# CLIMATE CHANGE AND INFECTIOUS DISEASES: HOW A WARMING PLANET IS FUELING GLOBAL HEALTH CRISES

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**ABSTRACT**

Climate change has emerged as a major driver of global health crises, particularly through its influence on the emergence and spread of infectious diseases. Rising global temperatures, altered precipitation patterns, and extreme weather events are accelerating ecological disruptions that facilitate zoonotic spillovers, vector proliferation, and pathogen evolution. This review explores the multifaceted links between climate change and infectious diseases, with a focus on vector-borne and zoonotic infections such as malaria, dengue, Lyme disease, leishmaniasis, and schistosomiasis. Drawing on bibliometric analysis and case studies from diverse geographies, including Europe, the Middle East, Africa, Asia, and the Americas, the article highlights shifting vector ecology, habitat encroachment, and disease emergence in previously unaffected regions. The burden of these health threats is disproportionately borne by low-income populations lacking access to healthcare and resilient infrastructure. Emphasizing a One Health framework, this paper advocates for integrated surveillance, global coordination, investment in research, and ecosystem conservation. As climate change reshapes the landscape of infectious disease risk, multisectoral and interdisciplinary responses are essential to mitigate future outbreaks and safeguard global health.

**KEYWORDS:** zoonoses, infectious disease, climate change, vector, spillover.

## INTRODUCTION

Climate change, once primarily viewed as an environmental concern, is now recognized as a pressing global health emergency. Rising global temperatures, altered precipitation patterns, and increased frequency of extreme weather events are not only degrading ecosystems but also driving the emergence and spread of infectious diseases, particularly zoonoses, which are diseases transmitted from animals to humans. These changes are reshaping the geographic distribution and transmission dynamics of pathogens and their vectors, creating novel public health challenges across the globe.

In this context, the convergence of climatic disruptions and ecological imbalance has fueled an alarming rise in infectious disease outbreaks, including vector-borne diseases like malaria, dengue, Lyme disease, and viral zoonoses such as COVID-19. This article presents a comprehensive overview of the mechanisms by which climate change contributes to the emergence and re-emergence of infectious diseases, supported by bibliometric analysis, real-world case studies, and policy recommendations based on One Health principles.

## THE CLIMATE-DISEASE NEXUS: MECHANISMS AND EVIDENCE

### 1. Disruption of Ecosystems and Habitat Encroachment

Human-induced environmental changes such as deforestation, urban expansion, and agricultural intensification, often accelerated by climate stressors, force wildlife into closer proximity with humans and livestock. This increases the likelihood of zoonotic spillovers, as seen in the emergence of diseases like SARS, Ebola, and COVID-19. The loss of biodiversity weakens natural barriers that limit pathogen transmission between species.

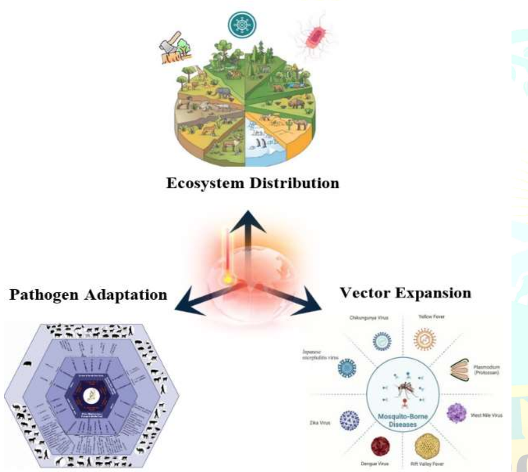



**Fig. 1:** The effect of climate change on Ecosystem Shift, Pathogen Evolution, and Vector Spread under Climate Pressure (source: author)

### 2. Vector Ecology and Geographic Expansion

Climate change alters the survival, reproduction, and distribution of disease vectors. For example, Mosquitoes, which transmit malaria, dengue, and Zika, thrive in warmer, wetter environments and are expanding into previously temperate regions. Ticks, vectors for Lyme disease and Babesiosis, are now established at higher altitudes and latitudes due to milder winters. Sandflies, responsible for leishmaniasis, are becoming more prevalent in arid and semi-arid zones affected by warming and desertification.

