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NEGATIVE IMPACTS OF CLIMATE CHANGE FOR UZBEKISTAN AND THE COUNTRIES OF CENTRAL ASIA

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Abstract

This study examines the impact of global climate change on the environment in the world as a whole, as well as on the Central Asian region and Uzbekistan. It was revealed that climate variability in arid areas negatively affects the state of water and land resources. Climate change carries risks in terms of growing agricultural products, which can lead to changes in agricultural practices. It was revealed that the main challenges for Uzbekistan today and in the future are the reduction of water resources due to climate change and the increase in the need for water in agriculture. Based on the results of the study, it can be concluded that investing in the use of innovative technologies in agriculture, as well as the reconstruction of the existing irrigation infrastructure in the face of climate change, will lead to long-term sustainability of the water sector of Uzbekistan and the use of land resources.

Key words: *Central Asia, Uzbekistan, climate change, greenhouse gas, sustainable development of water and land resources*

Introduction. Climate change is the defining crisis of our time, and it is happening even faster than humanity feared. No corner of the globe is immune from the devastating effects of climate change. Rising temperatures contribute to environmental degradation, natural disasters, extreme weather events, food and water shortages, economic shocks, conflict and terrorism. Sea levels are rising, the Arctic is melting, coral reefs are dying, oceans are acidifying, and forests are burning.

The Central Asian region is already facing the consequences of climate change, which poses a real threat to food, water and energy security, public health and hampers the achievement of the countries' sustainable development goals.

Central Asian countries are among the most vulnerable countries to climate change. Climate change affects the well-being of more than 70 million people, mostly living in rural areas of the Central Asian region. Given that agriculture is a key sector of the economy, the effects of climate change pose a serious threat to food security and sustainability in the region. Building resilience to the increasing impacts of climate change, such as glacial melt and drought, is a major priority in reducing poverty and improving livelihoods in the region [1].

In Central Asia, the fastest increase in average annual temperature occurs near the Caspian Sea. In the Aral Sea area and the southern desert regions of Central Asia - southern Kazakhstan, Uzbekistan, and Turkmenistan - precipitation has fallen by more than 5 percent over the decade.

Given the region's characteristics, vulnerability to climate change is manifested in the increased intensity of glacier and snow melt in the highlands of Tajikistan and Kyrgyzstan, changes in water supply, increasing frequency of natural disasters, and increased aridity. All these risks can cause huge damage to economic stability and food security in Central Asia [2].

All Central Asian countries are parties to the Paris Agreement and are integrating climate issues into government programs and strategies. Climate change mitigation issues are reflected in nationally determined contributions.

The World Bank report "Adaptation to Climate Change in Central Asia" (2009) notes that average temperatures in the region have already increased by 0.5°C; by 2030-2050 an increase of 1.6-2.6°C is projected. The cumulative effects of climate change and the almost complete depletion of the Aral Sea resources exacerbate the problem of water scarcity. Rising temperatures lead to earlier snowmelt, resulting in peak river flows in the spring and a decline of nearly 25% in the irrigation season. So far, runoff volumes are increasing due to the rapid melting of glaciers. However, according to forecasts, after the Central Asian region reaches peak flow rates by about 2050, the situation will change and the volume of flow will sharply decrease [3].

The main challenges for the water sector in Uzbekistan today and in the future are the decrease in water resources because of climate change and an increase in water demand due to population and economic growth. In 2017–2019, the growth of the Uzbekistan economy averaged 5.3%.

Uzbekistan is the largest country in Central Asia in terms of population, which demonstrates its rather rapid growth. From 2000 to 2021, it increased by 41.1%, and the average annual growth rate was 1.65%. As a result, during this period, the population of Uzbekistan increased by 10.071 million people. Moreover, there is a gradual acceleration of the average annual growth rate of the population; for the period of 2000–2010, this figure showed 1.35%, while the later period of 2010–2021 showed its growth and reached a figure of 1.93%.

Global warming is negatively affecting the water supply of the agricultural sector of the republic. In many parts of the world, the amount and regularity of precipitation have changed. Droughts and floods are increasing, and as a result, water scarcity and competition for water resources are increasing.

Climate change also negatively affects the availability of water for agriculture, where high input costs for primary production also put the relative stability of food production and supply at high risk.

