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# Climate Change and its Impact on Tajikistan

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## ABSTRACT

Tajikistan is prone to natural disasters and ranks high on the international climate impact lists. Disruptions in rainfall, growing temperatures, reductions in glacial cover and extreme weather events are among ongoing and anticipated impacts of climate change in Tajikistan. The long-term weather trends show more hot days and fewer cold days with considerable variations in precipitation. Hydropower generation is highly sensitive to weather and water conditions, and the changing climate is creating new challenges for environment problems, natural hazard, agriculture, water resources, Infrastructure and human health.

**Key Words :** Climate change, Topography, Environment, Agriculture

## INTRODUCTION

Tajikistan, located in the subtropical zone and has a mainly continental climate, however, it has extreme consistencies in climatic conditions according to height. Depending on the altitude, the climate can vary between arid to semiarid, summers can vary between long and hot to short and warm, and winters can vary between short and mild to long and extreme. Using the popular Köppen-Geiger climate classifications[1], the two most prevalent climates in Tajikistan are the Cold semi-arid (BSk) and the Hot-summer Mediterranean climate (Csa). The changes between the four main seasons are relatively unexpected. In the subtropical southwestern lowlands, which experience the highest temperatures, the climate is mainly dry. The summer temperature range in these lowlands is generally between 27°C to 30°C with extremes of up to +50°C. The winter range is from –1°C to 3°C. In the eastern Pamirs on the other side of the country, the summer temperatures range from 5°C to 20°C, and in winter, from –15°C to –20°C. In some areas (such as the province Murgab which borders China) winter temperatures can drop to –45°C; moreover, extremes of -60°C can be reached in the highest mountains. Annual precipitation in the lowlands and the mountain valleys average between 100 and 250 mm per year; while at the higher elevations (such as the high plateau of the Eastern Pamirs), average precipitation is only between 60 and 80 mm per year. The highest precipitation rate in a year was 2,236 mm and was measured near the Fedchenko Glacier in eastern Tajikistan [15].

### Topography:

The lower elevations of Tajikistan are divided into northern and southern regions by a complex of three mountain chains that constitute the westernmost extension of the massive Tian Shan system. Running essentially parallel from east to west, the chains are the Turkestan, Zeravshan (Zarafshan), and Hisor (Gissar) mountains. The last of these lies just north of the capital, Dushanbe, which is situated in west-central

1. World Bank (2018).Country Profile Tajikistan.Retrieved from: https://databank.worldbank.org/views/reports/reportwidget.aspx?Report_Name=CountryProfile&Id=b450fd57&tbar=y&dd =y&inf=n&zm=n&country=TJK

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Tajikistan[2].

More than half of Tajikistan lies above an elevation of 3,000 metres (9,800 ft). Even the lowlands, which are located in the Fergana Valley in the far north and in Khatlon Province in the southwest, are well above sea level. In the Turkestan range, highest of the western chains, the maximum elevation is 5,510 metres (18,080 ft). The highest elevations of this range are in the east, near the border with Kyrgyzstan. That region is dominated by the peaks of the Pamir-Alay mountain system, including two of the three highest elevations in the former Soviet Union: Mount Lenin — 7,134 metres (23,406 ft) and IsmoilSomoni Peak — 7,495 metres (24,590 ft). Several other peaks in the region also exceed 7,000 metres (23,000 ft). The mountains contain numerous glaciers, the largest of which, Fedchenko Glacier, covers more than 700 square kilometres (270 sq mi) and is the largest glacier in the world outside the polar regions. Because Tajikistan lies in an active seismic belt, severe earthquakes are common.

**Environment problem:**

Most of Tajikistan's environmental problems are related to the agricultural policies imposed on the country during the Soviet period. By 1991 heavy use of mineral fertilizers and agricultural chemicals was a major cause of pollution in the republic. Among those chemicals were DDT, banned by international convention, and several defoliants and herbicides. In addition to the damage they have done to the air, land, and water, the chemicals have contaminated the cottonseeds whose oil is used widely for cooking. Cotton farmers and their families are at particular risk from the overuse of agricultural chemicals, both from direct physical contact in the field and from the use of the branches of cotton plants at home for fuel. All of these toxic sources are believed to contribute to a high incidence of maternal and child mortality and birth defects. In 1994 the infant mortality rate was 43.2 per 1,000 births, the second highest rate among former Soviet republics. The rate in 1990 had been 40.0 infant deaths per 1,000 births.

