IMPACT OF CLIMATE CHANGE ON AGRICULTURE IN KHORESM REGION

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Abstract

This article analyzes the impact of climate change on agriculture in the Khorezm region and its main trends. The study takes into account the natural and climatic conditions of the region, the high dependence of agriculture on irrigation, and the characteristics of water resource use. As a result of climate change, the increase in air temperature, increased evaporation, increased risk of drought, and increased demand for water resources are assessed as the main factors affecting agricultural production. It also covers changes in temperature and humidity conditions, soil salinity, water scarcity, and their impact on the development of cotton, grain, vegetable and melon crops, and livestock. The article develops scientific and practical recommendations on priority areas for adapting agriculture in the Khorezm region to climate change, including the introduction of water-saving irrigation technologies, the use of climate-resistant crop varieties, the prevention of soil salinization, the improvement of irrigation and land reclamation systems, and the use of GIS and remote sensing technologies. The results of the study are of great importance in ensuring the sustainability of agriculture in the region and determining measures to adapt to future climate risks.

Keywords

climate change, Khorezm region, agriculture, agroclimatic conditions, air temperature, water resources, irrigation, water scarcity, drought, soil salinity, productivity, climate risk, adaptation, GIS technologies, agricultural sustainability.

ENTRANCE. Climate change, which is currently being observed globally, is having a significant impact on agriculture, one of the most important sectors of the

economy, along with natural geographical processes. Rising atmospheric temperatures, changes in the amount and seasonal distribution of precipitation, increased drought events, accelerated evaporation, and increased demand for water resources pose a serious threat to the sustainability of agricultural production. The consequences of climate change are especially pronounced in arid regions and regions that are highly dependent on water resources.

In the Republic of Uzbekistan, too, in recent years, changes in climate indicators, rising air temperatures, and the recurrence of extreme weather events have created new demands on the agricultural sector. Since the main part of the country's agriculture is based on irrigated agriculture, changes in the quantity and quality of water resources directly affect the efficiency of agricultural production. In the context of climate change, the increased demand for irrigation water, the increased risk of water shortages, and the intensification of soil degradation processes make the issue of sustainable development of agriculture even more urgent.

Khorezm region is one of the regions of Uzbekistan that is sensitive to climate change. The region's location in the lower reaches of the Amu Darya, the relatively low amount of natural precipitation, high air temperatures in the summer months, and high evaporation determine the high dependence of agriculture on water resources. The main areas of agriculture in the region are cotton growing, grain growing, rice growing, vegetable growing, melon growing, horticulture, and livestock breeding. The development of these sectors depends, first of all, on water supply, soil fertility, and the stability of agro-climatic conditions.

Under climate change, rising air temperatures in the Khorezm region may increase the water demand of agricultural crops during the growing season, accelerate moisture loss from the soil and plant surface, and increase drought stress. In addition, there is a possibility that high evaporation and specific characteristics of irrigation processes will

lead to increased environmental problems associated with soil salinization and degradation in the region. These processes will directly or indirectly affect the productivity of agricultural crops, production efficiency, and food security of the region.

From this point of view, a comprehensive study of the impact of climate change on agriculture in the Khorezm region, identification of the main risks and problems, and development of effective ways to reduce them are of significant scientific and practical importance. The study will provide a scientific basis for the sustainable development of agriculture by assessing the interrelationship of climate factors, the state of water resources, soil salinity, agroclimatic requirements of agricultural crops, and the adaptation capabilities of the region.

The main purpose of this article is to assess the impact of climate change on agriculture in the Khorezm region, identify the main emerging agro-climatic risks, and develop scientific and practical recommendations for adapting the region's agriculture to future climatic conditions.

MAIN PART. Khorezm region is one of the agriculturally specialized regions of Uzbekistan, and its agricultural production system is closely related to natural and climatic conditions and water resources. The region's location in the lower reaches of the Amu Darya, the arid climate of the region, low rainfall and high evaporation in the summer months have made agriculture strongly dependent on artificial irrigation. Therefore, any changes associated with climate change in the region are primarily reflected in water resources, soil moisture and vegetation conditions of agricultural crops. Cotton growing, grain growing, rice growing, vegetable growing, melon growing, horticulture and livestock farming occupy an important place in the agricultural system of Khorezm region. Most of these sectors require a high level of irrigation. Especially in the hot and dry months of the growing season, the demand for water by crops increases sharply. As a result of climate change, rising air temperatures and increased evaporation

may lead to a further increase in this demand.

The impact of climate change on the temperature regime

One of the most important factors determining the impact of climate change on agriculture is the change in air temperature. An increase in temperature directly affects the physiological processes of plants, the growing season, soil moisture and water consumption. Since the summer season itself is hot and dry in the conditions of Khorezm, an additional increase in temperature can increase heat stress for crops.

Under high temperature conditions, the transpiration process in plants is accelerated. As a result, plants use the available moisture in the soil faster and there is a need to reduce the interval between irrigations. If there is not enough water in such conditions, the development of plants slows down and the formation of crop elements deteriorates. Especially during the flowering and crop formation periods, prolonged high temperatures can negatively affect the productivity of agricultural crops.

