transition to integrated water resources management - IWRM);
- Optimizing the distribution of agricultural production with due regard for the needs of the country in need of agricultural products and minimize the use of water resources (here a need to consider the development of economic and mathematical model to optimize distribution of agricultural production);
- Implementation of measures that increase efficiency of irrigation systems - reconstruction of canals and hydraulic structures, the implementation of anti activities, etc.;
- Introduction of progressive methods • irrigation (drip, sprinkler irrigation) and improve existing (traditional), namely, the use of siphons, pipes;
- Implementation of a comprehensive reconstruction of irrigated land (Krause). Complex reconstruction includes the following activities:
    - Head intake;
    - Main canal and distribution network;
    - Sprinklers and spillway, the waste network;
    - Drainage network;
    - A capital planning;
    - Pumping stations (if available);
    - Maintenance of the road.
- Implementation of measures to improve the reclamation of land used (DRF) - performed on lands that do not require complete reconstruction. In general, this work is the reconstruction and, if necessary, additional construction of collector-drainage network;
- Construction of additional reservoirs and increasing capacity of existing ones. The latter include such reservoirs as Hauzhanskoe and Saryyazynskoe.;
- Reconstruction of existing and construction of new hydraulic structures that reduce waste and water management, etc.
- Implementation of breeding work on the cultivation of drought resistant crops.

Involvement of the possibility of additional water (slightly saline drainage water, underground water and sewage) and their quantitative capabilities.

These activities were calculated investment and financial flows to 2030. The calculation showed that the implementation of planned activities on adaptation scenario would eliminate the deficit of water resources by 2030, while the total value of expenditure for the period 2009-2030 years. the order of 16.1 billion dollars.

Such events as the "Optimizing distribution of agricultural production, which includes the development of the optimization of economic and mathematical models and re-specialization of production to climatic zones of the country, as well as the" Implementation of the selection work on growing drought-resistant crops ", which includes research, conducting experiments do not change Depending on the scenario.

**Improving the management of water resources - 4,1 million.**

**Optimization of the distribution of agricultural production - 18,5 million dollars.**

**Implementation of the breeding work on the cultivation of drought-resistant crops - 46 million dollars.**

Costs for other adaptation measures is significantly higher compared with the baseline scenario:
**Implementation of measures that increase efficiency of irrigation systems - 8231 million, including:**

- Implementation of a comprehensive reconstruction of irrigated land (Krause), an area 357 ha - 2,876 million. (In the baseline scenario - an area 143 ha);
- Implementation of measures to improve the reclamation of land used (DRF) on the area 535 ha - 4445 million. (In the baseline scenario - an area of 214 ha);
- Reconstruction of existing and construction of new hydraulic structures that reduce waste and water management, etc. - 910 million dollars. (In the baseline scenario - 850 million dollars.).

**The introduction of advanced irrigation methods - 4437 million, including:**

- Improvement of existing (traditional) methods of irrigation in the area of 960 hectares - 16,4 million dollars. (In the baseline scenario - an area of 385 ha);
- Drip irrigation on the area of 96 hectares - 2110 million. (Baseline Scenario - an area of 38 ha);
- Sprinkler on the area of 172 hectares - 2,310 million. (In the baseline scenario - an area of 69 ha).

**The involvement of additional water resources - 796 million dollars, among them:**

- Slightly saline drainage water (to bring the volume of 1000 million $m^3$) - 612 million dollars. (In the baseline scenario - 650 million $m^3$);
- Ground water (to bring the volume of use to 870 million $m^3$) - 514 million dollars. (In the baseline scenario - 470 million $m^3$);
- Waste water (to bring the volume of up to 670 million $m^3$) - 356 million dollars. (In the baseline scenario - 410 million $m^3$).

**Construction of additional reservoirs and increase capacity of existing reservoirs - 1335 million.**

**Adaptation Scenarios costs by type of investment million U.S. $**
**Category Investment Entity - Government;**
**Sources of I&FF funds - Internal budgetary funds**