Cotton requires particularly intense irrigation. In Tajikistan's cotton-growing regions, farms were established in large, semiarid tracts and in tracts reclaimed from the desert, but cotton's growing season is summer, when the region receives virtually no rainfall. The 50 percent increase in cotton cultivation mandated by Soviet and post-Soviet agricultural planners between 1964 and 1994 consequently overtaxed the regional water supply. Poorly designed irrigation networks led to massive runoff, which increased soil salinity and carried toxic agricultural chemicals downstream to other fields, the Aral Sea, and populated areas of the region.

By the 1980s, nearly 90 percent of water use in Central Asia was for agriculture. Of that quantity, nearly 75 percent came from the Amu Darya and the Syr Darya, the chief tributaries of the Aral Sea on the Kazakhstan-Uzbekistan border to the northwest of Tajikistan. As the desiccation of the Aral Sea came to international attention in the 1980s, water-use policy became a contentious issue between Soviet republics such as Tajikistan, where the main rivers rise, and those farther downstream, including Uzbekistan. By the end of the Soviet era, the central government had relinquished central control of water-use policy for Central Asia, but the republics had not agreed on an allocation policy.

Industry also causes pollution problems. A major offender is the production of nonferrous metals. One of Tajikistan's leading industrial sites, the aluminum plant at Tursunzoda (formerly known as Regar), west of Dushanbe near the border with Uzbekistan, generates large amounts of toxic waste gases that have been blamed for a sharp increase in the number of birth defects among people who live within range of its emissions.

In 1992 the Supreme Soviet of Tajikistan established a Ministry of Environmental Protection. However, the enforcement activity of the ministry was limited severely by the political upheavals that plagued Tajikistan in its first years of independence. The only registered private environmental group in Tajikistan in the early 1990s was a chapter of the Social-Ecological Alliance, the largest informal environmental association in the former Soviet Union. The Tajik branch's main functions have been to conduct environmental research and to organize protests against the Roghun Hydroelectric Plant project[3].

2. *"Topography and Drainage".Library of Congress Country Studies.Retrieved 31 July 2015.* This article incorporates public domain material from the Library of Congress Country Studies website http://lcweb2.loc.gov/frd/cs/.

3. *"Environmental problems".Library of Congress Country Studies.Retrieved 31 July 2015.* This article incorporates public domain material from the Library of Congress Country Studies website http://lcweb2.loc.gov/frd/cs/.

**Natural hazards:**

Earthquakes are of varying degrees and are frequent. Flooding and landslides sometimes occur during the annual Spring thaw[4].

**Environment - current issues:**

Inadequate sanitation facilities; increasing levels of soil salinity; industrial pollution; excessive pesticides; part of the basin of the shrinking Aral Sea suffers from severe overutilization of available water for irrigation and associated pollution.

