

Changing risk of vector-borne infections in uzbekistan under climate change

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Abstract: This thesis examines the shifting risk landscape of vector-borne infections in Uzbekistan under the influence of climate change. Uzbekistan is among the most climate-vulnerable countries in Central Asia, with average temperatures rising 0.27°C per decade—faster than the global average. These climatic shifts are expanding the geographic range and seasonal activity of disease vectors, including mosquitoes, ticks, and sand flies, creating new epidemiological risks. This study synthesizes available evidence on climate-vector-disease relationships in Uzbekistan and the broader Central Asian region. The thesis proposes an integrated "One Health" approach combining enhanced epidemiological surveillance, climate-informed early warning systems, and intersectoral coordination to address these emerging threats.

Keywords: vector-borne diseases, climate change, Uzbekistan, Crimean-Congo hemorrhagic fever, leishmaniasis, arboviruses, One Health, epidemiological surveillance.

Introduction

Climate change is increasingly recognized as one of the most significant threats to global public health. Rising temperatures, altered precipitation patterns, and more frequent extreme weather events are reshaping the distribution and transmission dynamics of infectious diseases worldwide. Among the most sensitive to these changes are vector-borne diseases—infections transmitted by arthropods such as mosquitoes, ticks, and sand flies—whose vectors are directly influenced by temperature, humidity, and environmental conditions.

Central Asia, and Uzbekistan in particular, occupies a position of high vulnerability to these climate-driven epidemiological shifts. The region is experiencing warming at rates exceeding global averages, with more frequent droughts, heatwaves, and water scarcity events. These changes are not merely environmental concerns; they are actively transforming the geography of disease risk, creating conditions favorable for vector establishment and pathogen transmission in areas previously considered unaffected.

Uzbekistan's southern regions, characterized by warmer temperatures and agricultural landscapes, have seen increasing mosquito populations and the emergence of tropical viruses over the past decade. Simultaneously, milder winters are enabling ticks that transmit CCHF to survive in higher numbers and expand their range northward. Sand

fly populations, responsible for leishmaniasis transmission, remain active in endemic zones, with mathematical models suggesting climate sensitivity in their distribution. The ecological crisis of the Aral Sea has created additional complexity, with land degradation and changing wildlife-livestock-human interactions amplifying zoonotic spillover risks in Karakalpakstan.

Main Body

1. Climate Trends in Uzbekistan and Their Epidemiological Significance

Uzbekistan is experiencing climate change at an accelerated pace. Over the past decade, average temperatures across the country have risen by 1–1.5°C, with summers becoming longer and droughts intensifying. The national warming rate is approximately 0.27°C per decade, exceeding the global average. These changes are particularly pronounced in southern and central regions, including Qashqadaryo, Bukhara, and Surkhandarya.

The epidemiological significance of these trends is substantial:

- **Temperature increases** accelerate vector life cycles, increasing population growth rates and shortening pathogen development times (extrinsic incubation period)
- **Warmer winters** reduce vector mortality, allowing more ticks and mosquitoes to survive the cold season
- **Changing precipitation patterns** create new breeding habitats for mosquitoes or drive vectors to seek new habitats as existing ones become unsuitable
- **Extreme weather events** (floods, droughts) disrupt ecosystems and create conditions favorable for disease emergence

A 2024 analysis found that Uzbekistan could experience a 20–40% rise in climate-driven health risks by 2050 without adaptive interventions. This projection underscores the urgent need for climate-informed epidemiological planning.

2. Vector-Borne Diseases of Increasing Concern in Uzbekistan

2.1 Crimean-Congo Hemorrhagic Fever (CCHF)

CCHF is a severe tick-borne viral disease transmitted primarily by *Hyalomma* ticks. It is endemic in southern Kazakhstan, bordering Uzbekistan, with cases reported in the Kyzylorda, Turkistan, and Zhambyl regions. The disease has a case fatality rate of approximately 14–21%.

Climate-driven changes: Recent analysis indicates that the geographic extent of CCHF foci in southern Kazakhstan has increased approximately 200-fold since the late 20th century, driven largely by climate-induced changes in tick ecology. Modeling studies suggest that *Hyalomma* ticks struggle to survive where warm-season water vapor deficit exceeds ~15 hPa; however, as parts of Central Asia become more humid

during spring and fall, previously inhospitable areas may now support tick populations. Milder winters are simultaneously reducing tick mortality.

Uzbekistan relevance: Given that the CCHF-endemic regions of Kazakhstan directly border Uzbekistan (Zhambyl region borders Uzbekistan's Tashkent region; Turkistan region borders Uzbekistan's Jizzakh and Sirdarya regions), there is significant risk of range expansion into Uzbekistan. Without effective adaptation measures, Uzbekistan may face rising case numbers and further expansion of endemic zones.