| | Improving the management of water resources allocation | | | Optimization of agricultural production | | | The implementation of activities that increase efficiency of irrigation systems | | | Introduction of advanced irrigation methods | | | Implementation of breeding work on the cultivation of drought resistant crops | | | Involvement of additional water resources | | | Construction additional reservoirs | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | IF | FF | O&M | IF | FF | O&M | IF | FF | O&M | IF | FF | O&M | IF | FF | O&M | IF | FF | O&M | IF | FF | C |
| **2009** | 0,0 | 0,1 | 0,0 | 0,0 | 0,0 | 0,0 | 143,4 | 0,0 | 10,0 | 68,0 | 0,6 | 3,4 | 0,4 | 0,6 | 0,0 | 0,0 | 0,0 | 0,0 | 19,2 | 0,2 | |
| **2010** | 0,1 | 0,3 | 0,0 | 0,0 | 0,2 | 0,0 | 158,8 | 0,0 | 11,1 | 73,0 | 0,6 | 3,6 | 0,4 | 0,6 | 0,0 | 32,7 | 0,3 | 1,6 | 21,2 | 0,2 | |
| **2011** | 0,4 | 0,1 | 0,0 | 0,0 | 0,4 | 0,0 | 174,5 | 0,0 | 12,2 | 78,5 | 0,7 | 3,9 | 0,8 | 1,2 | 0,0 | 38,5 | 0,4 | 1,9 | 23,3 | 0,2 | |
| **2012** | 0,4 | 0,1 | 0,0 | 0,0 | 0,4 | 0,0 | 190,7 | 0,0 | 13,3 | 84,5 | 0,7 | 4,2 | 0,8 | 1,2 | 0,0 | 38,5 | 0,4 | 1,9 | 25,6 | 0,3 | |
| **2013** | 0,4 | 0,1 | 0,0 | 0,0 | 0,4 | 0,0 | 207,3 | 0,0 | 14,5 | 91,2 | 0,8 | 4,5 | 0,8 | 1,2 | 0,0 | 38,5 | 0,4 | 1,9 | 28,2 | 0,3 | |
| **2014** | 0,4 | 0,1 | 0,0 | 1,0 | 0,0 | 0,0 | 224,4 | 0,0 | 15,7 | 98,5 | 0,8 | 4,9 | 0,8 | 1,2 | 0,0 | 38,5 | 0,4 | 1,9 | 31,0 | 0,3 | |
| **2015** | 0,4 | 0,1 | 0,0 | 1,0 | 0,0 | 0,0 | 242,0 | 0,0 | 16,9 | 106,7 | 0,9 | 5,3 | 0,8 | 1,2 | 0,0 | 38,5 | 0,4 | 1,9 | 34,1 | 0,3 | |
| **2016** | 0,2 | 0,0 | 0,0 | 1,0 | 0,0 | 0,0 | 260,3 | 0,0 | 18,2 | 115,7 | 0,9 | 5,8 | 1,0 | 1,3 | 0,0 | 51,3 | 0,5 | 2,6 | 37,5 | 0,4 | |
| **2017** | 0,2 | 0,0 | 0,0 | 1,0 | 0,0 | 0,0 | 279,2 | 0,0 | 19,5 | 125,7 | 1,0 | 6,3 | 1,0 | 1,3 | 0,0 | 51,3 | 0,5 | 2,6 | 41,2 | 0,4 | |
| **2018** | 0,2 | 0,0 | 0,0 | 1,0 | 0,0 | 0,0 | 298,9 | 0,0 | 20,9 | 136,8 | 1,1 | 6,8 | 1,0 | 1,3 | 0,0 | 51,3 | 0,5 | 2,6 | 45,4 | 0,5 | |
| **2019** | 0,2 | 0,0 | 0,0 | 1,0 | 0,0 | 0,0 | 319,3 | 0,0 | 22,4 | 149,3 | 1,2 | 7,4 | 1,0 | 1,3 | 0,0 | 51,3 | 0,5 | 2,6 | 49,9 | 0,5 | |
| **2020** | 0,2 | 0,0 | 0,0 | 1,0 | 0,0 | 0,0 | 340,7 | 0,0 | 23,8 | 163,2 | 1,3 | 8,1 | 1,0 | 1,3 | 0,0 | 51,3 | 0,5 | 2,6 | 54,9 | 0,5 | |
| **2021** | 0,0 | 0,0 | 0,0 | 1,0 | 0,0 | 0,0 | 363,0 | 0,0 | 25,4 | 178,7 | 1,4 | 8,9 | 1,0 | 1,3 | 0,0 | 83,3 | 0,8 | 4,2 | 60,4 | 0,6 | |
| **2022** | 0,0 | 0,0 | 0,0 | 1,0 | 0,0 | 0,0 | 386,4 | 0,0 | 27,0 | 196,2 | 1,5 | 9,8 | 1,0 | 1,3 | 0,0 | 83,3 | 0,8 | 4,2 | 66,4 | 0,7 | |
| **2023** | 0,0 | 0,0 | 0,0 | 1,0 | 0,0 | 0,0 | 411,0 | 0,0 | 28,8 | 215,8 | 1,6 | 10,8 | 1,0 | 1,3 | 0,0 | 83,3 | 0,8 | 4,2 | 73,1 | 0,7 | |
| **2024** | 0,0 | 0,0 | 0,0 | 1,0 | 0,0 | 0,0 | 436,9 | 0,0 | 30,6 | 237,8 | 1,7 | 11,9 | 1,0 | 1,3 | 0,0 | 83,3 | 0,8 | 4,2 | 76,7 | 0,8 | |
| **2025** | 0,0 | 0,0 | 0,0 | 1,0 | 0,0 | 0,0 | 464,2 | 0,0 | 32,5 | 262,7 | 1,9 | 13,1 | 1,0 | 1,3 | 0,0 | 83,3 | 0,8 | 4,2 | 80,5 | 0,8 | |
| **2026** | 0,0 | 0,0 | 0,0 | 1,0 | 0,0 | 0,0 | 493,1 | 0,0 | 34,5 | 290,7 | 2,1 | 14,5 | 1,0 | 1,3 | 0,0 | 96,2 | 1,0 | 4,8 | 84,6 | 0,8 | |
| **2027** | 0,0 | 0,0 | 0,0 | 1,0 | 0,0 | 0,0 | 523,7 | 0,0 | 36,7 | 322,4 | 2,2 | 16,1 | 1,0 | 1,3 | 0,0 | 96,2 | 1,0 | 4,8 | 88,8 | 0,9 | |
| **2028** | 0,0 | 0,0 | 0,0 | 1,0 | 0,0 | 0,0 | 556,2 | 0,0 | 38,9 | 358,2 | 2,4 | 17,9 | 1,0 | 1,3 | 0,0 | 96,2 | 1,0 | 4,8 | 93,2 | 0,9 | |
| **2029** | 0,0 | 0,0 | 0,0 | 1,0 | 0,0 | 0,0 | 590,8 | 0,0 | 41,4 | 398,7 | 2,7 | 19,9 | 1,0 | 1,3 | 0,0 | 96,2 | 1,0 | 4,8 | 97,9 | 1,0 | |
| **2030** | 0,0 | 0,0 | 0,0 | 1,0 | 0,0 | 0,0 | 627,7 | 0,0 | 43,9 | 444,7 | 2,9 | 22,2 | 1,0 | 1,3 | 0,0 | 115,4 | 1,2 | 5,8 | 102,8 | 1,0 | |
| **Total** | 3,0 | 0,9 | 0,2 | 16,3 | 1,3 | 0,8 | 7692,5 | 0,0 | 538,5 | 4197,0 | 31,0 | 209,2 | 19,0 | 27,1 | 0,0 | 1398,1 | 14,0 | 69,9 | 1235,8 | 12,4 | 8 |

**Adaptation Scenario. Total costs, million $ U.S.**
**Category Investment Entity - Government;**
**Sources of I&FF funds - Internal budgetary funds**

