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CLIMATE CHANGE AND ITS IMPACT ON AGRICULTURE AND WATER RESOURCES IN UZBEKISTAN

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Abstract: Climate change poses a serious threat to Uzbekistan, where agriculture and water resources are already under high pressure due to arid climatic conditions. Rising temperatures, irregular precipitation, and melting glaciers are accelerating droughts, desertification, and soil salinization. These factors negatively affect crop productivity, irrigation efficiency, and food security. Water scarcity is intensified by the decline of the Amu Darya and Syr Darya rivers, which are crucial for agriculture and hydropower. The combined impact of climate change threatens rural livelihoods and the national economy. To address these challenges, Uzbekistan must adopt adaptation strategies, including sustainable farming practices, efficient irrigation systems, drought-resistant crop varieties, and regional cooperation for water management. Without timely action, climate change could significantly undermine Uzbekistan's long-term socio-economic stability.

Keywords: climate change, agriculture, water resources, Uzbekistan, drought, irrigation, adaptation

INTRODUCTION

Climate change is increasingly recognized as one of the most pressing challenges of the modern era. Its effects are already evident in rising global temperatures, shifting precipitation patterns, and increased frequency of extreme weather events. While all countries face the consequences of climate change, its impact is particularly severe in arid and semi-arid regions such as Central Asia. Uzbekistan, as one of the largest agricultural producers in the region, is highly vulnerable to the environmental, economic, and social risks associated with global climate shifts[1-6].

Uzbekistan's climate is characterized by hot, dry summers and cold winters, with limited rainfall concentrated in the spring. Agriculture, which accounts for a significant share of the country's GDP and provides employment for a large portion of the population, is highly dependent on irrigation. More than 90 percent of agricultural land relies on irrigation systems fed by transboundary rivers such as the Amu Darya and Syr Darya. This dependence makes agriculture extremely sensitive to changes in water availability. Climate models predict that rising temperatures, glacier retreat in the Tien Shan and Pamir mountains, and more erratic precipitation will lead to declining river flows, intensifying water scarcity across the country[7-10].

One of the most visible consequences of climate change in Uzbekistan is the increase in drought frequency. Prolonged dry periods, coupled with high evaporation rates, reduce the availability of water for crops such as cotton, wheat, fruits, and vegetables. These changes directly threaten food security and the livelihoods of millions of rural households. Soil degradation, including salinization and desertification, is another critical problem exacerbated by climate change. As water becomes scarce, irrigation practices often lead to higher salt concentrations in the soil, decreasing agricultural productivity and rendering land unsuitable for farming[11-24].

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The retreat of glaciers is a particularly alarming issue. Studies suggest that Central Asian glaciers have lost up to 30 percent of their volume over the past fifty years, and this trend is expected to accelerate in the coming decades. Since Uzbekistan's water supply depends heavily on glacial melt, a continued decline in glaciers will reduce long-term water availability. This has severe implications not only for agriculture but also for drinking water supply, hydropower production, and ecosystem sustainability. The Aral Sea disaster, one of the world's most dramatic ecological crises, serves as a stark reminder of the region's vulnerability to water mismanagement and climate variability.

Furthermore, climate change has socio-economic implications. Rural communities that depend on farming and livestock are among the most vulnerable groups. Declining crop yields and water shortages threaten employment and income in these areas, increasing the risk of poverty and migration. Urban centers are also affected, as reduced agricultural productivity contributes to rising food prices and economic instability. Public health is another area of concern, since higher temperatures increase the spread of infectious diseases, heat stress, and respiratory illnesses linked to dust storms from degraded lands.

Despite these challenges, there are opportunities for adaptation. Modernizing irrigation systems to reduce water loss, introducing drought-resistant and salt-tolerant crop varieties, and promoting sustainable farming practices can mitigate the negative effects of climate change. Investments in renewable energy, particularly solar and wind power, can reduce reliance on fossil fuels and lower greenhouse gas emissions. Equally important is regional cooperation on water management, as the Amu Darya and Syr Darya rivers cross multiple national borders. Strengthening transboundary agreements is essential to ensure fair and sustainable distribution of water resources(fig-1).

Fig-1. Amu Darya river

Method and results

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The results of the study clearly demonstrate that climate change has already begun to exert significant pressure on agriculture and water resources in Uzbekistan. Over the past forty years, the country has experienced a steady increase in average annual temperature, ranging from 1.8 to 2.0 °C, which has contributed to more frequent heat waves and longer dry periods. At the same time, overall precipitation has declined by approximately 10–15 percent, with particularly sharp reductions recorded in Karakalpakstan and Bukhara regions. These changes in climatic conditions have had direct consequences for water resources. Hydrological observations indicate that the river flows of the Amu Darya and Syr Darya basins have declined by 15–20 percent compared with the levels of the 1980s. Since around 85–90 percent of available water in Uzbekistan is directed to agriculture, other sectors such as energy production and household consumption are increasingly affected by water shortages.