**Climate change impacts on agriculture:**

The impact of climate Change among the all sectors most exposed to climate change globally and especially in Tajikistan. Recent reports and simulation studies predict adverse effects on the global yields of all major crops due to climate change[5]. In Tajikistan, agriculture is increasingly being challenged by the change in the hydro-meteorological regime which results from climate change. 68% of the permanent cropland of Tajikistan depends on irrigation. The expected reduction in river flow due to accelerated glacier melting which is expected to increase – poses a further existential challenge to the country's crop production. This challenge is especially relevant for irrigation dependent crops, specifically cotton[6] . Climate-induced impacts on crop yields will nevertheless be varied, crop specific, and site-specific. In terms of crop productivity, it is important to note that although the multi-model mean of the high emission scenario (RCP8.5) indicates an increase in extreme precipitation (above 20 mm/ day), this increase is rather moderate with an approximate increase by 1 day reaching a total of 3.5 days by 2080. On the other hand, the multi-model mean for the same high emissions scenario projects an increase for heat days (40°C) by 12.5 days and for tropical nights to a value of almost 10 nights per year by 2080. These projections can be translated indirectly into potentially more intense and frequent droughts which will impact agricultural yield quality and quantity. In addition, tropical nights intensify the impacts of heat waves as a livestock's ability to cope with high temperatures during the day is diminished due to insufficient cooling for recovery at night. Furthermore, the negative consequences of more frequent and intense heat waves would likely jeopardize any potentially positive results for agricultural productivity due to a projected increase in the growing season length (GSL). Under the high emissions scenario, the projected reduction in frost days will reduce the risk of frost damage to crops and livestock, but will also likely increase the risk of pests and diseases which no longer can be eradicated by low temperatures. Overall, to make it possible to "Climate Proof" the agricultural sector, various adaptation options to climate change need to be evaluated against the projected climate risks, and the alternatives to current agricultural practices must be identified. Amongst these, the following strategies should be considered accordingly: Facilitating changes in the production systems by promoting sustainable and resilient agriculture techniques; The bridging of respective transitional costs or adaptation costs due to the introduction of new methods of production; Increasing awareness and the building of a sound knowledge base regarding climate trends, risks, and options for producers and other agricultural businesses and financial institutions; Providing access to and facilitating the interpretation of weather and climate information for seasonal as well as long-term planning by the Ministry of Agriculture, local producers, and extension service providers; Supporting alternative income options, diversification, and introducing risk-sharing strategies.

**Climate change impacts on water resources:**

An increase in mean temperatures will lead to more evaporation and consequently, vegetation (such as pastures and crops) will require more water to sustain their production. If precipitation during the vegetation period does not increase – as is the case during spring – periods of water scarcity will last longer and affect more people both directly and indirectly. An increase in the mean precipitation at locations above the snowline causes a potential increase of the snow-depth if slopes are level

4. The World Factbook,Economy of Tajikistan This article incorporates public domain material from the CIA *World Factbook* website https://www.cia.gov/the-world-factbook/.
5. Pilot Program for Climate Resilience (2018).Assessment on Tajikistan Agricultural Production and Climate Change Impact Modelling 2018.
6. USAID (2016).Tajikistan-Property Rights and Resource Governance Profile. Retrieved from: https://www.landlinks.org/wpcontent/uploads/2016/09/USAID_Land_Tenure_Tajikistan_Pr ofile.pdf

enough. But at the same time, the snowline can generally be expected to retreat due to higher temperatures. Whether the total amount of snow increases or decreases depends strongly on local conditions such as elevation and sun exposure. For the moment, only local hydrological observations can offer definitive answers to these questions. Regardless of these local circumstances, the fact remains that if less water is stored as snow – the source responsible for providing the largest portion of irrigation water during the vegetation period – then water might become unreliable and eventually scarce. Moreover, the retreat of glaciers, the loss of glacial mass, and the related decreased water storage capacity resulting from the projected higher temperatures will increase the flow variability of rivers and strongly contribute to fluctuations in water availability and quality. These factors are especially concerning at the end of summer and the end of the vegetation period when most other water sources have already been exhausted. In summary, the observed trends contribute to an increased risk of water scarcity for different sectors that rely on irrigation water. Additionally, there is a likely increase in the risk of spring flooding as well as glacial lake outbursts during snowmelt due to the quantity of meltwater exceeding its historical level.

