

Geophase analysis of geocological changes caused by climate change in the Khorezm region

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Abstract: This article presents a geospatial analysis of geocological changes in the Khorezm region as a result of climate change. The article geospatial analysis of the main geocological indicators in the Khorezm region, such as temperature, precipitation, soil moisture, groundwater level, desertification processes, and changes in vegetation cover, is carried out in the period 2000-2023. Based on space images, GIS technologies, and monitoring data of important geocological indicators, the ecological situation in various districts of the region is monitored and analyzed.

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Key words: climate change; geocological changes; geospatial analysis; Khorezm region; desertification; salinity; groundwater; GIS technologies; adaptation measures

Introduction

In recent years, global climate change has had a significant impact on ecological systems around the world. In recent decades, a number of geocological changes have been observed in the Khorezm region under the influence of global climate change, which have a serious impact on the environment, agriculture, and living conditions of the population [1]. Increased temperatures, decreased precipitation, increased winds, and reduced water resources are creating serious geocological problems in the natural and geographical system of the region. Khorezm region is an agroecologically active region, and any changes in climate directly affect soil quality, water resources, and the agricultural system. Against the background of global climate change, Khorezm region faces a unique set of geocological problems: increased temperatures, changes in precipitation patterns, water scarcity, soil degradation, and decreased biodiversity.[2]Assessing the dynamics of these changes, analyzing their spatial distribution, and predicting future trends will allow us to develop the necessary measures to stabilize the ecological situation in the region.

The region has a unique ecosystem, mainly consisting of the Amu Darya and the adjacent Khorezm oasis, which plays an important role in preserving the region's biodiversity and ensuring human life. Ecosystems in this area are of particular importance in terms of sustainable use of natural resources, management of land and water resources, as well as the provision of ecological services.

However, in recent years, global climate change has been seriously affecting the ecological stability of this region. As a result of a consistent increase in temperature, instability of the precipitation regime, droughts and increased frequency of extreme weather events, drastic changes are observed in the natural state of ecosystems. These factors lead to negative consequences such as degradation of vegetation cover, loss of some plant and animal species, and destruction of habitats.

In particular, changes in vegetation cover accelerate desertification, leading to a decrease in soil fertility and an increase in the risk of erosion. The loss of biodiversity, in turn, weakens the functional capacity of ecosystems and limits their ability to cope with climate change. As a result, the health and long-term sustainability of ecosystems are at risk. This situation disrupts the ecological balance of flora and fauna that has developed over centuries in the region.

Methodology

A rigorous methodological approach was adopted to conduct an in-depth analysis of the geocological consequences of climate change in the Khorezm region. The main objective of the study was to comprehensively assess the impact of climate change on ecosystems, water resources, agriculture, and the potential of the local population, which required the integration of various sources and research methods.

Literature review and methodology

The impact of climate change on the Central Asian regions has been studied by a number of domestic and foreign researchers. Stulina (2018) studied the impact of climate change on agriculture in Uzbekistan and noted that the average annual temperature in Uzbekistan increased by 1.5°C during 1950-2017, which negatively affected the productivity of agricultural crops. Dukhovny and Stulina (2021) reviewed the problems of water resources management in Central Asia and summarized local experiences in irrigation and land reclamation under climate change.

Rakhmatullaev et al. (2022) studied desertification processes in the northwestern regions of Uzbekistan using the example of the Khorezm region and noted that the increase in the level of soil salinity and degradation in these regions negatively affects agricultural production. Abdullaev et al. (2020) analyzed the dynamics of changes in groundwater levels in the Khorezm region and identified a trend of deterioration in their quality and increased mineralization.[3].

Globally, the IPCC (2022) report predicts that the average temperature in the Central Asian region will increase by 2.5°C by 2050, which could lead to further drought, water scarcity, and agricultural difficulties. This projection is also relevant for the Khorezm region, which is already facing problems of water scarcity and soil degradation.

Kurbanov et al. (2019) studied landscape changes in the Khorezm region using remote sensing methods and found that the area of vegetation cover in the region decreased by 7.2% during 2000-2018, and this process was mainly associated with climate change and anthropogenic impact. Rakhimov (2021) analyzed changes in the agrolandscapes of the Khorezm region using geoinformation systems and showed that the growth of the area of saline lands in

different districts of the region is uneven, and this process is accelerating in the northern parts of the region.

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Results

Internationally, according to FAO (2021), more than 60% of irrigated land in northwestern Uzbekistan is subject to varying degrees of salinity, which is a significant challenge for stabilizing agricultural production in the face of global climate change. According to the United Nations Development Programme (2020), Uzbekistan is among the 50 countries most vulnerable to climate change, and the country faces water security challenges, particularly in the Amu Darya basin.

