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How Is Climate Change Impacting the Spread of Vector Borne Diseases

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Abstract

In the twenty-first century, climate change and global warming are highlighted as significant challenges by the World Health Organization. The terms are often used interchangeably, with global warming being a factor of climate change. Rising global temperatures caused by CO2 emissions from fossil fuels and deforestation are fueling the greenhouse effect and ecological disruptions, leading to an increase in infectious diseases worldwide. Arthropod vectors, such as mosquitoes and ticks, are sensitive to climatic changes, impacting their behavior and pathogen transmission patterns. The spread of diseases like malaria, tick-borne illnesses, leishmaniasis, bluetongue, and arboviruses is influenced by climatic factors, including temperature, humidity, and rainfall distribution. The emergence of vector-borne diseases in new regions of the world demonstrates the direct correlation between climate change and disease spread dynamics. Climate change predictions suggest a further exacerbation of disease transmission rates and environmental health risks in the future.

Keywords: Vector borne diseases, West Nile Fever, Malaria, Climate change, Global warming, Blue tongue
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Introduction

In the twenty-first century, "climate change and global warming" are the biggest problems facing humanity, according to the World Health Organization (WHO). Every element of our lives is in danger from them. The terms "climate change" and "global warming" are frequently used interchangeably, despite the fact that global warming is only one of many factors linked to climate change. A rise in the average global temperature over the past few decades, both in frequency and intensity, is commonly referred to as "global warming." The greenhouse effect is the result of rising CO_2 emissions brought on by the world's growing use of fossil fuels and the simultaneous destruction of forests and trees. Increased exposure to causative agents, altered ecosystems, and population susceptibility are all linked to changes in disease epidemiology brought on by global warming. The geographic distribution of intermediate hosts and vectors, such as migratory birds, rodents, and invertebrate hosts (insects), is also impacted by global warming. For instance, the WHO estimates that 92 million people are infected with Chlamydia each year, a zoonotic bacterial pathogen that can be carried by birds. People tend to underestimate the harm that climate change and global warming cause to human health. An estimated 36% of young children's deaths and 34% of all childhood illnesses globally are attributed to changes in environmental factors. Climate change is a major factor in the occurrence of cholera, dengue fever, diarrhea, and deadly malaria.

Infectious Vector Borne Diseases (VBDs) are primarily spread by arthropod vectors, which exhibit heightened sensitivity to climatic variations for several reasons. As ectothermic organisms, arthropods rely on external environmental factors to regulate their internal temperature. The larval stages of these vectors typically necessitate the availability of water bodies and/or specific humidity levels. Additionally, the frequency of vector bites tends to rise with increasing temperatures until a certain upper limit is reached, beyond which it declines. The development and replication of pathogens within vectors (known as the extrinsic incubation period or EIP) or in their surrounding environment also accelerate at elevated temperatures. Moreover, temperature conditions play a crucial role in influencing the development and survival rates of these vectors.

Changes In VBDs Spread Pattern

Malaria: Human malaria is caused by five types of *Plasmodium* parasites and transmitted by female *Anopheles* mosquitoes. *Plasmodium falciparum*, the tropical form, causes the most severe clinical form of malaria and is found throughout the tropics and Sub-Saharan Africa, accounting for roughly 90% of all malaria cases worldwide. *Plasmodium vivax*, a more temperate form, was previously common in Europe. Anopheles mosquitoes require sufficient rainfall to establish breeding sites that will not dry out or wash away over a 9-12 day period. Replication of the parasite within the mosquito vector requires a minimum air temperature of 15-16 °C for *P. vivax* and 19-20 °C for *P. falciparum*. Increased temperatures close to the upper limit for vector and pathogen survival (roughly around 35-37 °C) tend to reduce transmission, whereas increased variation in daily temperatures near the lower limit tends to increase transmission. *P. falciparum* infections in humans are becoming more common in tropical highland areas of the world, such as Eastern Africa, Nepal, and Colombia. More recently, competent malaria vectors have been discovered at higher elevations. For native highland populations, who typically lack protective immunity and are more susceptible to severe malaria morbidity and mortality, this has major ramifications.

Tick borne diseases: In Europe and Eurasia, there is ample evidence linking the rise of tick-borne illnesses to global warming. Fortunately, diseases carried by ticks typically manifest much more slowly than those carried by mosquitoes, despite the fact that ticks are capable of transmitting the widest variety of pathogens of any arthropod vector. It is commonly known that *Ixodes ricinus* ticks, which are the vector of Borrelia burgdorferi spirochetes, have spread poleward throughout Europe and Eurasia. As the vector of tick-borne encephalitis virus, Omsk hemorrhagic fever virus, *Rickettsia slovaca*, *Rickettsia raoultii*, *Anaplasma marginale*, *Babesia canis*, *Babesia caballi* and *Theileria equi*, it was also reported that another tick species *Dermacentor reticulatus*, had expanded throughout Europe and Eurasia.