2.2 Mosquito-Borne Arboviruses

Uzbekistan's southern regions—Surkhandarya, Qashqadaryo, and Bukhara—have seen increasing mosquito populations and the spread of tropical viruses over the past decade. Regional epidemiological monitoring between 2015 and 2025 has identified these areas as facing high vector-borne disease risk.

Dengue fever, though not currently endemic in Uzbekistan, is the second most prevalent and deadly vector-borne infection worldwide after malaria, and its vectors are expanding globally. With increasing international tourism and migration from dengue-endemic regions of Southeast Asia, the risk of importation and local transmission is growing.

Genomic surveillance efforts: Uzbekistan has recognized the need to enhance genomic surveillance capabilities for arboviruses. Researchers at the Research Institute of Virology in Uzbekistan have highlighted the importance of studying these pathogens and increasing the country's genomic surveillance capacity, particularly given the influx of tourists from tropical countries.

2.3 Cutaneous Leishmaniasis

Leishmaniasis is a vector-borne zoonotic disease transmitted by sand flies. It is endemic in Uzbekistan, with cases reported annually. According to WHO data, approximately 2 million people are infected globally each year, with Uzbekistan registering 508 cases in 2015, 766 in 2016, and 749 in 2017.

Climate sensitivity: Sand flies require warm conditions for survival and reproduction, with daily temperatures needing to remain above 20°C for at least 50 days for population development. The disease is therefore climate-sensitive, with its geographic distribution linked to suitable environmental conditions. Mathematical modeling using climate predictors is being employed to forecast potential spread and assess the impact of climate change on vector populations.

2.4 Hantavirus Infections

Hantaviruses are rodent-borne pathogens that cause hemorrhagic fever with renal syndrome (HFRS) and hantavirus pulmonary syndrome (HPS). Global climate change

and rapid urbanization are altering the population dynamics of wild rodents, the primary reservoirs of hantaviruses.

Regional risk assessment: A systematic review analyzing 42 studies found that a 1.5–2.0°C increase in average winter temperatures enhances the survival rates of rodent genera (*Apodemus*, *Microtus*, *Rattus*) that carry hantaviruses. Urbanization facilitates the formation of synanthropic foci, escalating risks of sporadic outbreaks. In the Central Asian region, including Uzbekistan, risks remain consistently low due to the arid climate; however, suburban areas require ongoing epidemiological monitoring.

2.5 Zoonotic Risks from the Aral Sea Region

The Karakalpakstan region is considered particularly vulnerable to emerging zoonotic diseases due to the long-term impacts of the Aral Sea crisis. Desertification, ecosystem degradation, water scarcity, biodiversity loss, and climate extremes are increasing pressure on both ecosystems and communities while intensifying wildlife-livestock-human interactions.

Spillover pathways: Wild ungulates such as urial, ibex, argali, and markhor increasingly share grazing areas with domestic livestock. Seasonal livestock movements and overgrazing further amplify spillover risks. Environmental degradation and habitat fragmentation may also contribute to the reactivation and spread of dormant pathogens.

Conclusion

Climate change is fundamentally altering the risk landscape for vector-borne infections in Uzbekistan. Rising temperatures, changing precipitation patterns, and more frequent extreme weather events are creating conditions favorable for the expansion of disease vectors and the pathogens they carry. Southern regions—Surkhandarya, Qashqadaryo, and Bukhara—face the most immediate risks, with increasing mosquito populations and tropical virus spread already observed. The expansion of CCHF vectors from neighboring Kazakhstan presents a growing threat to border regions, while cutaneous leishmaniasis remains endemic with climate-sensitive transmission dynamics. The Aral Sea crisis region adds a layer of complexity, with ecosystem degradation amplifying zoonotic spillover risks.

The evidence available suggests that Uzbekistan is at a critical juncture. The same climate trends that threaten public health are also creating opportunities for proactive, integrated intervention. Uzbekistan's participation in international One Health initiatives, such as Nature4Health, demonstrates commitment to addressing these challenges. However, sustained investment in surveillance infrastructure, intersectoral coordination, and adaptive management is essential.

Ultimately, addressing vector-borne disease risks in a changing climate is about protecting the health of communities, safeguarding food security, and ensuring sustainable development. The young people who will inherit this changing environment deserve proactive, evidence-based action. Uzbekistan's response to this challenge will serve as a model for other climate-vulnerable countries in Central Asia and beyond.

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