On the other hand, a moderate increase in temperature may extend the growing season of some crops and allow for a relatively early start of spring planting. However, in the conditions of Khorezm, such positive aspects are directly dependent on the availability of water resources and the resistance of crops to high temperatures. Therefore, temperature changes should be assessed not only as a separate indicator, but also in a complex with water supply, soil moisture and agrotechnical measures.

Changes in precipitation and humidity conditions

In the Khorezm region, the amount of precipitation does not fully cover the total water needs of agricultural crops. Therefore, the main part of agriculture is carried out through irrigation systems. In addition to the annual amount of precipitation, its seasonal distribution is also of great importance.

Reduced rainfall during the growing season or short periods of heavy rainfall are not always beneficial for agriculture. If heavy rainfall exceeds the soil's water absorption

capacity, it can lead to increased surface runoff and soil erosion. Conversely, prolonged periods of drought can lead to a sharp decrease in soil moisture and an increase in the need for irrigation.

In the conditions of Khorezm, it is important to analyze precipitation and temperature changes together. Because an increase in temperature can lead to a deterioration in the water balance due to increased evaporation even if the amount of precipitation does not change. Therefore, for the agriculture of the region, not only the amount of precipitation, but also the ratio between precipitation and evaporation is an important agro-climatic indicator.

Impact on water resources and irrigation systems

The sustainability of agriculture in Khorezm region is determined primarily by the availability of water resources. The region's location in the lower reaches of the Amu Darya River requires special attention to water resource management. In the context of climate change, the gap between increasing water demand and the availability of water resources may become a significant problem for agriculture.

As a result of rising temperatures and increased evaporation, the amount of water needed to irrigate crops will increase. At the same time, water losses in irrigation canals, filtration and evaporation processes will also increase total water consumption. As a result, increasing water use efficiency will become one of the most important areas in the adaptation of Khorezm agriculture to climate change.

Modernizing irrigation systems, increasing the efficiency of canals, digitizing water accounting, and introducing water-saving technologies can help reduce the risk of water shortages. Improving drip irrigation, sprinkler irrigation, and sprinkler irrigation technologies, as well as adjusting irrigation timing to the actual water demand of crops, can help reduce the risk of water shortages.

Soil salinization and degradation processes

Another of the most important problems related to climate change in agriculture in the Khorezm region is soil salinization. The natural conditions of the region, the relatively shallow location of groundwater, strong evaporation, and the peculiarities of irrigation systems create favorable conditions for the formation of salinization processes.

Increased evaporation due to global warming can lead to a decrease in soil moisture and the accumulation of salts dissolved in water in the upper layers of the soil. The risk of secondary salinization increases, especially in areas with low efficiency of collector-drainage systems. Increased soil salinity makes it difficult for plants to absorb water and nutrients through their root systems. As a result, crop growth slows down, yields decrease, and in some cases, the efficiency of land use for agriculture decreases dramatically.

Therefore, one of the main tasks in climate change adaptation measures should be not only saving irrigation water, but also improving the land reclamation condition. Regular monitoring of collector-drainage networks, mapping of saline areas, regional differentiation of land reclamation measures, and the use of salt-tolerant crop varieties are important.

Impact of climate change on major agricultural crops

The main crops grown in Khorezm region have different responses to climate change. Although cotton is a heat-requiring crop, excessive temperatures and water shortages during the growing season can negatively affect its yield. In particular, increased heat stress during flowering and pod formation affects crop quality.

In grain production, changes in temperature affect the duration of the growing season and the stages of crop formation. Changes in temperatures in the winter-spring period can change the rate of grain development. Water shortages at certain stages of the growing season led to a decrease in yield.

Vegetable and melon crops are also sensitive to high temperatures and water shortages. Under such conditions, the demand for water by crops increases, and the

quality and quantity of the crop may decrease. Therefore, it is important to determine the optimal planting dates, improve the irrigation regime, and use varieties suitable for the climate in crop production.

Rice cultivation, being a water-intensive sector, is one of the most sensitive to changes in water resources. In the future, in conditions of increasing water scarcity, the issue of optimizing the area of crops with high water consumption may become relevant.

The impact of climate change on livestock

Climate change is also affecting the livestock sector in Khorezm region. Prolonged high temperatures in the summer months increase heat stress in livestock. This can negatively affect animal nutrition, water consumption, and milk and meat productivity.

Reduced productivity of forage crops in drought conditions also poses an additional problem for livestock farming. Therefore, it is important to ensure uninterrupted water supply, heat protection, feed reserves, and the use of livestock breeds suitable for climatic conditions in livestock farms.

Adapting Khorezm agriculture to climate change

To ensure the sustainability of agriculture in the Khorezm region in the face of climate change, it is necessary to implement comprehensive adaptation measures. First of all, it is necessary to form a system for the effective use of water resources. The efficiency of using existing water resources can be increased by widely introducing water-saving technologies, modernizing irrigation networks, and reducing water losses.