| | Improving water management | Optimization of distribution of agricultural production | Implementation of measures that increase efficiency of irrigation systems | Introduction of advanced irrigation methods | Implementation of breeding work on the cultivation of drought resistant crops | Involvement of additional water resources | Construction of additional reservoirs | Other investments |
|---|---|---|---|---|---|---|---|---|
| | IF+FF+O&M | IF+FF+O&M | IF+FF+O&M | IF+FF+O&M | IF+FF+O&M | IF+FF+O&M | IF+FF+O&M | IF+FF+O&M |
| **2009** | 0,1 | 0,0 | 153,5 | 72,0 | 1,0 | 0,0 | 20,8 | 11,5 |
| **2010** | 0,4 | 0,2 | 169,9 | 77,3 | 1,0 | 34,7 | 22,9 | 14,4 |
| **2011** | 0,5 | 0,4 | 186,7 | 83,1 | 1,9 | 40,8 | 25,1 | 16,3 |
| **2012** | 0,5 | 0,4 | 204,0 | 89,5 | 1,9 | 40,8 | 27,7 | 17,3 |
| **2013** | 0,5 | 0,4 | 221,8 | 96,5 | 1,9 | 40,8 | 30,4 | 18,3 |
| **2014** | 0,5 | 1,0 | 240,1 | 104,3 | 1,9 | 40,8 | 33,5 | 19,2 |
| **2015** | 0,5 | 1,0 | 259,0 | 112,9 | 1,9 | 40,8 | 36,8 | 20,2 |
| **2016** | 0,2 | 1,0 | 278,5 | 122,4 | 2,3 | 54,4 | 40,5 | 21,2 |
| **2017** | 0,2 | 1,0 | 298,7 | 133,0 | 2,3 | 54,4 | 44,5 | 22,1 |
| **2018** | 0,2 | 1,0 | 319,8 | 144,7 | 2,3 | 54,4 | 49,0 | 23,1 |
| **2019** | 0,2 | 1,0 | 341,7 | 157,9 | 2,3 | 54,4 | 53,9 | 24,0 |
| **2020** | 0,2 | 1,0 | 364,5 | 172,6 | 2,3 | 54,4 | 59,3 | 25,0 |
| **2021** | 0,0 | 1,0 | 388,4 | 189,0 | 2,3 | 88,3 | 65,2 | 26,9 |
| **2022** | 0,0 | 1,0 | 413,5 | 207,4 | 2,3 | 88,3 | 71,7 | 27,9 |
| **2023** | 0,0 | 1,0 | 439,8 | 228,1 | 2,3 | 88,3 | 78,9 | 28,8 |
| **2024** | 0,0 | 1,0 | 467,5 | 251,4 | 2,3 | 88,3 | 82,8 | 29,8 |
| **2025** | 0,0 | 1,0 | 496,7 | 277,7 | 2,3 | 88,3 | 87,0 | 30,8 |
| **2026** | 0,0 | 1,0 | 527,6 | 307,2 | 2,3 | 101,9 | 91,3 | 31,7 |
| **2027** | 0,0 | 1,0 | 560,4 | 340,7 | 2,3 | 101,9 | 95,9 | 32,7 |
| **2028** | 0,0 | 1,0 | 595,1 | 378,5 | 2,3 | 101,9 | 100,7 | 33,7 |
| **2029** | 0,0 | 1,0 | 632,2 | 421,3 | 2,3 | 101,9 | 105,7 | 34,6 |
| **2030** | 0,0 | 1,0 | 671,7 | 469,8 | 2,3 | 122,3 | 111,0 | 34,6 |
| **Total** | 4,1 | 18,5 | 8230,9 | 4437,2 | 46,2 | 1482,0 | 1334,7 | 544,2 |

**Table: Adaptation Scenario: Cumulative Discounted IF, FF, and O&M Estimates, By Investment Type, Investment Entity, and Funding Source**

| Category of Investment Entity | Source of I&FF Funds | | Cumulative Discounted IF, FF, & O&M Estimates For Adaptation Scenario (million 2005US$) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Investment Type 1 | | | Investment Type 2 | | | Investment Type 3 | | | Investment Type 4 | | | All Investment Types | | |
| | | | IF | FF | O&M costs | IF | FF | O&M costs | IF | FF | O&M costs | IF | FF | O&M costs | IF | FF | O&M costs |
| Households | Domestic | Equity and debt | | | | | | | | | | | | | | | |
| | Total Household Funds (all domestic) | | | | | | | | | | | | | | | | |
| Corporations | Domestic | Domestic equity (including internal cash flow) | | | | | | | | | | | | | | | |
| | | Domestic borrowing (bonds and loans) | | | | | | | | | | | | | | | |
| | | Total Domestic Sources | | | | | | | | | | | | | | | |
| | Foreign | Foreign direct investment (FDI) | | | | | | | | | | | | | | | |
| | | Foreign borrowing (loans) | | | | | | | | | | | | | | | |
| | | Foreign aid (ODA) | | | | | | | | | | | | | | | |
| | | Total Foreign Sources | | | | | | | | | | | | | | | |
| | Total Corporation Funds | | | | | | | | | | | | | | | | |
| Government | Domestic | Domestic funds (budgetary) | | | | | | | | | | | | | | | |
| | Foreign | Foreign borrowing (loans) | | | | | | | | | | | | | | | |
| | | Bilateral foreign aid (bilateral ODA) | | | | | | | | | | | | | | | |
| | | Multilateral foreign aid (multilateral ODA) | | | | | | | | | | | | | | | |
| | | Total Foreign Sources | | | | | | | | | | | | | | | |
| | Total Government Funds | | | | | | | | | | | | | | | | |
| Total | | | | | | | | | | | | | | | | | |

Improving the management of water resources allocation optimization of agricultural production The implementation of activities that increase efficiency of irrigation systems, introduction of advanced irrigation methods Implementation of breeding work on the cultivation of drought resistant crops Involvement of additional water resources

The annual cost of "Implementation of measures that increase efficiency of irrigation systems" subject to the implementation of adaptation scenario for the period from 2009 to 2030 at an annual 6-10% increase in Mr. increase more than 4 times. It is argued that this period will increase significantly and the material-technical base, and the financial ability of the state to implement such measures.

Adaptation scenario provides for the event, "The introduction of advanced irrigation methods" for the period from 2009 to 2030 with an annual 7-11% increase in Mr. costs will increase by more than 6 times. This is because, firstly, in this scenario is expected to significantly increase the amount of land which will be introduced advanced irrigation methods and, secondly, these events are accompanied by significant water savings, increasing productivity and improving agriculture.

**The main indicators of adaptation scenario**

| Activity | The total amount of costs, mln | The total volume of savings (additional) water, billion $m^3$ |
|---|---|---|
| **Improving water management** | 4,1 | 0,2-0,3 |
| **Optimization of the distribution of agricultural production** | 18,5 | 1,0-1,5 |
| **Implementation of measures that increase efficiency of irrigation systems, including** | 8231 | |
| Implementation of a comprehensive reconstruction of irrigated land (Krause) - an area of 357 ha | 2876 | 0,4-0,5 |
| Implementation of measures to improve the reclamation of land used (DRF) - an area of 535 ha | 4445 | 0,4-0,5 |
| Reconstruction of existing and construction of new hydraulic structures that reduce waste and water management, etc. | 910 | 0,2-0,3 |
| **The introduction of advanced irrigation methods, including** | 4437 | |
| improving the existing (traditional) methods of irrigation - an area of 385 ha | 16,4 | 0,7-0,8 |
| drip irrigation - an area of 96 ha | 2110 | 0,4-0,5 |
| sprinkler irrigation - an area of 69 hectares | 2310 | 0,4-0,5 |
| **The involvement of additional water resources** | 1398 | |
| slightly saline drainage water (to bring the volume of 1000 million $m^3$) | 577 | 1,0 |
| ground water (to bring the volume of up to 870 million $m^3$) | 485 | 0,9 |
| Waste water (to bring the volume of up to 670 million $m^3$) | 336 | 0,7 |
| **Construction of additional reservoirs and increasing capacity of existing reservoirs** | 1335 | 1,0 |
| TOTAL | 15424 | 7,3-8,5 |

The foregoing shows that activities in the water sector, identified by the adaptation scenario, will be fully adapted to the expected climate change. With a total outlay of more than 15 billion dollars (taking into account other costs - more than 16 billion dollars) deficit of water resources will be fully covered, in addition, there is the possibility of expanding the irrigated area, which is required in connection with population growth and demand for its main food. It should be noted that the adaptation scenario takes into account the most adverse climate change scenario.