**Climate change impacts on human health:**

Climate change related increases in the frequency and intensity of extreme weather events (such as heat waves and droughts and changes in hydrological cycles favouring mudflows, landslides, glacier lake outbursts, floods, and avalanches) are predicted to lead to various direct as well as indirect, detrimental effects on human health. Climate change is projected to lead to a reduction in agriculture and pasture production capacity which will have ramifications on the food security and the nutritional status of the population. More frequent and severe, infectious disease outbreaks as well as an expansion in the exposure to water and foodborne diseases are likely consequences of shifting habitat conditions and the projected reduction in the ecosystem's capacity to provide important services and a loss in biodiversity[7] . Increasing temperatures and flood related water contamination are equally projected to further increase the rates of gastrointestinal infections[8] and they will also create more favourable conditions for the reproduction of Malaria mosquitoes; therefore, increasing the country's subjectivity to Malaria Rising temperatures will result in more frequent heatwaves in Tajikistan leading to an increase in heat related issues such as heat stress – which is particularly dangerous for vulnerable groups such as the elderly and small children and infants. Furthermore, heat stress might have secondary effects in terms of labour capacity since increasing temperatures could impact the activities of labourers, especially in the southern and northern lowland regions. The number of heat days above 40°C is expected to increase. Under the high emissions scenario, RCP8.5, the multi-model mean for heat days (40°C) shows an increase of up to 12.5 days by 2080 (relative to 1986-2005 period). In addition, under the high emissions scenario, RCP8.5, there is a projected increase of the multi-model mean for tropical nights to a value of almost 10 nights per year by 2080. At the same time, Tajikistan already suffers from chronic weaknesses of its health care infrastructure, an example of which is the insufficient and improper sanitation and water facilities in most rural medical facilities and schools. Much of the physical infrastructure of the country's rural health facilities (e.g. heating, electricity, communication systems, water supply, sewage, and sanitation infrastructure) are highly vulnerable to the effects of extreme weather events. This further reduces the capacity of the health care system to cope with the emerging challenges of climate induced health issues and the effects of extreme weather events on the population[9]

**Climate change impacts on infrastructure:**

Extreme weather and climate risks in Tajikistan have led to frequent damages to houses, roads, bridges, riverbank enforcement structures, and other infrastructure such as irrigation channels and electric lines. A study from 2019 identified mudflows, droughts, high

7. WHO (2009).Protecting health from climate change – Tajikistan. Retrieved from: http://www.euro.who.int/__data/assets/pdf_file/0003/13295 1/Protecting_health_TJK.pdf

8. UNFCCC (2017). Human health and adaptation: understanding climate impacts on health and opportunities for action. Retrieved from: https://unfccc.int/sites/default/files/resource/docs/2017/sb sta/eng/02.pdf

9. WHO (2009).Protecting health from climate change – Tajikistan. Retrieved from: http://www.euro.who.int/__data/assets/pdf_file/0003/13295 1/Protecting_health_TJK.pdf

temperatures, and strong winds as main climaterelated risks that cause damages and losses on many types of infrastructure[10]. In general, roads are particularly exposed to changes in temperature and extreme heat events[11]. To partially reduce this risk in Tajikistan, vehicles of more than 6t per axle are not allowed to drive from 10am to 8pm during the summer months when the temperature reaches above 26°C to avoid pavement deformations. Such measures, though necessary to preserve the condition of the road, cause traffic disruptions, and have direct impacts on the local and national economy. High precipitation events plus increases in water levels impact road foundations as well as the capacity of drainage and overflow systems to deal with stronger or faster water flows that lead to floods and siltation that affect bridges. The vulnerability of transport infrastructure is at the heart of local resilience to climate change. Infrastructure is simultaneously vulnerable to extreme weather events and also essential for livelihoods and access to socio-economic services such as healthcare, education, and credit (especially in rural and remote areas). Infrastructure is additionally very important for post-disaster recovery and reconstruction. Extreme weather events (such as mudflows triggered by heavy rains, droughts, high temperatures, and strong winds) can also have devastating effects on economic production sites and settlements. The incurred damages of such events highly depend on the quality of the building materials which are related to the availability of financial resources. Due to the important role of remittances for the local economy, new houses are often built by families receiving remittances and are more likely to be constructed from high-quality, sturdy materials. A decrease in remittances consequently influences the quality of the houses built. Overall, climate change will decrease the life span of infrastructure, while significantly increasing the maintenance costs to keep infrastructure functioning[12]. A hotter climate will also amplify the effect of less snow and more rain in winter as well as early snowmelt in spring which will lead to more water during a reduced period in spring and less water for the rest of the year. The resulting droughts and floods equally affect infrastructure such as hydropower generation plants[13]. Furthermore, the risks resulting from the impacts of droughts and mudflows are likely connected because droughts increase land degradation and may consequently lead to a higher susceptibility towards erosion and mudflow. However, erosion and mudflows have to be considered as intermediate impacts since these impacts are not entirely caused by climate-related hazards, but rather, they require a precondition such as land degradation. It can hence be established that the most important factors aggravating these climate risks in the region in the last decades are the increase in vulnerability due to socio-economic developments.

