

CLIMATE CHANGES AFFECTING ENVIRONMENT AND AGRICULTURE IN THE AREA OF DUSHANBE

M. DAVLATOV¹, R. PASCALAU¹, Laura SMULEAC¹, R. JURAKHONZODA²

¹ University of Life Sciences „King Mihai I” from Timisoara

² Tajik Technical University named after M.S. Osimi

Corresponding author: laurasmuleac@usvt.ro

Abstract. Climate change is a big problem that countries all over the world face, affecting both nature and farming. In Dushanbe, the capital of Tajikistan, changing weather patterns highlight the urgent need for detailed study. The area's physical features, such as its hilly landscape and susceptibility to changing weather, worsen problems in farming. Thus, the link between climate change and agricultural success needs careful examination to understand how higher temperatures, changes in rainfall, and severe weather are impacting local farms and food availability. This initial look shows how crucial it is to grasp these issues, as they not only create serious challenges for farming output but also endanger farmers' incomes and the economic health of the community in Dushanbe. The current research focused on the specific impacts and adaptive measures needed to address these urgent concerns. The research shows that climate change affects agriculture in the Dushanbe area in many ways, with impacts on crop yields and seasonal trends. Important findings show a notable increase in average temperatures, along with erratic rainfall patterns, which worsen soil deterioration and lower crop output. In response to these findings, policymakers need to focus on creating adaptive farming methods and investing in sustainable technologies. A focused policy approach that includes local knowledge and engages stakeholders at all levels is necessary for ensuring long-term sustainability in the region's farming sector

Keywords: climate change, sustainable agriculture, temperature, rainfall, crop output

INTRODUCTION

A noticeable rise in global temperatures has become a key feature of climate change, affecting many sectors and areas. This situation, mainly caused by human-made greenhouse gas emissions, shows up as more common extreme weather occurrences, changes in rainfall patterns, and higher sea levels. The effects go beyond just harming the environment and touch on agricultural yield, water supply, and global food security (Shyam et al., 2011).

Climate change is one of the greatest threats to key sectors of society, and agriculture is one of the industries most vulnerable to it. Over the past few decades, phenomena such as rising global temperatures, changing precipitation patterns, and the frequency of extreme events have begun to make their presence felt, with significant consequences for agricultural practices and food production (Smuleac et al., 2020, 2023).

High temperatures can lead to changes in the distribution of precipitation and moisture exchange, thus influencing the availability of water resources for plants. Some regions may be affected by longer and more intense periods of drought, which can reduce crop yields or compromise their quality. Also, increasing temperatures can accelerate evapotranspiration processes, causing greater loss of water from the soil. This increases the need for irrigation and can lead to water stress for crops. At the same time, the spread of specific pests and diseases in plants is favored, affecting their health and yield. On the other hand, certain crops could benefit from higher temperatures in certain regions, extending the growing season or allowing the cultivation of plants that otherwise could not survive in colder climate conditions (Zhu et al., 2011).

Areas such as Dushanbe are especially at risk, as changing climate conditions threaten traditional farming methods and worsen existing social and economic inequalities (Jurakhonzoda et al., 2023, Smuleac et al., 2024). It is essential to have adaptation and

mitigation plans for resilience, which need cooperation at both local and global levels. Not addressing the complex challenges brought by climate change could worsen poverty, lead to more migration, and increase conflict over scarce resources, highlighting the pressing need for joint efforts to protect the futures of affected communities (Hallegatte et al., 2016, Pascalau et al., 2021, 2024).

MATERIAL AND METHODS

It is important to know the climate situation in Dushanbe to understand and lessen the bad effects of climate change on its nature and farming output. By looking into these effects, researchers and policymakers can find the specific weaknesses in the area, helping them create better adaptation plans. Particularly, the changes in rainfall and higher temperatures endanger essential crops and water supplies that are vital for local communities. Also, Dushanbe is in a mountainous region, which makes the melting glaciers that supply its rivers very important to examine. These glaciers significantly influence the water available during key planting times, and their decline might worsen water shortage problems. Thus, thorough research on these climate changes is crucial not just for maintaining agricultural production but also for supporting sustainable growth and resilience in the community (Hallegatte et al., 2016).



Fig. 1. Location of Dushanbe

Recent changes in weather patterns in Dushanbe have caused worries for both environmentalists and farming experts. In recent decades, the area has seen a clear rise in average temperatures, leading to more frequent and longer heatwaves that negatively impact crop production and water supply. Additionally, rainfall has become more irregular, showing a trend towards heavy downpours followed by long dry periods. This unpredictability creates difficulties for local farmers who depend on traditional farming methods that need stable weather to thrive (Food and Agriculture Organization). As Dushanbe faces these changing weather conditions, the relationship between farming and environmental sustainability is crucial. Tackling these problems requires both short-term and long-term solutions, such as using farming methods that can withstand climate change and enhancing water management systems to reduce the effects of these weather changes on the local environment.