# 3. Results

The main result of this work / project is that for the first time in Turkmenistan, an analysis of investment and financial flows in the sector "Water management" of the most vulnerable to climate change and adaptation measures have been developed to facilitate removal of water scarcity. National water specialists have acquired skills investment financial analysis. International experts gave their experience of national experts and trained their leadership on financial analysis. The project has provided significant assistance to the National Panel on Climate Change in the coverage of issues of global climate change among decision-makers and leaders of ministries and departments.

The project also demonstrated the economic benefits of carrying out adaptation activities. Given an annual average income obtained from 1 ha of irrigated area is equal to U.S. $ 350, it can be concluded that the elimination of the deficit of water 5 km 3, the irrigated area increased by 500 thousand hectares, and the benefit from conducting adaptation measures will be about 175 million dollars. U.S.

## 3.1. Additional changes to the IF, FF and O&M expenditures, as well as the cost of subsidies

Additional changes represent the difference in all types of investment in adaptation scenarios compared to baseline.

The volume of investment in some activities in both scenarios is the same, that is because the "Optimizing distribution of agricultural production, which includes the development of the optimization of economic and mathematical models and re-specialization of production in the zones of the country, as well as" Implementation of the breeding work on the cultivation of drought resistant crops, includes research, conducting experiments do not vary depending on the scenario and require considerable time.

Costs for other adaptation measures is significantly higher compared with the baseline scenario, due to the significant increase in the amount of work (for example, increase the amount of land subject to complex reconstruction, introduction of advanced irrigation methods over a larger area, etc.).

**Implementation of measures that increase efficiency of irrigation systems - 8231 million, including:**

- Implementation of a comprehensive reconstruction of irrigated land (Krause), an area 357 ha - 2,876 million.
- Implementation of measures to improve the reclamation of land used (DRF) on the area 535 ha - 4445 million.
- Reconstruction of existing and construction of new hydraulic structures that reduce waste and water management, etc. - 910 million dollars.

**The introduction of advanced irrigation methods - 4437 million, including:**

- Improvement of existing (traditional) methods of irrigation in the area of 960 hectares - 16,4 million dollars.
- Drip irrigation on the area of 96 hectares - 2110 million.
- Sprinkler on the area of 172 hectares - 2,310 million.

**The involvement of additional water resources - 796 million dollars, among them:**

- Slightly saline drainage water (to bring the volume of 1000 million $m^3$) - 612 million dollars.
- Ground water (to bring the volume of use to 870 million $m^3$) - 514 million dollars.
- Waste water (to bring the volume of up to 670 million $m^3$) - 356 million dollars.

**Construction of additional reservoirs and increase capacity of existing reservoirs - 1335 million. This concerns such reservoirs, such as:**

- Increase capacity and Saryyazynskogo Hauzhanskogo reservoirs;
- Construction of additional capacity Zeidskogo reservoir;

- Construction of small reservoirs obnemu on small rivers

In calculating the acceptance of the conditions that investment on items such as improving water resource management, optimization of the distribution of agricultural production, the implementation of breeding work on the cultivation of drought-tolerant crops - the same in both scenarios. In other activities, investments made in the adaptation scenario is significantly higher than in the base. The total amount of costs in the baseline scenario for the period 2009-2030 years is 10482 million dollars. And on adaptation scenario - 16,098 million dollars. Ie additional quantity of investment is 5616 million dollars.

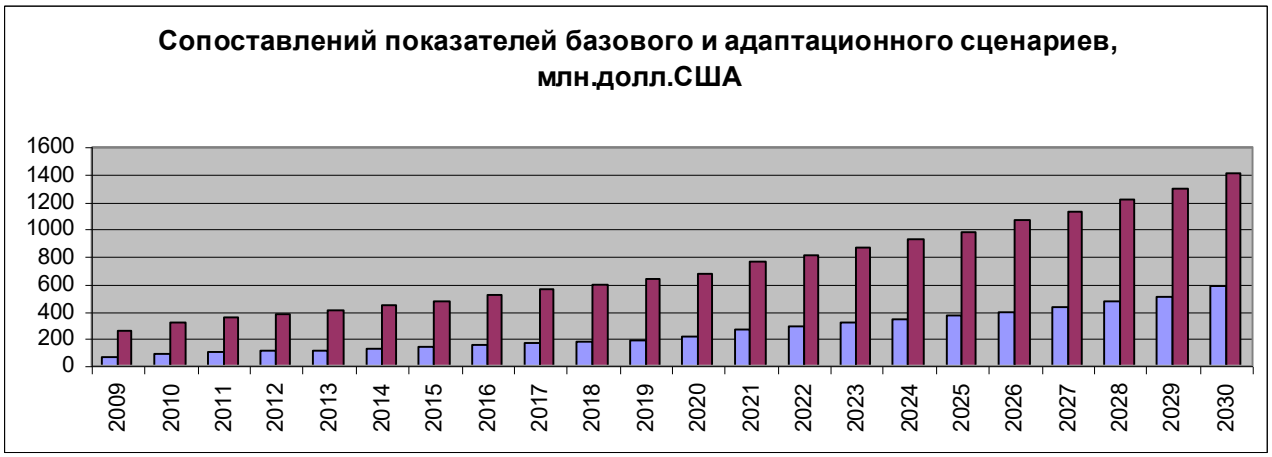
The table lists the additional investment by the established cost, and their discounted value. Discount rate adopted in the calculation - 0,10.

**Additional costs by type of investment million U.S. $**
**Category Investment Entity - Government;**
**Sources of I&FF funds - Internal budgetary funds**