Agricultural production success varies from region to region, and this is highly dependent on an increase in the number of extreme climate events such as prolonged

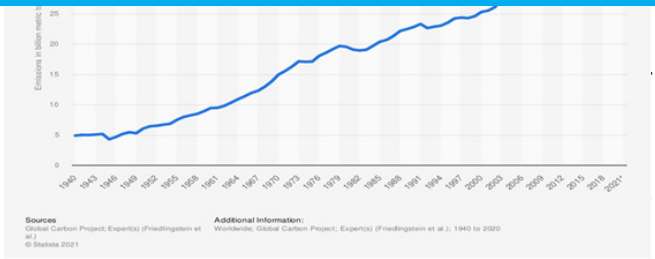

Fig. 1. Annual CO2 emissions worldwide from 1940 to 2020(in billion metric tons)

In 2021, the GMST (was 1.11 ± 0.13°C above the pre-industrial base period (1850–1900)). Considering La Niña cooling conditions, 2021 was colder than previous years, but the last 7 years are still the warmest years on record [4].

Billions of tons of CO2 are released into the atmosphere every year from coal, oil and gas mining. Human activity is producing greenhouse gas emissions at an all-time high and there are no signs of slowing down.

Greenhouse gas emissions are mainly due to the fuel and energy complex, agriculture, the industrial sector and waste (Figure 2).

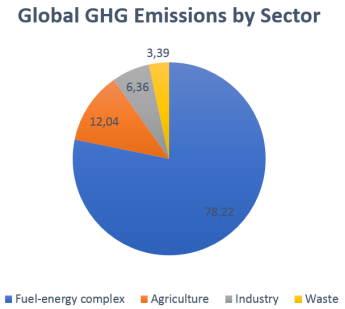

Fig. 2 Global GHG Emissions by Sector, 2019

Agriculture is the second largest source of global greenhouse gas emissions after the energy sector (including transport), producing 12.04% of all emissions (Figure 2). Scientific and intergovernmental organizations unanimously emphasize the urgency of the threat to food security (FS) in the world.

For almost three decades, the UN has annually brought together almost all the countries of the world for a global climate summit - the so-called Conference of the Parties ("Conference of the Parties"), or COP. Parties are 197 countries that signed the United Nations Framework Convention on Climate Change (UNFCCC) in 1992. The main goal of the convention is "to prevent dangerous anthropogenic impact on the Earth's climate system" [5].

The past four years have been the four hottest years on record. We are one degree Celsius above pre-industrial levels and close to what scientists warn would be an "unacceptable risk," according to a September 2019 report from the World Meteorological Organization (WMO). The 2015 Paris Agreement on climate change calls for keeping possible warming "well below" 2 degrees Celsius and efforts to further limit the rise to 1.5 degrees. But if we don't slow down global emissions, temperatures could rise above three degrees Celsius by 2100, causing further irreversible damage to our ecosystems [6].

Climate variability in arid and mountainous areas directly threatens populations, infrastructure and arable land. The risk of natural disasters forces part of the rural population to migrate to other areas.

Limiting global warming to 1.5°C will require "fast and far-reaching" transitions across land, energy, industrial systems, as well as buildings, transportation and cities. Global human-caused carbon dioxide (CO2) emissions will need to be reduced by almost 45% by 2030 compared to 2010 levels, reaching "net zero" around 2050 [7].

According to the Intergovernmental Panel on Climate Change (IPCC), the consequences of climate change, which have acquired a global character and unprecedented scale, are also fully manifested in the Central Asian region. As a result of the Aral Sea disaster, climate change in the region is twice as intense as the world average. Among the negative manifestations are the increase in the frequency and geography of dust storms, the worsening problems of land degradation and the reduction of water resources. The temperature in the region is growing faster than the world average. The impacts of climate change on the states of Central Asia are likely to come in the form of melting glaciers, destabilizing river flow, increased aridity, and impacts on agriculture and fisheries, thereby increasing demand for water sources [8].

Discussion. The impacts and risks will primarily manifest themselves in rural areas, as they are particularly vulnerable to the effects of climate change. Their livelihood depends on the availability of resources, which are deteriorating due to rising temperatures. Natural disasters (floods, aridity, etc.) caused by climate change are on the rise.

Climate change is also negatively affecting the availability of water for agriculture, where high primary production costs also threaten the relative stability of production and food supply.

Table 1.

Contribution of greenhouse gases to MtCO2e

The country	2017	2018	2019
Uzbekistan	172,94	180,45	185,39
The whole world	48251,88	49368,04	49758,23

In 2019, Uzbekistan emitted 185.39 million tons of CO2 equivalent, which is 0.37% of global emissions (Table 1). At the same time, global emissions increased by more than 50%.