RESULTS AND DISCUSSIONS

Analysis of temperature and precipitation changes over the past decades

In the last few decades, weather data shows clear changes in temperature and rainfall patterns, affecting both the environment and farming in Dushanbe. Average temperatures have been rising, especially in summer, leading to a hotter climate that adds pressure on water supplies and crop growth. At the same time, rainfall has become less predictable, causing droughts followed by heavy rain, which results in soil erosion and lower crop yields. These changes create a big problem for farmers who need to adjust their methods to deal with the erratic weather. The economic effects are serious, as lower agricultural output endangers food availability and threatens the livelihoods of local people who depend on farming. To lessen these impacts and support sustainable farming practices amid changing weather conditions, effective strategies are necessary (Muthukumara Mani et al., 2018). The year 2000 was the driest year in Tajikistan, 3 million people were affected.

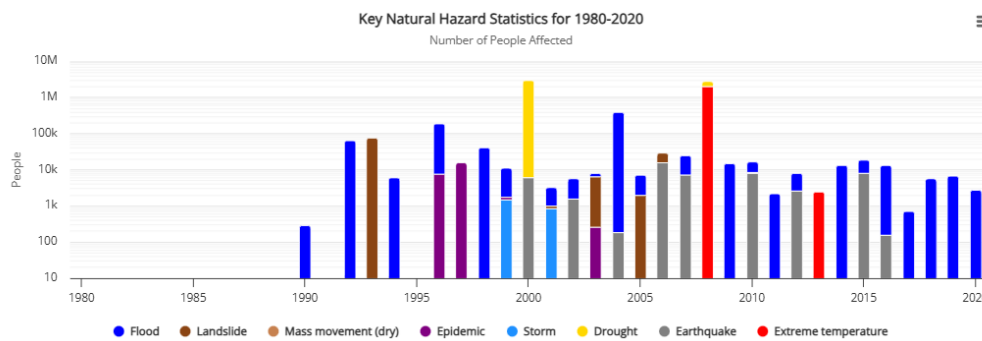


Fig. 2. Overview of the most frequent natural disaster Tajikistan and the impacts on human populations (<https://climateknowledgeportal.worldbank.org/country/tajikistan>)

Impact of climate variability on local weather patterns

Changes in climate have clearly affected local weather in and around Dushanbe, shown by changes in rainfall and temperature patterns. As global climate changes happen, the area has seen more unpredictable rainfall and long dry spells, which directly affect farming and water supply. Farmers now face problems with rain timing and seasonal temperature changes, making old farming schedules less dependable. For example, crops that were once grown in certain seasons now have difficulties due to surprising weather, resulting in lower production and threatened food safety. Additionally, the rise in severe weather events, like heatwaves and sudden heavy rain, has increased the risks for local ecosystems and farming methods (Hallegatte et al., 2016). Grasping these trends is vital for creating adaptive plans that help the environment and agricultural sectors stay strong in Dushanbe.

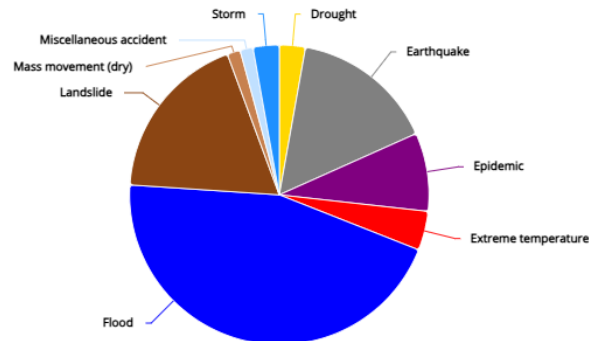


Fig. 3. Average annual natural hazard occurrence
(<https://climateknowledgeportal.worldbank.org/country/tajikistan>)

Effects of Climate Change on Agriculture

The effects of climate change on farming are serious, especially in Dushanbe, where higher temperatures are changing growing times and crop outputs. As rainfall patterns become more unpredictable, water shortages are a major issue for farmers who need steady irrigation. This change in weather not only threatens food availability but also increases the problems faced by rural areas already dealing with economic stress. Additionally, the rise in pests and diseases, driven by warmer temperatures, adds extra risks to crop strength, making it harder and more expensive for farmers to manage these threats. This combined problem—lower yields and rising expenses—puts significant pressure on farming systems and endangers old farming methods. Thus, changing farming strategies is crucial, requiring new methods to guarantee sustainability and strength against the ongoing effects of climate change (Hallegatte et al., 2016).

Changes in crop yields and agricultural productivity

The changes in how much crops grow and farm productivity near Dushanbe have been strongly affected by climate change, leading to different effects on local farming methods. A major worry is the increasing unpredictability in weather, especially the more common droughts and changes in rainfall patterns, which directly impact how crops grow and how much moisture is in the soil. This unpredictability forces farmers to change their growing methods, often leading to lower yields because of a lack of water or bad weather that interferes with planting times. Additionally, using climate-resistant crop types has shown some potential in easing these problems, but broad use is still limited because of money issues and old farming methods. As the need for food rises along with a growing population, grasping these changes is key for creating effective farming policies that aim to maintain production and improve food security in the area.