### 3. Pathogen Dynamics and Transmission Efficiency

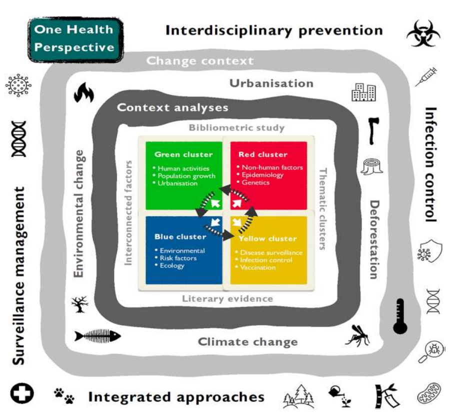
Temperature, rainfall, and humidity influence pathogen replication and transmission. Elevated temperatures accelerate the extrinsic incubation period of many viruses in insect vectors, making them infectious more quickly. Moreover, climate variability influences the timing and intensity of disease outbreaks, complicating traditional seasonal surveillance systems.

Figure 1 pictorially illustrates the multifaceted impacts of climate change on the emergence and transmission of infectious diseases, highlighting three interconnected domains: disruption of ecosystems and habitat encroachment, alterations in vector ecology and geographic expansion, and changes in pathogen dynamics and transmission efficiency.

## FINDINGS FROM BIBLIOMETRIC AND THEMATIC ANALYSIS

A recent bibliometric analysis conducted by Leal *et al.* (2025) identified four interrelated thematic clusters in climate-related infectious disease research, showed in Figure 1 and Figure 2

1. **Green Cluster** (Human Activities and Urbanization): Links urban expansion, population growth, and anthropogenic climate change to increased risk of zoonotic disease emergence due to environmental degradation and closer human-animal interaction.



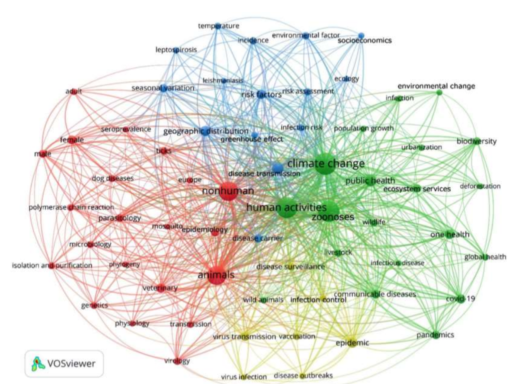



**Fig. 2 & 3:** Bibliometric and Thematic Analysis image (Left). Schematic representation of interrelated factors contributing to evolving zoonotic disease propensity framed by a One Health perspective (Right) Adopted from Leal *et al.* (2025)

**2. Red Cluster** (Nonhuman Biological and Epidemiological Factors): Highlights the role of changing vector and host behaviour, pathogen evolution, and interspecies genetic shifts in response to climate stressors.

**3. Blue Cluster** (Environmental Risk Factors): Emphasizes climate-induced changes in habitats and vector life cycles, impacting diseases like leishmaniasis and leptospirosis.

**4. Yellow Cluster** (Surveillance and Control): Stresses the importance of integrated surveillance, infection control, and vaccination programs—especially under a One Health framework.