Although Uzbekistan does not make a significant contribution to GHG emissions, global climate change brings significant damage to the country's economic development in the social sphere. The average rate of warming in Uzbekistan exceeds the average rate on a global scale. If the global temperature trend of the period from 1890 to 2010 increased by 0.7 degrees, then in Tashkent, according to observational data, it increased by 1.7 degrees.

In Uzbekistan, there is a tendency for the climate to dry out. In the next 30 years, the air temperature will rise if humanity does not take measures to reduce greenhouse gas emissions, introduce "green" technologies, as well as the principles of rational use of natural resources.

Greenhouse gas emissions in Uzbekistan in 2019 for agriculture amounted to 17.8% of the total. The volume of emissions is 33.7 million tons of CO2 equivalent at present, the total greenhouse gas emissions of the Republic of Uzbekistan are about 200 million tons of CO2-eq. In terms of emissions, the country occupies 38th place in the world ranking, 4th place among the CIS countries, and 2nd place in the Central Asian region [9].

In late spring and summer, the frequency and intensity of abnormally hot periods increased. The region of the Aral Sea region is most susceptible to this phenomenon. In the last 5 years, records of maximum air temperature have been updated in this area almost every year.

The number of days with an air temperature of 400 C and above has increased. In the desert zone, in the north and south of the republic, the number of abnormally hot days ranged from 25 to 40 days (against the norm of 15-30 days).

The duration of dry periods has increased, which leads to increased atmospheric drought and increased water scarcity. In recent years, the number of days with atmospheric drought has been 50-80 days, with an average long-term value of 30-70 days.

Natural disasters will be a serious test for the economies of the countries of the region. Thus, according to the World Bank, the damage to the economies of Tajikistan, Turkmenistan and Kyrgyzstan, caused by them today, ranges from 0.4% to 1.3% of their annual GDP [10].

In recent decades, there has been a noticeable decrease in water absorption. Recently, the annual volume of water resources used by Uzbekistan averages 51-53 km3 per year, which is 20% less than in the 80s of the last century (despite the fact that during this time the country's population has doubled) [11].

The growing scarcity of water is exacerbated by the highly inefficient use of water in its delivery and consumption, especially in agricultural land. The combination of semi-

desert and desert conditions, agriculture's dependence on irrigation and progressive climate change mean that crop failures could affect entire regions, jeopardizing food crops.

Since 1961, the mass of glaciers in the Tien Shan (sources of the Syr Darya River) and Pamir (Amu Darya) has decreased by 25%. The saturation of rivers with glacial waters has also decreased. According to forecasts, with an increase in the average annual temperature by 20°C, glaciers can lose up to 50% of their volume, and with continuous warming up to 40°C, the loss will reach up to 78%. By 2050, there is a possibility of a 10–15% reduction in water resources in the Amudarya basin. In the Syr Darya basin, water may be reduced to 2%. With a further increase in air temperature, the river runoff decreases. The rivers of the Amudarya basin and small streams are more sensitive to climate warming [12].

In 50 years (15 years have already passed), the water deficit, taking into account the growing agriculture and population growth, will reach 25%. The Tien Shan alone annually loses 5 gigatons of ice (1 gt is a cube with sides of 1 km each). For comparison, 3.5 gt would be enough to meet the water needs (including for agriculture and industry) of the whole of Germany.

The level of pressure on water resources in Uzbekistan and Turkmenistan is assessed by experts as critical (more than 100 percent). The volumes of water that these countries use account for 169 percent and 144 percent of their water reserves, respectively [13]. Uzbekistan ranked 25th out of 164 in the ranking of countries suffering from water scarcity, published by the World Resources Institute.

For Uzbekistan, the lack of water is considered an emergency, given the lack of water in a number of regions of Uzbekistan, in particular in the Karakalpak region, which can lead to a social and environmental disaster.

Over the 50-year period of modern irrigation, some changes have occurred in the process itself, such as subsidence deformations, erosion, gully formations, suffusion processes, landslide processes, surface washout, recirculation of reservoir banks, and channel erosion. banks of irrigation canals. In connection with the rise in the level of groundwater and the moistening of loess rocks in the aeration zone, two problems are currently acute: salinization and waterlogging [14].

If the current land and water management model continues, food scarcity will increase, land quality will deteriorate, and water supplies will decline.