As such, the increase in intensity in sediment – and mudflows in the case of heavy rain events is mainly caused by land degradation due to higher livestock numbers and lack of adequate pasture management. Additionally, population growth and remittances have further increased the exposure to hazards in the last 20 years due to the construction of new houses, roads, bridges, riverbank enforcement structures, and other infrastructure (irrigation, electricity network) in the vicinity of rivers, gullies, and other vulnerable areas. The following key figures are an attempt to quantify the above-described risks to infrastructure related to climate change: Of the 14,000 kilometres of registered roads in Tajikistan, over 500 km are annually exposed to adverse natural events, among which climatic factors play the main role. Today, there are about 1,200 reported landslide areas that directly pose a threat to settlements, roads, irrigation facilities,

10. Abdurasulova, G., Demenge J., Mohidinov, N., Renner, K., Yodalieva, M. and Zebisch, M. (2019). Climate Risk and Vulnerability Assessment (CRVA) in JabborRasulov district, Tajikistan a pilot study. Retrieved from: https://www.uniquelanduse.de/en/publications/climate/735-climate-risk-andvulnerability-assessment-crva-in-jabbor-rasulov-district,- tajikistan-a-pilot-study

11. ADB (2014). Climate Proofing ADB Investment in the Transport Sector: Initial Experience. Retrieved from: https://www.adb.org/sites/default/files/publication/152434 /climate-proofing-adb-investment-transport.pdf

12. D. Twerefou, K. Adjei-Mantey, and N. Strzepek (2014). The economic impact of climate change on road infrastructure in sub-Saharan Africa countries: evidence from Ghana. Retrieved from: https://www.wider.unu.edu/publication/economicimpact-climate-change-road-infrastructure-sub-saharanafrica-countries

13. EBRD (2014).Climate Resilience and Hydropower in Tajikistan. Retrieved from: https://www.ebrd.com/news/2014/climate-resilience-andhydropower-in-tajikistan.html.

and other infrastructure. Annually, roughly 100,000 people are affected by flooding[14] . Overall, in the period from 1992 to 2016, major disasters caused economic losses above 1.8 billion USD and affected more than 80% of the population of Tajikistan. In summary, the above-described occurrences of disasters such as landslides, mudslides, floods, and droughts are indicative of the already high level of exposure of Tajikistan's population and infrastructure to weather and climate events. The combined catalysing effects of land degradation and climate change are now further augmenting this high level of risk[15] .

## Conclusion:

"Tajikistan is the most vulnerable country to climate change in the ECA region (Europe and Central Asia)." Over the past decades, the number of natural disasters in the country has increased many-fold, which poses a serious threat to the well-being of both the country's population and the entire region, 93% of the Tajikistan's territory is mountains, and only 7% of the land is considered flat. The country's population is 9 million people, and there are only 0.06 hectares of irrigated land per each resident. Tajikistan is highly vulnerable to such climate shocks droughts, floods, landslides, etc. Up to one third of the glaciers in Central Asia. Such disasters are particularly devastating for the country's agricultural sector, Infrastructure, water resources and Human Health. Global climate change has a direct impact on intensification of natural processes in the territory of our country. According to experts, general temperature rise is observed in the territory of the Republic of Tajikistan, and the number of droughts and natural disasters has increased. Reducing glaciers that feed the main rivers in our country and the entire Central Asian region may jeopardize the energy industry and agriculture of these countries. In this regard, the Government is developing urgent measures to adapt to climate change.

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14. World Bank (2015). Europe and Central Asia Risk Profile: Tajikistan. Retrieved from: http://pubdocs.worldbank.org/en/871081485186894798/tajiki stan-low-res.pdf

15. World Bank (2018). Integrating Climate Change Adaptation and Water Management in the Design and Construction of Roads: Assessment of Opportunities in Tajikistan. Retrieved from: http://roadsforwater.org/wpcontent/uploads/2018/04/Tajikistan-report-WBassessment.pdf.