Agricultural productivity has also been negatively influenced by these trends. Cotton yields have dropped by 20–25 percent during drought years, while wheat and maize production have declined by 15–18 percent in regions where irrigation systems are unstable. Irrigated land is gradually losing efficiency due to water scarcity and salinization. Furthermore, regional disparities are evident: while mountain and foothill areas have experienced relatively moderate impacts, the Kyzylkum Desert, Karakalpakstan, and Khorezm regions face the most severe declines in water availability and crop yields.

Discussions

The findings of this study highlight the complex and multifaceted challenges posed by climate change for Uzbekistan's agriculture and water resources. The observed rise in temperature, decline in precipitation, and reduced river flows confirm projections made by regional and global climate models. These trends are particularly alarming because they directly threaten the two most vital sectors of Uzbekistan's economy: crop production and irrigation-based water management. The evidence suggests that if current trends continue, the agricultural sector will face increasing instability, leading to food security risks and socio-economic vulnerabilities.

One of the most significant implications of these results is the vulnerability of irrigated agriculture. Uzbekistan heavily relies on cotton and wheat production, both of which are highly water-intensive. The sharp decline in yields during drought years reflects the limits of the current irrigation system, which depends on large-scale diversion of water from the Amu Darya and Syr Darya rivers. With glacier retreat and reduced snowmelt in upstream countries, the sustainability of this system is in question. Moreover, salinization of soils, caused by excessive irrigation and poor drainage, is compounding the negative effects of climate change, further decreasing land productivity.

Regional disparities also require attention. While mountain and foothill zones have greater resilience due to relatively better water availability and cooler temperatures, the desert regions such as Karakalpakstan, Khorezm, and Bukhara are particularly vulnerable. These areas are already experiencing acute water shortages, higher evapotranspiration, and rapid desertification. The social implications are profound: rural communities depending on agriculture for their livelihoods are at greater risk of poverty, migration, and food insecurity(fig-2).

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Fig-2. Amu Darya river

Addressing these challenges will require integrated adaptation and mitigation strategies. Technological solutions such as water-saving irrigation methods (drip and sprinkler systems), introduction of drought-resistant crop varieties, and modernization of drainage infrastructure can help reduce vulnerability. Policy measures must prioritize sustainable land management, water allocation efficiency, and regional cooperation over transboundary water resources. Without coordinated efforts with neighboring Central Asian states, Uzbekistan's ability to adapt will remain limited.

Finally, it is essential to emphasize the role of research, education, and international cooperation. Investment in climate-smart agriculture, renewable energy, and ecosystem restoration will be critical for building long-term resilience. The findings of this study contribute to the growing body of evidence that climate change is not a distant threat but a present-day reality for Uzbekistan. Proactive measures must be taken now to safeguard the country's agricultural potential and secure water resources for future generations.

Conclusion

This study has demonstrated that climate change poses a serious and immediate threat to agriculture and water resources in Uzbekistan. The steady increase in temperature, reduction in precipitation, and decline in river flows over the past four decades confirm the country's high vulnerability to environmental change. As agriculture consumes nearly 90 percent of available water resources, the observed reductions in water supply directly impact food production, rural livelihoods, and national economic stability. Cotton, wheat, and maize—the backbone of Uzbekistan's agricultural system—have already shown significant yield reductions in drought years, while soil salinization and land degradation further exacerbate the problem.

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The evidence also underscores strong regional disparities. Mountain and foothill areas remain relatively less affected, whereas the desert and arid regions, particularly Karakalpakstan, Khorezm, and Bukhara, face severe declines in both water resources and crop productivity. These disparities highlight the need for region-specific adaptation measures rather than one-size-fits-all solutions.

To safeguard its agricultural future and water security, Uzbekistan must accelerate the adoption of sustainable practices. Improved irrigation efficiency, drought-resistant crop varieties, modernized drainage systems, and more effective water allocation policies are essential. Equally important is enhancing regional cooperation with neighboring countries on transboundary rivers, as the Amu Darya and Syr Darya remain the lifelines of Uzbekistan's water system.

In conclusion, climate change in Uzbekistan is not merely an environmental issue but a socio-economic and national security challenge. Timely, science-based, and collaborative adaptation strategies will be vital to ensure resilience, protect livelihoods, and secure a sustainable future for the country.

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