This problem has both institutional and technological reasons. Poorly managed irrigation systems and water infrastructure (pumping stations) and resulting salinization and waterlogging create additional risks and costs for the country.

Agricultural losses due to poor management in Uzbekistan amount to about US$919 million per year in the Syr Darya and Amu Darya basins. This problem is exacerbated by the fact that 75% of the pumping stations used for irrigated agriculture are out of service and need to be replaced.

As a result of the implementation of projects for the reconstruction of existing and construction of new pumping stations, the reduction in greenhouse gas emissions would amount to 51 thousand tons of CO2/year [15].

Climate change carries risks in terms of growing agricultural products in sufficient quantities, which may lead to changes in agricultural practices and the diet of the population.

At present, agriculture is still the most important industry for the countries of Central Asia. Kyrgyzstan, Tajikistan and Uzbekistan are much more dependent on agriculture, while agriculture in Kazakhstan focuses mainly on grain and meat products.

According to the level of the global safety index (JFSI), the countries with the highest rating of PB have indicators from 81.5 to 87.4. For the CA countries, these indicators in 2020 were:

- Kazakhstan - 70.8. Compared to the previous year, it increased by 3.5 units;
- Uzbekistan - 50.9.

Analysts estimate the export potential of the agricultural sector of Uzbekistan at more than 5 billion US dollars. According to projected climate change data, irrigation rates will increase by 5–10% by 2030. If the current model of land and water management continues, food shortages will increase, land quality will deteriorate, and water supplies will decline. The management of water and land resources in Uzbekistan requires an integrated approach, taking into account the characteristics of the landscape and climatic conditions. The main measures to reduce greenhouse gas emissions in economic sectors are aimed at modernizing the water sector and agriculture.

Massive gains have been made in the management and control of irrigation systems in the last 20 years, with much success in retrofitting modern technology to existing infrastructure. The key focus of these changes has been on:

• Better understanding of when it is best to apply water to crops and how much to apply. This improved understanding has been enabled by breakthrough sensing, communications, and software technologies supported by education and support programs for farmers.

• Changing the operating arrangements in irrigation systems so that farmers can request when they want water to suit their needs, as opposed to having to take water at a time that suits the underlying distribution infrastructure and the canal system operator's needs.

• Automation of canal systems and on-farm distribution systems to optimize the operation of these systems with respect to water conservation (spill reduction) and customer service (efficiency of use), i.e., to provide water as close as possible to when farmers want it and to distribute the water without the wastage that is typically associated with manual operations.

Results. On October 20, 2018, the Cabinet of Ministers of the Republic of Uzbekistan issued Decree No. 841 "On measures to implement national goals and objectives in the field of sustainable development for the period up to 2030," which defines national goals and objectives in the field of sustainable development for the period up to 2030, with target 2.4. on the introduction of agricultural methods that will increase agricultural productivity. Goal 6 states that by 2030, all sectors of the economy will have greatly improved water efficiency (target 6.4) [16].

It is widely documented that the irrigation systems in Uzbekistan have poor water use efficiency and, as a direct implication, there are widespread salinity problems, threatening the sustainability of the sector. The poor efficiency of water distribution is essentially due to poor control, i.e., much more water is taken into the system than is required to match plant needs. This surplus water ultimately finds its way into the drainage system as either a direct spill from the supply canals, runoff from farm fields due to excessive application, or from deep percolation from the fields and canals, which may require pumping from drainage wells. Much attention has been given to the lining of canals to reduce infrastructure losses, but the significance of these losses in the overall water balance does not appear to be known with certainty.

Taking into account the variety of conditions for conducting agricultural activities in Uzbekistan, it is planned to move from attempts to create a universal model for managing water facilities (operation and maintenance of water facilities, including irrigation and drainage networks, water distributors, pumping stations, etc.) to more flexible and diverse mechanisms.

In 2019, the "Strategy for the Development of Agriculture of the Republic of Uzbekistan for 2020–2030" was approved, which covers the following strategic priorities: ensuring food security of the population; creating a favorable agribusiness climate and value chains; reducing the role of the state in managing the sector and increasing investment attractiveness; ensuring the rational use of natural resources and environmental protection; development of modern systems of public administration; phased diversification of public spending in support of the sector; development of science, education, information and consulting services in agriculture; rural development; and the development of a transparent system of industry statistics [17].