| | Improving the management of water resources allocation | | | Optimization of agricultural production | | | Implementation activities that increase efficiency of irrigation systems | | | Introduction of advanced irrigation methods | | | Implementation of breeding work on the cultivation of drought resistant crops | | | Involvement of additional water resources | | | Construction of additional reservoirs | | | Other Investments | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | IF | FF | O&M | IF | FF | O&M | IF | FF | O&M | IF | FF | O&M | IF | FF | O&M | IF | FF | O&M | IF | FF | O&M | IF | FF | O |
| **2009** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 22,6 | 0,0 | 1,6 | 40,8 | 0,4 | 2,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1,0 | 0,0 | **0,1** | **0,0** | **0,0** | **0** |
| **2010** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 24,8 | 0,0 | 1,7 | 43,8 | 0,4 | 2,2 | 0,0 | 0,0 | 0,0 | 12,8 | 0,1 | 0,6 | 1,5 | 0,0 | **0,1** | **0,0** | **0,0** | **0** |
| **2011** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 27,3 | 0,0 | 1,9 | 47,1 | 0,4 | 2,3 | 0,0 | 0,0 | 0,0 | 19,2 | 0,2 | 1,0 | 2,1 | 0,0 | **0,1** | **0,0** | **0,0** | **0** |
| **2012** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 30,1 | 0,0 | 2,1 | 50,7 | 0,4 | 2,5 | 0,0 | 0,0 | 0,0 | 19,2 | 0,2 | 1,0 | 3,0 | 0,0 | **0,2** | **0,0** | **0,0** | **0** |
| **2013** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 33,1 | 0,0 | 2,3 | 54,7 | 0,5 | 2,7 | 0,0 | 0,0 | 0,0 | 19,2 | 0,2 | 1,0 | 4,1 | 0,0 | **0,3** | **0,0** | **0,0** | **0** |
| **2014** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 36,4 | 0,0 | 2,5 | 59,1 | 0,5 | 2,9 | 0,0 | 0,0 | 0,0 | 19,2 | 0,2 | 1,0 | 5,5 | 0,1 | **0,4** | **0,0** | **0,0** | **0** |
| **2015** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 40,0 | 0,0 | 2,8 | 64,0 | 0,5 | 3,2 | 0,0 | 0,0 | 0,0 | 19,2 | 0,2 | 1,0 | 7,2 | 0,1 | **0,5** | **0,0** | **0,0** | **0** |
| **2016** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 44,0 | 0,0 | 3,1 | 69,4 | 0,6 | 3,5 | 0,0 | 0,0 | 0,0 | 19,2 | 0,2 | 1,0 | 9,1 | 0,1 | **0,6** | **0,0** | **0,0** | **0** |
| **2017** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 48,4 | 0,0 | 3,4 | 75,4 | 0,6 | 3,8 | 0,0 | 0,0 | 0,0 | 19,2 | 0,2 | 1,0 | 11,5 | 0,1 | **0,8** | **0,0** | **0,0** | **0** |
| **2018** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 53,3 | 0,0 | 3,7 | 82,1 | 0,7 | 4,1 | 0,0 | 0,0 | 0,0 | 19,2 | 0,2 | 1,0 | 14,1 | 0,1 | **1,0** | **0,0** | **0,0** | **0** |
| **2019** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 58,6 | 0,0 | 4,1 | 89,6 | 0,7 | 4,5 | 0,0 | 0,0 | 0,0 | 19,2 | 0,2 | 1,0 | 17,2 | 0,2 | **1,2** | **0,0** | **0,0** | **0** |
| **2020** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 64,4 | 0,0 | 4,5 | 97,9 | 0,8 | 4,9 | 0,0 | 0,0 | 0,0 | 19,2 | 0,2 | 1,0 | 20,8 | 0,2 | **1,5** | **0,0** | **0,0** | **0** |
| **2021** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 70,9 | 0,0 | 5,0 | 107,2 | 0,8 | 5,3 | 0,0 | 0,0 | 0,0 | 44,9 | 0,4 | 2,2 | 24,8 | 0,2 | **1,7** | **0,0** | **0,0** | **0** |
| **2022** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 78,0 | 0,0 | 5,5 | 117,7 | 0,9 | 5,9 | 0,0 | 0,0 | 0,0 | 44,9 | 0,4 | 2,2 | 29,4 | 0,3 | **2,1** | **0,0** | **0,0** | **0** |
| **2023** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 85,8 | 0,0 | 6,0 | 129,5 | 1,0 | 6,5 | 0,0 | 0,0 | 0,0 | 44,9 | 0,4 | 2,2 | 34,6 | 0,3 | **2,4** | **0,0** | **0,0** | **0** |
| **2024** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 94,3 | 0,0 | 6,6 | 142,7 | 1,0 | 7,1 | 0,0 | 0,0 | 0,0 | 44,9 | 0,4 | 2,2 | 36,8 | 0,4 | **2,6** | **0,0** | **0,0** | **0** |
| **2025** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 103,8 | 0,0 | 7,3 | 157,6 | 1,1 | 7,9 | 0,0 | 0,0 | 0,0 | 44,9 | 0,4 | 2,2 | 39,2 | 0,4 | **2,7** | **0,0** | **0,0** | **0** |
| **2026** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 114,2 | 0,0 | 8,0 | 174,4 | 1,2 | 8,7 | 0,0 | 0,0 | 0,0 | 38,5 | 0,4 | 1,9 | 41,8 | 0,4 | **2,9** | **0,0** | **0,0** | **0** |
| **2027** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 125,6 | 0,0 | 8,8 | 193,4 | 1,3 | 9,6 | 0,0 | 0,0 | 0,0 | 44,9 | 0,4 | 2,2 | 44,6 | 0,4 | **3,1** | **0,0** | **0,0** | **0** |
| **2028** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 138,1 | 0,0 | 9,7 | 214,9 | 1,5 | 10,7 | 0,0 | 0,0 | 0,0 | 38,5 | 0,4 | 1,9 | 47,6 | 0,5 | **3,3** | **0,0** | **0,0** | **0** |
| **2029** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 152,0 | 0,0 | 10,6 | 239,2 | 1,6 | 11,9 | 0,0 | 0,0 | 0,0 | 38,5 | 0,4 | 1,9 | 50,8 | 0,5 | **3,6** | **0,0** | **0,0** | **0** |
| **2030** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 167,1 | 0,0 | 11,7 | 266,8 | 1,8 | 13,3 | 0,0 | 0,0 | 0,0 | 57,7 | 0,6 | 2,9 | 54,3 | 0,5 | **3,8** | **0,0** | **0,0** | **0** |
| **Total** | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 0,0 | 1612,7 | 0,0 | 112,9 | 2518,2 | 18,6 | 125,5 | 0,0 | 0,0 | 0,0 | 647,4 | 6,5 | 32,4 | 501,4 | 5,0 | **35,1** | **0,0** | **0,0** | **0** |