## REAL-WORLD ILLUSTRATIONS OF CLIMATE-DISEASE LINKAGES WITH ZOONOTIC DISEASES

The intersection of climate change and infectious disease emergence is no longer theoretical—it is already manifesting across diverse geographies. Empirical data from various countries show how rising temperatures, altered precipitation patterns, and land-use changes are driving disease transmission dynamics. Below are detailed real-world examples illustrating this growing public health challenge were illustrated in Figure 4:

**1. Tick-Borne Diseases in Northern Europe (Finland and Scandinavia)**

In Finland, surveillance data from the National Infectious Disease Register over the past two decades show a significant rise in tick-borne diseases, notably Lyme borreliosis and tick-borne encephalitis (TBE). This increase correlates strongly with warming temperatures that extend the active season and geographic range of Ixodes ricinus, the primary tick vector. Traditionally limited to southern Finland, ticks are now found further north and at higher altitudes, indicating a climate-driven shift. Similar patterns are reported in Sweden, Norway, and the Baltic states, where milder winters and earlier springs contribute to prolonged vector activity.

**2. Leishmaniasis Expansion in the Middle East (Iran)**

In Iran, cutaneously transmitted leishmaniasis, a parasitic disease spread by sandflies, has been expanding its range. Climate modeling studies project a northward shift of Phlebotomus spp. habitats due to increased temperatures and aridification of previously temperate areas. Urbanization and water management practices such as dam construction also contribute to ecological changes favourable to sandfly breeding. These projections suggest that millions more people may be at risk in new endemic regions if adaptation strategies are not implemented.

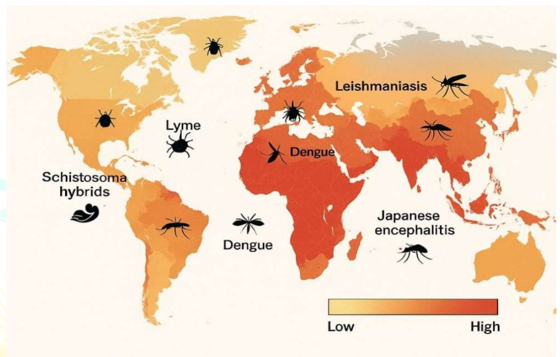



**Fig. 4:** Climate-Disease Linkages with zoonotic diseases, the Global Burden of Vector Dynamics and Their Relationship with Zoonotic Diseases Under Climate Pressure (source: author)

**3. Emerging Tick-Borne Threats in the United States**

In the United States, Babesiosis, a malaria-like disease caused by Babesia microti and transmitted by ticks, is becoming more common, especially in the Northeastern and Midwestern states. The Centres for Disease Control and Prevention (CDC) notes increasing prevalence, with concerns about the pathogen's potential to contaminate the national blood supply, especially since many infections are asymptomatic. Warmer winters and earlier spring thaws allow ticks to become active earlier in the year, contributing to a longer transmission season. Similar expansions have been documented for Rocky Mountain spotted fever and Ehrlichiosis.

**4. Arthropod-Borne Diseases in Rapidly Urbanizing China**

In parts of China, the combination of climate change and rapid urbanization is altering the epidemiology of diseases spread by arthropods and rodents. For instance, Japanese encephalitis—once largely rural, is now appearing in urban and peri-urban settings. The rise in flooding events and poor drainage systems due to erratic rainfall contributes to mosquito proliferation. Studies in southern China link the northward expansion of *Culex tritaeniorhynchus*, the primary mosquito vector, to increasing temperatures and humidity.

**5. Hybrid Schistosomiasis in West Africa**

In Senegal and other parts of West Africa, researchers have identified the hybridization of Schistosoma haematobium and *S. bovis,* two parasitic flatworms affecting humans and livestock, respectively. Climate-induced changes in freshwater systems, such as river damming, fluctuating water levels, and increased irrigation, are believed to facilitate cross-species encounters among snails, humans, and livestock, thereby encouraging parasite hybridization. These hybrids show greater adaptability and may pose a greater risk of persistent and more virulent infections, complicating control efforts.

**6. Dengue and Malaria Shifts in Tropical and Subtropical Regions**

Dengue fever and malaria remain paradigmatic vector-borne diseases highly sensitive to climate. In Latin America, Sub-Saharan Africa, and South Asia, warming trends and increasing urban humidity have led to a rise in dengue outbreaks in urban centers where Aedes aegypti mosquitoes thrive in stagnant water from urban waste and poor drainage. In Kenya's highlands, historically too cool for malaria transmission, cases have been recorded above 2,000 meters elevation, a shift directly linked to warming temperatures. In Brazil, altered rainfall patterns and deforestation have intensified Anopheles mosquito breeding, increasing the burden of malaria and zoonotic simian malaria in human populations.