Over 11 human-emerging bacterial tick-borne pathogens, including several species of *Borrelia* and *Rickettsiae*, have been identified in Europe in recent years. The pathogens' epidemiological spread is also facilitated by ticks carried by migratory birds. One study found that at least one tick was present in 16 of 43 migratory bird species. Along with varying degrees of *Babesia microti*, *B. capreoli* and *B. venatorum* the ticks tested positive for *C. burnetii* and *R. helvetica*.

Leishmaniasis: Similar to mosquitoes, temperature affects sand fly biting rates, diapause, and pathogen (protozoa) development in the vector. Sand flies are found in Europe below 800 meters above sea level and south of latitude 45 °N. They have, however, recently extended as far north as 49 °N. Sand flies will quickly establish in nations that are currently on the edge of their geographic range, such as Germany, Austria, Switzerland, and the Atlantic coast, as a result of anticipated climatic changes in Europe that will provide ideal temperatures for them. Leishmaniasis is a protozoan parasitic infection that can be spread by sand flies. By the end of the twenty-first century, Brazil is expected to see a 15% increase in annual hospital admissions due to leishmaniasis, with higher relative growth in the south.

Blue tongue: A virus that is spread by midges and is not contagious, bluetongue primarily affects sheep but can also infect cattle, goats, antelope, deer and camels. Biting midges of the *Culicoides* genus spread the bluetongue virus (BTV). Its appearance in northern Europe in 2006 is regarded as a perfect illustration of how VBDs are affected by early climate change. In southern Europe, there was a significant BTV outbreak caused by the Afrotropical midge vector Culicoides *imicola*. According to modeling studies, in 2006, the climate in southern Europe facilitated the spread of the Afrotropical midge vector, while in northern Europe, it increased the vectorial capacity of native *Culicoides* vectors to transmit BTV. The outbreak and the summer 2006 heat wave in Europe occurred at the same time.

Arbovirus diseases: The Asian tiger mosquito, *Aedes albopictus*, and the yellow fever mosquito, *Aedes aegypti*, are believed to be the primary competent vectors of the arboviruses dengue, Zika, yellow fever and chikungunya. With a 30-fold increase in incidence worldwide over the previous 50 years, dengue is the mosquito-borne disease that spreads the fastest. Because its eggs cannot withstand temperate winters, *A. aegypti's* current range is more limited to the tropics and subtropics, and future projections indicate a moderate latitudinal shift in its potential ecological niche.

An outbreak of ZIKV began in Brazil in 2015 and quickly expanded to the majority of South and Central American and Caribbean nations. In the years that followed, ZIKV spread throughout a few Southeast Asian and African nations. Limited and local transmission happened in the southern U.S. states of Florida and Texas during the summer of 2017. The "2015 El Niño caused exceptional climatic conditions in north-eastern South America during winter and spring in the Southern Hemisphere," according to scientists, was emphasized when the outbreak began. This assertion was consistent with earlier research showing a strong correlation between dengue outbreaks in South America and Southeast Asia, regional climate anomalies, and the El Niño climate phenomenon. The El Niño Southern Oscillation's positive phase has been linked to infectious disease outbreaks worldwide, including Rift Valley fever, malaria, and cholera in East Africa, increased risk of arbovirus and malaria transmission in Latin America and Southeast Asia, and outbreaks of malaria and cholera in India. A rainfall- and temperature-driven model of the disease basic reproduction ratio (R0, the number of secondary infections produced by a single case introduced into a completely susceptible population) for ZIKV confirmed that the climatic conditions related to El Niño 2015-16 were optimal for the mosquito-borne transmission risk of ZIKV in Latin America.

West Nile Virus (WNV) is the most common encephalitic Flavivirus, infecting humans, horses, birds, and other mammals. With the exception of Antarctica, WNV is primarily spread by *Culex* mosquitoes on all continents. The significance of weather and climate in causing WNV epidemics has already been covered in a number of studies. Since the 1930s, WNV has been circulating in Africa, and in 1999, it made its debut in New York City, USA. In the United States, a higher risk of WNV transmission by urban mosquitoes was linked to milder winters and droughts during the boreal spring season. Events with heavy rainfall were also linked to a higher risk of WNV transmission. Since WNV's extrinsic incubation period in *Culex* mosquitoes decreases dramatically with rising temperatures, climate change will surely impact future outbreaks of West Nile Fever.

Conclusions

The epidemiological disease cycle consists of a host, a pathogen, and, in some cases, an intermediate host/vector. Every vector host's suitable habitat/ecological niche is determined by a complex combination of environmental conditions (for example, temperature and humidity). The presence of suitable vectors is a prerequisite for the emergence of vector-borne diseases. Climate change and global warming will have a catastrophic impact on human, animal and environmental ecosystems. This in turn affects the vectors life cycle including its survival, habitats and life cycle patterns. All these have led to spread of various arbovirus diseases, tick borne and fly borne human and animal diseases.

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