Adaptation strategies employed by local farmers

In answer to the bad effects of climate change, farmers in Dushanbe have taken on several ways to adapt to the situation. They are diversifying crops, which helps them avoid relying on just one type of plant and deal better with changing weather and pests. Some are mixing old farming knowledge with new methods to create better irrigation systems that use less water, which is in short supply. They are also using drought-resistant seeds to keep their harvests going even when the rainfall is more unpredictable. Additionally, many are getting involved in agroforestry, which not only helps improve the soil but also brings in more money by growing trees and bushes. These steps show that farmers are working hard to maintain

sustainable practices in the face of climate problems, thus helping local farming systems (Food and Agriculture Organization).

Environmental Consequences of Climate Change

The various environmental effects of climate change are clear in Dushanbe, where changes in temperature and rainfall patterns disrupt local ecosystems. Rising temperatures are causing more frequent and severe droughts, which reduce water supplies necessary for farming and drinking. This results in a growing imbalance in the area's plant and animal life, pushing native species to adapt or risk extinction. Moreover, the increase in extreme weather events like heavy rains and floods worsens soil erosion and land degradation, making agricultural areas more vulnerable. This environmental decline not only threatens food security but also creates significant economic stress for farmers who find it hard to maintain production amid unpredictable weather conditions. Therefore, it is crucial to understand and address these issues to develop adaptive strategies for ecosystems and local communities (Food and Agriculture Organization).

Impact on local biodiversity and ecosystems

Climate change brings big problems to local biodiversity and ecosystems, especially in the Dushanbe area. Changes in rainfall and rising temperatures are harming habitats, which hits native plants and animals hard. For example, changes in climate can upset seasonal cycles, affecting breeding and migration of important species for the region's ecological balance. As a result, some species find it hard to adapt and face a greater risk of extinction when they cannot compete with invasive species that do well in changing conditions. Additionally, losing biodiversity weakens ecosystem services like pollination and soil health, which are essential for sustainable farming practices in Dushanbe (Hallegatte et al., 2016). Tackling these issues needs thorough plans that not only lessen the impacts of climate change but also support efforts to conserve biodiversity in the region and ensure a strong ecosystem that can support local agriculture during these changes.

Water resource management challenges due to climate shifts

The complicated link between climate changes and managing water resources brings big problems, especially in places like Dushanbe, where farming depends a lot on steady water supply. Climate change causes unpredictable rain and increases evaporation, making fresh water less certain. This unpredictability makes irrigation harder, risking local crops and the incomes of farmers who rely on constant water sources. The changes in climate affect both surface water and groundwater recharge, making competition tougher among farming, industry, and home users for fewer supplies. Additionally, the poor management strategies make these problems worse, making it difficult to adapt to changing water availability. To tackle these complex issues, we need combined approaches that include new technology and sustainable practices with traditional knowledge, ensuring fair water distribution in the face of climate change challenges (Intergovernmental Panel on Climate Change / Working Group Technical Support Unit).

CONCLUSIONS

In conclusion, the complex relationship between climate change and farming methods in Dushanbe is very important. The data shown in this study highlights not just the short-term effects of changing weather on crop production but also the lasting effects on food security and economic health in the area. Notably, changes in temperature and rainfall negatively impact key crops like cotton and fruits, posing challenges for local farmers and worsening economic inequalities. Additionally, many farming sectors do not use adequate adaptive methods, making them more exposed to unpredictable climate events. Therefore, it is essential to have a varied

approach that includes sustainable farming practices, better resource use, and strong policy measures to lessen these harmful impacts. This research highlights the need for regional collaboration and investment in climate resilience projects, creating a base for future studies and policies aimed at tackling the urgent environmental issues in Dushanbe (Food and Agriculture Organization).

The research shows that climate change affects agriculture in the Dushanbe area in many ways, with impacts on crop yields and seasonal trends. Important findings show a notable increase in average temperatures, along with erratic rainfall patterns, which worsen soil deterioration and lower crop output. Furthermore, the evidence indicates that smallholder farmers, making up a major part of the agricultural workforce, face greater challenges because of their limited ability to adapt and lack of financial resources. As a result, these changes pose risks not only to food security but also to the economic health of farming communities. In response to these findings, policymakers need to focus on creating adaptive farming methods and investing in sustainable technologies. Actions like improving irrigation and diversifying crops can help lessen negative impacts while increasing resilience. In the end, a focused policy approach that includes local knowledge and engages stakeholders at all levels is necessary for ensuring long-term sustainability in the region's farming sector.

Future studies need to look at mixing local knowledge with scientific advances to tackle the complex problems caused by climate change in Dushanbe. Looking into old farming methods can show good ways that support modern environmental aims. Also, doing detailed research on soil health and water management will give important information to guide policies that boost farming resilience. It is also important to encourage teamwork among involved parties, such as government agencies, NGOs, and local farmers, to promote community-led projects. Moreover, funding in sustainable technologies, like drip irrigation and systems to collect rainwater, could help reduce water shortages while increasing crop output. Finally, campaigns to raise public awareness will be key in teaching people about sustainable methods and encouraging changes in behaviour. By focusing on these areas, future work in Dushanbe can build a stronger plan for effectively addressing climate-related challenges.

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