**7. Rodent-Borne Diseases in Asia and Latin America**

In areas such as Bangladesh, India, and Peru, rodent-borne diseases like leptospirosis and hantavirus pulmonary syndrome are increasing in frequency. Unseasonal heavy rainfall and flooding events are becoming more common due to climate change, contaminating water sources with rodent urine, facilitating human infection through mucosal exposure or skin contact.

In urban slums and flood-prone regions, poor sanitation infrastructure magnifies these outbreaks, disproportionately affecting the most marginalized.

## VULNERABILITY AND INEQUALITY IN DISEASE BURDEN

The impacts of climate-linked diseases are not evenly distributed. Communities in low-income regions are particularly vulnerable due to:

- Poor sanitation and limited access to healthcare.
- Greater exposure to climate extremes (floods, droughts).
- Malnutrition, which weakens immune defenses.
- High population density in urban slums and refugee camps.

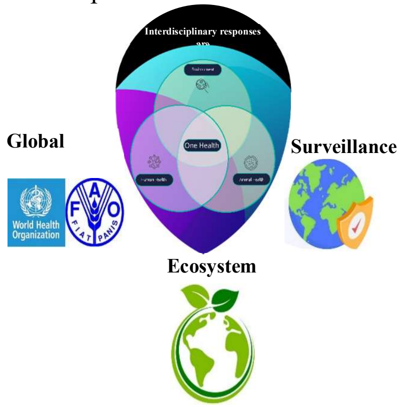
These populations often face a compounded burden of disease and climate risk, exacerbating existing inequalities.

## TOWARDS SOLUTIONS: A MULTISECTORAL, ONE HEALTH APPROACH

To curb the health impacts of climate change, an integrated strategy is required as shown in figure 5. The following recommendations emerge from the reviewed research:

1. **Global Coordination:** International bodies like the WHO, WOAH, FAO, and UNEP should lead a unified response to zoonotic threats exacerbated by climate change, promoting global data sharing, outbreak response, and research collaboration.
2. **Policy Integration:** Governments must embed climate-health connections into national policy frameworks. Climate adaptation plans should include disease surveillance, public health preparedness, and ecosystem conservation.
3. **Investment in Science and Infrastructure**: Funding must support research on vector ecology, pathogen evolution, and early warning systems, especially in underserved regions. Health infrastructure must be climate-resilient and equitable.
4. **Education and Awareness**: Training for healthcare professionals and community outreach are crucial. Public engagement helps improve behavioral responses and foster resilience to disease outbreaks.
5. **Biodiversity Conservation**: Preserving intact ecosystems limits pathogen spillover and sustains the ecological buffers that prevent outbreaks.
6. **Embrace the One Health Paradigm**: Recognize the interconnectedness of human, animal, and environmental health.

Promote interdisciplinary research and cross-sectoral governance for sustainable disease prevention.




## CONCLUSION

As climate change continues to reshape the global landscape, it is becoming an increasingly dominant force in public health. The rising incidence of zoonotic and vector-borne diseases, once confined to tropical zones, is now a worldwide concern. The evidence is clear: the destabilization of ecosystems, accelerated pathogen transmission, and growing vulnerability of at-risk communities are all symptoms of a planet in crisis. This review underscores the urgent need for integrated action to mitigate climate-driven infectious disease threats. Solutions must bridge the gap between climate science, epidemiology, public health, and ecological stewardship. By adopting a One Health approach and reinforcing global collaboration, we can not only prevent the next pandemic but also promote a healthier, more resilient future for all living beings. The health of our planet is inseparable from our own. Addressing climate change is not just about environmental protection, it is a fundamental act of disease prevention and a moral imperative for global health equity.

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