The second important area is the development and implementation of climate-resistant crop varieties. The use of varieties that are resistant to heat, drought, and salinity will ensure the stability of yields in the future.

A third direction is to reconsider the crop placement system. Determining the area of water-intensive crops based on the water supply capabilities of the region, increasing the share of low-water-demanding crops, and improving crop rotation will increase

agricultural sustainability. The fourth area is related to the protection of soil resources. It is important to strengthen land reclamation measures against salinization, use organic fertilizers, implement soil moisture conservation technologies, and restore degraded areas. The fifth direction is the use of modern GIS and remote sensing technologies in agriculture. Satellite images can be used to regularly monitor the state of crop vegetation, soil moisture, salinity levels, and drought processes. This approach allows for the rapid identification of problem areas in agricultural fields and the timely implementation of appropriate agrotechnical measures.

It is also important to predict future climate conditions. Forecasts based on the CMIP6 global climate models under the SSP scenarios allow us to estimate future changes in temperature and precipitation in the region. By integrating such forecast information into agricultural planning, it is possible to develop crop placement, water resource allocation and adaptation strategies in advance.

In general, the formation of an agricultural system adapted to climate change in the Khorezm region should be carried out not only through a single-direction measure, but also based on a comprehensive approach that includes saving water resources, preventing soil salinization, selecting climate-resistant crops, improving agrotechnical measures, and using modern GIS technologies.

CONCLUSION. The conducted analyses show that climate change is one of the most important natural factors affecting the future development of agriculture in the Khorezm region. The region's location in the lower reaches of the Amu Darya, the dominance of an arid continental climate, low rainfall, and high dependence of agriculture on irrigation increase the region's sensitivity to climate change. Therefore, changes in temperature, precipitation, evaporation, and water resources directly affect the sustainability of agricultural production.

As a result of climate change, the increase in air temperature and the increase in

the duration of high temperature periods may lead to an increase in the need for water in agricultural crops. The increased evaporation process causes a faster decrease in soil moisture, increasing the demand for irrigation water during the growing season. Since the productivity of crops such as cotton, grain, vegetables, melons and rice is directly dependent on water supply and temperature conditions, it is necessary to organize agrotechnical measures in accordance with climatic conditions in the future.

The results of the study show that the state of water resources is of particular strategic importance for agriculture in the Khorezm region. The increased risk of water shortages in the context of climate change requires increasing the efficiency of irrigation systems. From this point of view, it is important to widely introduce water-saving irrigation technologies, reduce water losses in irrigation canals, improve water distribution, and digitally monitor irrigation processes.

Another important problem related to climate change in the Khorezm region is soil salinity. Increased temperature and evaporation, the state of irrigation and collector-drainage systems can affect the reclamation properties of the soil. Therefore, regular monitoring of soil salinity, identification of areas with deteriorated reclamation conditions, improvement of drainage systems, and the use of salinity-resistant crop varieties should be one of the important directions in the development of agriculture.

In the future, to increase the adaptability of agriculture in the Khorezm region to climate change, it is advisable to improve the territorial distribution system of crops, optimize the area of water-intensive crops, and expand crops that require less water and are resistant to drought and salinity. At the same time, adapting planting dates to climatic conditions, using soil moisture conservation technologies, and organizing agrotechnical measures in accordance with the changing conditions of the growing season will ensure the stability of yields. The use of GIS and remote sensing technologies in agriculture is also important in managing regional climate risks. Based on satellite data, it is possible

to regionally assess crop vegetation status, soil moisture, salinity levels, and drought processes, as well as quickly detect changes. In addition, forecasting future climate conditions based on CMIP6 climate models allows for long-term planning of agricultural production and the definition of adaptation measures in advance.

Thus, reducing the impact of climate change on agriculture in the Khorezm region requires a comprehensive approach based on the rational use of water resources, prevention of soil salinization, introduction of climate-resistant crop varieties, use of modern agrotechnologies, and development of digital monitoring systems. Such an approach will ensure the environmental and economic sustainability of agricultural production, the efficient use of existing natural resources, and increase the adaptability of the Khorezm region to future climate conditions.

REFERENCES USED

1. Decree of the President of the Republic of Uzbekistan No. PF-158 dated September 11, 2023. On the "Uzbekistan - 2030" strategy.
2. Resolution of the President of the Republic of Uzbekistan No. PQ-4477 dated October 4, 2019. “On approval of the Strategy of the Republic of Uzbekistan for the transition to a “green” economy for the period 2019–2030”.
3. Cabinet of Ministers of the Republic of Uzbekistan. National policy and strategic documents of the Republic of Uzbekistan on climate change. – Tashkent.
4. World Bank. Uzbekistan Country Climate and Development Report. – Washington, DC: World Bank, 2023.
5. World Bank. Reducing the Vulnerability of Uzbekistan's Agricultural Systems to Climate Change: Impact Assessment and Adaptation Options. – Washington, DC: World Bank.