**Table: Incremental Cumulative Discounted IF & FF Estimates, By Investment Type, Investment Entity, and Funding Source**

| Category of Investment Entity | Source of I&FF Funds | | Incremental Cumulative Discounted IF, FF, & O&M Estimates (million 2005US$) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Investment Type 1 | | | Investment Type 2 | | | Investment Type 3 | | | Investment Type 4 | | | All Investment Types | | |
| | | | ΔIF | ΔFF | ΔO&M costs | ΔIF | ΔFF | ΔO&M costs | ΔIF | ΔFF | ΔO&M costs | ΔIF | ΔFF | ΔO&M costs | ΔIF | ΔFF | ΔO&M costs |
| Households | Domestic | Equity and debt | | | | | | | | | | | | | | | |
| | Total Household Funds (all domestic) | | | | | | | | | | | | | | | | |
| Corporations | Domestic | Domestic equity (including internal cash flow) | | | | | | | | | | | | | | | |
| | | Domestic borrowing (bonds and loans) | | | | | | | | | | | | | | | |
| | | Total Domestic Sources | | | | | | | | | | | | | | | |
| | Foreign | Foreign direct investment (FDI) | | | | | | | | | | | | | | | |
| | | Foreign borrowing (loans) | | | | | | | | | | | | | | | |
| | | Foreign aid (ODA) | | | | | | | | | | | | | | | |
| | | Total Foreign Sources | | | | | | | | | | | | | | | |
| | Total Corporation Funds | | | | | | | | | | | | | | | | |
| Government | Domestic | Domestic funds (budgetary) | | | | | | | | | | | | | | | |
| | Foreign | Foreign borrowing (loans) | | | | | | | | | | | | | | | |
| | | Bilateral foreign aid (bilateral ODA) | | | | | | | | | | | | | | | |
| | | Multilateral foreign aid (multilateral ODA) | | | | | | | | | | | | | | | |
| | | Total Foreign Sources | | | | | | | | | | | | | | | |
| | Total Government Funds | | | | | | | | | | | | | | | | |
| Total | | | | | | | | | | | | | | | | | |




**Additional annual IF, FF and OO, million $ U.S.**
**Category Investment Entity - Government;**
**Sources of I&FF funds - Internal budgetary funds**

| Year | Without discounting | | | With discounting | | |
|---|---|---|---|---|---|---|
| | **ΔIF** | **ΔFF** | **ΔO&M** | **ΔIF** | **ΔFF** | **ΔO&M** |
| **2009** | 64,4 | 0,4 | 3,7 | 64,4 | 0,4 | 3,7 |
| **2010** | 82,9 | 0,5 | 4,7 | 75,4 | 0,5 | 4,2 |
| **2011** | 95,8 | 0,6 | 5,4 | 79,2 | 0,5 | 4,4 |
| **2012** | 103,0 | 0,7 | 5,8 | 77,4 | 0,5 | 4,4 |
| **2013** | 111,2 | 0,7 | 6,3 | 75,9 | 0,5 | 4,3 |
| **2014** | 120,2 | 0,7 | 6,8 | 74,7 | 0,5 | 4,2 |
| **2015** | 130,4 | 0,8 | 7,5 | 73,6 | 0,4 | 4,2 |
| **2016** | 141,8 | 0,9 | 8,1 | 72,8 | 0,4 | 4,2 |
| **2017** | 154,5 | 0,9 | 8,9 | 72,1 | 0,4 | 4,2 |
| **2018** | 168,7 | 1,0 | 9,8 | 71,6 | 0,4 | 4,1 |
| **2019** | 184,6 | 1,1 | 10,7 | 71,2 | 0,4 | 4,1 |
| **2020** | 202,4 | 1,2 | 11,8 | 70,9 | 0,4 | 4,1 |
| **2021** | 247,8 | 1,5 | 14,3 | 79,0 | 0,5 | 4,6 |
| **2022** | 270,0 | 1,6 | 15,6 | 78,2 | 0,5 | 4,5 |
| **2023** | 294,8 | 1,8 | 17,1 | 77,6 | 0,5 | 4,5 |
| **2024** | 318,8 | 1,9 | 18,5 | 76,3 | 0,4 | 4,4 |
| **2025** | 345,5 | 2,0 | 20,1 | 75,2 | 0,4 | 4,4 |
| **2026** | 368,9 | 2,0 | 21,5 | 73 | 0,4 | 4,3 |
| **2027** | 408,5 | 2,2 | 23,8 | 73,5 | 0,4 | 4,3 |
| **2028** | 439,1 | 2,3 | 25,6 | 71,8 | 0,4 | 4,2 |
| **2029** | 480,5 | 2,5 | 28,1 | 71,4 | 0,4 | 4,2 |
| **2030** | 545,9 | 2,9 | 31,7 | 73,8 | 0,4 | 4,3 |
| **Total** | **5279,8** | **30,1** | **305,9** | **1628,9** | **9,6** | **93,8** |

## 3.2. Policy implications

Despite the fact that the existing legislative framework makes it possible now to successfully implement water management in the country, the expected climate change, increasing water scarcity and the introduction of the industry's new economic mechanisms necessitated the strengthening of legislative and legal and regulatory framework for water management in Turkmenistan.

Implementation of the presented scenarios require specific actions such as enactment of the transition to paid use of water or a decision to move to a system of integrated water resources management, etc. This primarily concerns political decisions on the following:

- The transition from administrative district of the principle of water management in the management of irrigation systems - Integrated Water Resources Management (IWRM);
- Study and implementation experience of water user associations and farmers associations;
- Gradual introduction of paid water use;
- Encouraging the introduction of new technologies that economize irrigation water;
- Increased breeding work on the cultivation of drought-and salt-tolerant crops.

The existing legal framework of water relations did not meet modern requirements and require improvement. Administrative-territorial system of water management leads to inconsistency management decisions within a single pool. There is inconsistency in the use and protection of water resources (surface, underground, return water), the gap and lack of coherence between the individual links and the levels of water management, lack of mutual interest between the management of water resources and water users to improve productivity of water use. All this requires a gradual and consistent implementation of IWRM principles.

One of the basic principles of IWRM is the creation of on-farm level self-government water resources. At present, Turkmenistan, management of water resources at farm level is carried out by households - water users under the contract and with technical assistance to public water agencies. At the meeting of the XX National Meeting of Turkmenistan in March 2007, laws were passed "On farms" and "On farmers' associations", which outlines the education of larger associations of peasants, instead of individual small farmers and tenants. On the basis of these associations and may be streamlining and improving water management at farm level.

Experience in implementing integrated water resources management (IWRM) exists in many countries, and in Turkmenistan this activity is just beginning. As a pilot project is one of the irrigation channels in Lebap channel (channel Boerse) is governed by this principle. The Government of the country's wise to consider the results of this project and if necessary, to consider the introduction of this mechanism in other aquatic systems. To do this, government should decide to change the structure of management of water complex.

As noted earlier, in Turkmenistan, surface sources, mostly are transboundary. Countries in the basins of transboundary rivers, united by aquatic ecosystems. Any changes in water management in one country will inevitably affect the interests of other countries. The need for a modern interconnected and coordinated management of transboundary water resources caused by nature and requires the creation and development of a cooperative mechanism for integrated approaches.

As is known, tension in the management of transboundary water resources in Central Asia has developed in the basins of the Amu Darya and Syr Darya. The Central Asian countries have a great experience working together to address the problems of interstate water relations, the positive results of which are recognized worldwide. Another 18 February 1992 the heads of departments of water management in Central Asia Kazakhstan signed the "Agreement between the Central Asian states on cooperation in joint management and protection of water resources of interstate sources", which was subsequently endorsed by Heads of State March 26, 1993 in Kyzyl-Orda. This Agreement, the parties have created the Interstate Coordination Water Commission (ICWC), the executive bodies BWO Amu Darya "and BVO "Syr".