Studies by Nazarov and Muminov (2023) show that the temperature in the Khorezm region is expected to increase by 1.0-1.5°C and the amount of precipitation to decrease by 5-10% by 2030, which may further complicate the geoecological situation in the region. We can see that the need to develop adaptation measures in the region is emphasized.

The scientific literature has covered various aspects of geoecological changes in the Khorezm region. However, to date, a comprehensive geospatial analysis of these changes has not been sufficiently studied, which emphasizes the relevance of this study.

Table 1. Geophase Analysis of Geoecological Changes in the Khorezm Region under Climate Change

№	Geophase	Time interval	Main climate trends	Dominant processes	Geo-ecological consequences
1	Historical phase (1991–2020)	1991–2020	Climate warming, severe drought; average annual precipitation \approx 80 mm, evapotranspiration \approx 1500 mm	Increased evaporation \rightarrow soil salinization	Decline of vegetation cover, high salinity levels in soils
2	Forecast 2021–2050	2021–2050	Continued warming trend	Moderate to high salinity increase	Reduction in low-salinity lands; increase in moderate/high-salinity lands
3	Forecast 2051–2100	2051–2100	Projected continuation of warming	Highest salinity levels	Expansion of high-salinity areas, moderate increase, decrease in lowest-salinity lands

The impacts of climate change on ecosystems in the Khorezm region are multifaceted and widespread, posing serious challenges to the region's biodiversity, ecological balance, and sustainability. This section examines the specific impacts of climate change on Khorezm ecosystems, including changes in vegetation, biodiversity loss, habitat degradation, and impacts on ecosystem services and human well-being..

Discussion

The impacts of climate change on agriculture in Khorezm region are significant and multifaceted, posing challenges to food security, agricultural productivity, and the livelihoods of farmers in this important sector. This section examines the specific impacts of climate change on agriculture in Khorezm, including changes in temperature, precipitation patterns, crop yields, pest infestation, and water availability, as well as the implications for sustainable agricultural practices and community resilience.

1. Changes in temperature and precipitation patterns: Climate change is altering temperature and precipitation patterns in Khorezm region, leading to shifts in growing seasons, water availability, and crop suitability. Rising temperatures can affect crop growth and yield, affecting crop development, flowering, and fruiting stages. Changes in precipitation patterns, including changes in precipitation intensity and distribution, can lead to water stress, soil erosion, and reduced soil moisture, which in turn affect the resilience of agricultural systems to environmental changes. These changes pose challenges for Khorezm farmers and require adaptive strategies to mitigate the impacts of climate change on agricultural production.

2. Crop yield and productivity: The impact of climate change on crop yields and agricultural productivity in Khorezm is significant, affecting food security, economic stability, and rural livelihoods. Changes in temperature, precipitation, and extreme weather events can lead to yield fluctuations, crop failure, and reduced agricultural output. Increased pest, disease, and weed pressure will further exacerbate yield losses and reduce the quality of agricultural products. Khorezm farmers face challenges in ensuring sustainable and sustainable crop production under changing climate conditions, which requires the introduction of climate-resilient agricultural practices and technologies.[6].

3. Water availability and irrigation: Water availability is a key factor affecting agricultural productivity in Khorezm region, and climate change will affect the availability and quality of water resources for irrigation. Changes in precipitation, increased evaporation rates, and reduced water flow in the Amu Darya River could lead to water scarcity and

competition among agricultural users for limited water resources.[7]. Sustainable water management practices, efficient irrigation techniques, and water conservation measures are essential to increase water use efficiency, reduce water waste, and ensure the sustainability of agricultural practices in Khorezm. Improving access to irrigation infrastructure, promoting water-saving technologies, and implementing water management initiatives are key strategies to address water-related challenges in agriculture.[8].

Conclusion

In conclusion, the impacts of climate change on agriculture in Khorezm region are complex and interrelated, affecting crop yields, water availability, and agricultural sustainability. By understanding the specific impacts of climate change on temperature, precipitation patterns, crop yields, and water availability, we can develop targeted strategies for climate-resilient agriculture, sustainable water management, and community adaptation in Khorezm. Enhancing agricultural sustainability, encouraging crop diversification, and enhancing climate adaptation capacity are essential for ensuring the long-term viability and prosperity of agriculture in a changing climate.

In conclusion, the impacts of climate change in the Khorezm region are profound and wide-ranging, affecting water security, agricultural livelihoods, and the well-being of the population. The impacts of climate change on water scarcity, agricultural productivity, and sharpBy understanding the specific impact of climate change on vulnerability, we can develop targeted strategies for community resilience, social equity, and sustainable development in Khorezm. Empowering local communities, expanding access to resources and services, and supporting community-based adaptation initiatives are essential to increasing the resilience and long-term sustainability of communities in the face of a changing climate.

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