Uzbekistan is a party to the UN Framework Convention on Climate Change (FCCC), the Kyoto Protocol and, since November 2018, the Paris Agreement. Unconditional implementation of the Paris Agreement is a basic component of the country's climate policy. As a result, within the framework of the Paris climate agreement in Uzbekistan, by 2030, a reduction in the share of greenhouse

gases in GDP by 35% will be achieved.

One of the main legislative documents for fulfilling the country's obligations under the Paris Agreement is the Strategy for the Development of Agriculture of the Republic of Uzbekistan for 2020-2030 (Presidential Decree UP-5853 of 23.10.2019). Implementation of measures to improve land fertility is envisaged.

The Ministry of Innovative Development financed a project worth 993 million soums, as well as 2 start-up projects worth 664.2 million soums, which are aimed at developing innovative technologies to combat soil salinization and climate change on the dried bottom of the Aral Sea, as well as improving the environmental situation on saline lands of the Aral Sea region.

Uzbekistan, becoming the first member state of the Global Green Growth Institute among the CIS countries, plans to implement joint projects with GGGI, primarily in the Aral Sea region by attracting financial resources from the UN Green Climate Fund and other international donor organizations.

Within the framework of adaptation to climate change with the aim of rational management of water and land resources in Uzbekistan, it is necessary to apply water-saving and resource-saving technologies for irrigation and irrigation regimes for agricultural crops and improve reclamation, soil conditions of irrigated lands, and their mutually related optimal combinations.

As shown by the analysis of the implementation of the leading drip irrigation practices on the territory of irrigated lands in Uzbekistan, it has led to a significant reduction in water losses.

The potential for improvement in Uzbekistan is enormous. Numerous implementations from around the world have demonstrated that system-based automation technology can transform the operation of large-scale irrigation systems, saving huge quantities of water and providing the surety of supply to justify complementary investments in farm automation systems. Given the significant cost of pumping water in the Amu Darya and Syr-Darya basins, the return on investment is expected to be much greater than in many other global locations.

Conclusions. The modernization of irrigation systems and hydraulic structures using the innovative in some regions of the republic meets the requirements of a comprehensive program for the implementation of measures to control climate change.

With regard to institutional objectives, the aspects of climate change and their impact on agricultural production in the country are not given due attention, either at the level of national policy or on the part of farmers. The first task should be to raise awareness among relevant partner organizations about the expected impacts of climate change on agricultural water use and advise them on appropriate adaptation measures.

Possible measures could include the following:

- Improvement of production technologies with an emphasis on efficient use of irrigation and rainwater;
- Promotion of river basin approaches and practices for the protection, conservation, and management of land and water resources (water sources, soil protection in upper watersheds, grassland restoration, etc.);
- Identification of sources of funding for the implementation of activities;
- Negotiations with foreign donor organizations and international financial institutions to identify the resources required for the implementation of automation processes;
- Ensuring interaction with the community and stakeholders;
- Organization of advanced training courses for specialists in the field of agriculture and water management on the use of automated systems and their management of these water facilities.
- The provision of advisory services to political actors to improve the political and institutional environment and develop capacities for adaptation to climate change;
- Facilitating the exchange of knowledge on climate change and agriculture between practitioners and policy makers.

Perhaps it would be appropriate to create some kind of infrastructure to combat climate change. A dedicated development center is needed to coordinate services for scattered climate change risk mitigation projects, build partnerships and leverage the synergy of fragmented actions of all interested donors in the country. The center can also operate the system digitally online.

It can be concluded that an increase in food shortages will be associated with limited land and water resources and projected climate change, in which irrigation rates will increase by 5–10% by 2030. While maintaining the current model of food, land, and water resources management, the deficit will continue to grow, the land quality will deteriorate, and the water supply will be reduced.

Solving the problems of land degradation requires applying water-saving and resource-saving technologies to irrigation and irrigation regimes for agricultural crops and improving reclamation regimes, soil conditions of irrigated lands, and their mutually related optimal combinations.

The goal is, of course, one: to solve the water problem and use water resources rationally. Reforms in agriculture are needed to improve water management in Uzbekistan.

In the near future, improving management, rationalizing use, and searching for internal reserves of water resources can meet the growing demand for water. The main task is to ensure the productive use of every drop of water in all areas of water use in order to reduce water consumption per unit of production or per physical consumer.

The implementation of these innovative technologies is expected to show local results that will be critical to the implementation of the agricultural water efficiency reform roadmap.

Deliberate state policy of the state, institutional reforms, and investments in the modernization of infrastructure, especially irrigation, will strengthen water security in the face of climate change and lead to the achievement of the sustainable development goals.

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