In regional level systematically conducted interstate dialogue.

As an example:
In the Nukus Declaration of Central Asian states and international organizations on issues of sustainable development in the Aral Sea (September 1995) signed by the heads of all five countries, said:
***"We reiterate our full support for international agreements, in particular, the Declaration on the Sustainable Development (Rio de Janeiro, 1992), World Charter for Nature, the international convention to combat desertification, global climate change, conservation of biological diversity and the protection of transboundary waters. In addition, we believe it necessary to establish an international convention on Sustainable Development in the Aral Sea. Issues of joint water and unification of environmental standards and related legislation should take priority in her position."***

Ashgabat Declaration on 04/09/1999 Ashgabat
***... Considering that the use of water resources in the Aral Sea should be in the interests of all countries with the principles of good neighborliness and mutual interests, stressing the importance of the efforts of the founders of the fund to enhance cooperation on water resources management and environmental protection, restoration of aquatic ecosystems, prevent pollution of transboundary waters.***

Dushanbe Declaration of Dushanbe 10/06/2002
***... the need for a special UN commission and the development of the Concept of Sustainable Development of the Aral Sea ...***

Recognition of the principles of international law basin countries (the founding IFAS) enhances their ability when applying to the UN to assist in the continuing involvement of international financial institutions and bilateral donors to address regional water environmental issues for sustainable development in the region.

Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Helsinki, 1992) came into force on October 6, 1996. It specifies that "Transboundary waters - means any surface or ground waters which mark, cross or are located on the borders between two or more States, where transboundary waters flow directly into the sea, their completion is determined on a straight line across the mouth of the river between the points horizon, low-flow water their shores."

The offer of accession of all of the region to the Convention was discussed at the meeting ICWC in Almaty, 14-15 June 2002, and the protocol decision was made to record "The members of the ICWC consider making proposals to the governments of their states in the prescribed manner the possibility of ratifying the Convention on Protection and Use of Transboundary Watercourses and International Lakes (Helsinki, 1992)."

Cooperation in Central Asia to address the most pressing problems of the region clearly expressed during the development of Aral Sea Basin Program (ASBP). The program consists of four priority areas:

- Stabilization of the ecological situation in the Aral Sea;
- Restoration of the crisis zone around the Aral Sea;
- Improving the management of international waters in the Aral Sea, strengthening the capacity of regional bodies for planning and implementation of the ASBP.

The solution to this problem has led to the creation of special institutions as the International Fund for Saving the Aral Sea (IFAS), which includes the Board of IFAS, the Interstate Coordination Water Commission (ICWC), the Interstate Commission on Sustainable Development (ICSD) and attached by the Commission of the Scientific Information Centre (SIC). Activity IFAS, which are publicly funded CAR was substantially supported by external financial assistance through the United Nations Development Program and Global Environment Facility (GEF).

In addition, each of the Central Asian countries adopted the "National Plan of Action for the Protection of the Environment (NEAP).

One of the determinants of the effectiveness of environmental policy are:

- Management and regulation of environmental issues;
- Perfection of legislation in the field of environmental protection;
- The effectiveness of economic methods and mechanisms of environmental management.

The common and most important for the Central Asian Region (CAR) is that the presidents and governments in all five countries support and implement a policy to ensure environmental safety. All countries have developed the "National Programme of Action for the Protection of the Environment (NEAP), put into effect and successfully operate the basic laws for the implementation of environmental policies, mostly similar economic mechanisms of environmental management.

Cooperation in Central Asia through regional programs and institutions has been established by certain methods, style and procedure of cooperation between the management and use of transboundary water resurssov. These approaches of its kind, is unique, because in this framework provides for coordination, contingency planning, adjustment and distribution of water resources on an ongoing basis.

However, it shows the progress of joint activities and analysts' estimates in water management in regional and intergovernmental organizations is a certain inertia and stagnation, and in particular to improve the regional water policy and strengthening the legislative framework. For the effective management of transboundary basins requires new system of national and regional norms and regulations on utilization and protection of water resources with clear procedures, economic mechanisms and criteria.

Here we should note the initiative of President of Turkmenistan in April 2009 at the Summit of Heads of State organizers Fund for the Aral Sea in Kazakhstan, where he made a proposal on the joint solution of acute energy problems in Central Asian countries and issues of transboundary water resources. If the agreed solution of water problems Turkmenistan ensures neighbors natural and liquefied gas, as well as electricity in sufficient quantity.

Nationally, one of the policy measures required for implementation of advanced irrigation methods such as drip, is to create a mechanism for encouraging water conservation, this should make extensive use of methods to promote. Promote water conservation is one of the main mechanisms to address water scarcity. This requires the decision of the Government on the implementation of this mechanism in practice with pre-development methodology of calculation of the cost savings of water.

To date, Turkmenistan to set some standards for the use of any method or technology (eg drip irrigation) to be impossible. Today, it is important to build an environmentally friendly public consciousness of people. Its importance lies in the fact that the technological, engineering and organizational problems often do not work precisely because of the "human" factor.

Application of new technologies in research on breeding drought-resistant and salt-tolerant crops in the work is labeled as **"the exercise of breeding work on the cultivation of drought-resistant crops.** Only that on May 17 passed a new law on seed production "establishes the legal framework for the production, harvesting, processing, storage, sale, transport and use of plant seeds, organization and functioning of seed production, as well as the implementation of state control in seed production in Turkmenistan. The adoption of this law of adaptation activities **"implementation of breeding work on the cultivation of drought-resistant crops"** to get a push and it will be possible dalneyschego development of this event.

Such measures as rainwater harvesting in the settlements in the not treated as irrelevant. This issue requires further study on the effectiveness of the event. Regarding wastewater, the work provided for in the baseline scenario to bring the volume of wastewater treatment and further use of irrigation in the amount of 410 mln. $m^3$/god, and adaptation scenarios - to bring the volume up to 670 mln. $m^3$/god.

At the present time in Turkmenistan on the initiative of the President is in the process of bringing national legislation into conformity to international standards. If international treaties of Turkmenistan stipulates other rules than those contained in natsiognalnyh laws, then the rules of international treaties.

### 3.3. Key uncertainties and methodological limitations

1. As the main uncertainty is necessary to note the absence of formally approved program of industry development for the period up to 2030, which served as the basis for determining the baseline scenario for the prevailing rate of development of the industry in the "historical" period (2000-2008).
2. Among the uncertainties can be included and some of the specific indicators that were used in the calculations. In the long term to 2030, some of them may change - new models of agriculture and land reclamation techniques, and this in turn will change and operating expenses.
3. Lack of correct performance of financial flows necessitated their definition of peer review. In reality, this figure may change as the upward and downward.
4. Calculations of adaptation activities carried out around without developing a specific project for the implementation of each of these activities.
5. Significant uncertainties are also constructed scenarios of climate change.
6. The persistence of water issues at the intergovernmental level in CA.

## 4. Background

**All investments are carried out in the water sector from the state budget. In this connection, the table on sources of investment are not reported in this paper.**

Calculations of investment income in both variants are made in accordance with the aggregated specific capital investments for construction and reconstruction of reclamation systems (Stan 33-2.1.03-85) and on the basis of these projects analogs performed Institute "Turkmensuvylymtaslama [20-27].

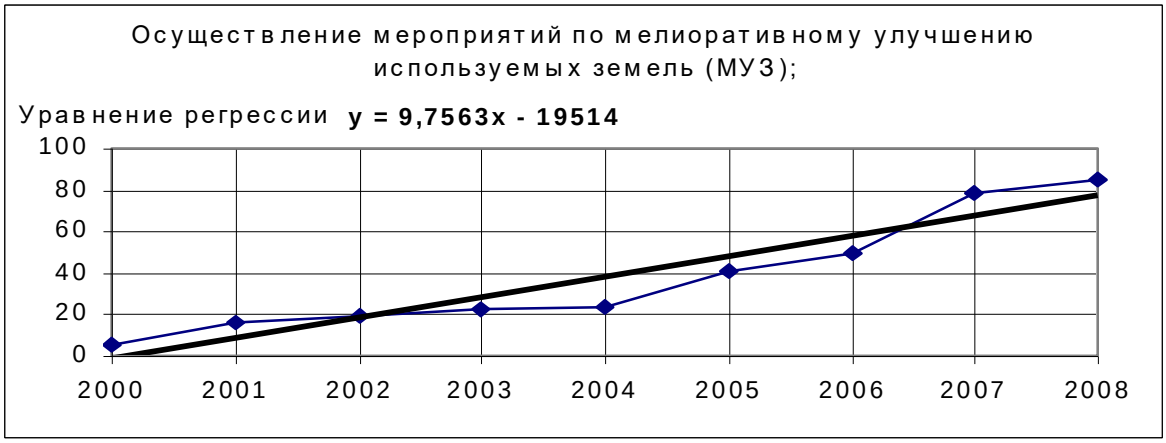
ACRONYMS

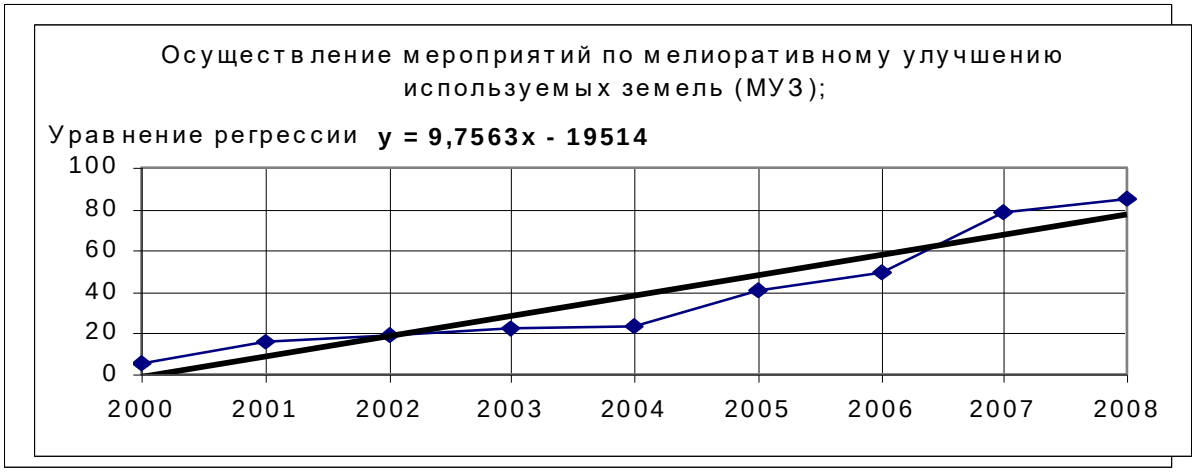
| | | |
|---|---|---|
| UN | – | United Nations |
| IWRM | – | Integrated Water Resources Management |
| Eff | – | Efficiency |
| Krause | – | A comprehensive reconstruction of irrigation |
| MUZ | – | Reclamation land improvement |
| Stan | – | Collection of technical and economic standards |
| IF | – | Investment Flow |
| FF | – | Financial Flow |
| O&M | – | Operation and Maintenance costs |
| BWO | – | Basin Water Association |
| SRC | – | State Commission on Reserves |
| $km^2$ | – | Square kilometers |
| billion $m^3$ | – | Billion cubic meters |
| million $m^3$ | – | Million cubic meters |

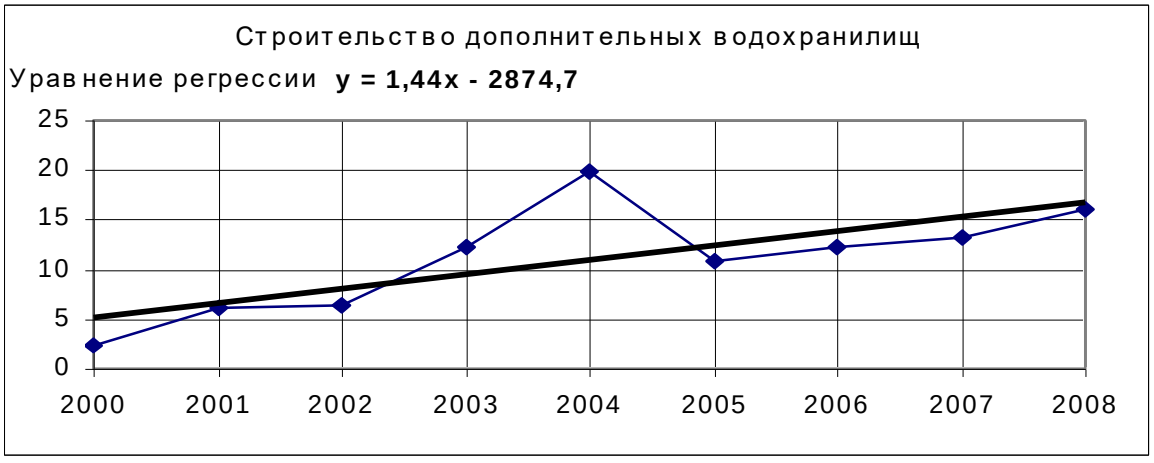
| | | |
|---|---|---|
| $m^3/s$ | – | Cubic meters per second |

## Annexes

To demonstrate the determination of the trends in some activities below shows the dynamics of investments in "historical" period and the regression equation, based on what was built by the baseline scenario.



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## Projects analogues and regulations


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