

# Impact of climate change on vector-borne diseases

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## Abstract

Climate change over the past few years has impacted the environment and its dynamics in a significant way. Pathogens earlier limited to few areas involving few specific susceptible hosts and active vectors are now pervading to new areas and attacking new host species. Such changes need to be monitored for active prevention of vector borne diseases. Different pathogens are evolving to climate change in different manner that is difficult to model or understand. But studies in this aspect can help highlight effective mitigation strategies to control such vector borne diseases.

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## INTRODUCTION

Vector-borne diseases involve pathogens that depend on the presence of a vertebrate host and an arthropod vector for its transmission and survival. Hence all factors that affect the survival of the host and the vector specie, affect the occurrence, intensity and pattern of the condition/ disease.

Mosquitoes, ticks etc. serve as vectors for numerous viral, filarial and protozoan pathogens of great public health importance in both humans and other animals. Mosquitoes become infected with the pathogens when acquiring a blood meal from an infected vertebrate host and, following an incubation period during which the pathogen develops or replicates within the vector mosquito, they transmit the pathogens to a susceptible host during a subsequent blood meal.

The ability or inherent capability of a vector to successfully transmit a pathogen and to the efficiency of disease transmission is referred to as its vectorial capacity, or vector competence. It is determined by genetic components of the mosquito and pathogen as well as by environmental components like temperature. Other variables involved in vectorial capacity include the vector population density, the extrinsic incubation period required for vectors to become infectious and the daily survival rate of competent vectors (Takken and Koenraadt, 2013). Unlike humans and other mammals, mosquitoes do not have genes for the production of antibodies and other molecules of the adaptive immune

response. Rapid and widespread urbanization, agricultural intensification and exploitation of natural resources now make it difficult to draw boundaries between urban and rural as well as rural and natural landscape.

Vectors are mainly ectothermic that means their body temperature is altered as per the ambient temperature. Mosquito vectors breed in aquatic habitats and increase in rainfall affects their breeding sites.

Climate change refers to the long- term changes in the Earth's average weather pattern. It is driven by anthropogenic activities that has led to increased greenhouse gas emissions, deforestation and contamination of natural resources (Riedy, 2016).

## MOSQUITO BORNE DISEASES

There are more than 100 million cases of Dengue reported worldwide each year (Brady and Hay, 2020). *Aedes aegypti* is responsible for transmission of Dengue fever (Paupy *et al.*, 2009). *Aedes albopictus* acts as the vector to Chikengunya virus (Weaver and Forrester, 2015). The *Aedes aegypti* mosquito are highly anthropophilic (Crawford *et al.*, 2017) *Aedes albopictus* mosquito feed on other vertebrate species too when human host are unavailable (Kim *et al.*, 2017). Both species are known to feed in early morning or evening. They dwell in natural aquatic habitats like tree holes, bamboo holes, crop fields (Zahouli *et al.*, 2017).

But rising urbanization has led to creation of new alternate habitats like septic tanks, tyres filled with water, gutters (Adebote *et al.*, 2011 and Nwoke *et al.*, 1993). Additionally, due to pre-exposure in water bodies, resistance to public health insecticides like carbamates, organophosphates and pyrethroids have been seen in *Aedes* spp. mosquito and is a threat to control (Moyes *et al.*, 2017).

Diseases like West Nile fever, Saint Louis encephalitis, Rift valley fever and Lymphatic filariasis are transmitted by *Culex pipens* specie. Mosquito abundance is affected by multiple factors like temperature and topography. Change in regular precipitation patterns has led to rise in availability of stagnant water sources where mosquito can lay eggs (Ragab *et al.*, 2024). In Korea and Japan, mosquito transmission has been reported to be increased by many months by a mere 5° celsius rise in ambient temperature (Philips, 2016).

### TICK BORNE DISEASES

Ticks are known to act as vector to several zoonotic and infectious diseases like Crimean congo haemorrhagic fever, Lyme disease, Relapsing fever (Spotted fever and Q disease), Tick borne encephalitis, Tularaemia. In Canada, it was reported that rising atmospheric temperature has enabled ticks to spread to higher latitudes as *Ixodes* sp. ticks are spreading to new zones beyond few endemic sites. Rise in incidence of extreme weather events like, heat waves (Kirchmeier-Young *et al.*, 2025), floods, earthquakes, forest fires have changed the habitat of tick vectors (Bouchard *et al.*, 2019). Fragmentation of natural habitats and rise of synanthropic ecosystems as human settlements are invading new habitats has led to rise in interaction of ticks and susceptible hosts. The incidence of tick-borne diseases has reported doubled over 13 years between

2004 to 2016 (Rosenberg, 2018). Further data has not been reported but is expected to be alarming.

### CONTROL OF VECTOR BORNE DISEASES

The control of vector borne diseases requires a comprehensive strategy of vector control as well as awareness in humans. Government institutions can implement mosquito eradication measures like use of larvicides and adulticides in public spaces to prevent the breeding sites of mosquito vectors. Biological measures like use of *Gambusia affinis* fish can be used. *Gambusia affinis* thrive in water bodies and effective larvivorous fishes. Other larvivorous fishes include *Poecilia reticulata*, *Tilapia mossambica* and *Sarotherodon niloticus* have also been reported (Wang *et al.*, 1990). Use of larvae of mosquito of genus *Toxorhynchites* have been used as they lack the need of blood feeding and rather feed on larvae of other species of mosquitos (Yasuno and Tonn, 1970). *Wolbachia* bacteria is reported to cause genetic changes in the mosquito populations and thus help in eradication of the vector (Huang *et al.*, 2017). Cleaning of drainages and timely fogging can help in control of vectors. People need to be educated to prevent the stagnation of water near household.

Occupational safety and education initiatives for health workers, sanitation workers as well as personnels frequenting areas of high vector density like forest guards and armed forces personnels need to use appropriate measures for safety against mosquito and ticks. Effective surveillance networks should be established for coordination between medical and veterinary facilities. Real time monitoring of vector population density using AI and Internet of Things can be helpful. Use of geographical positioning system data for mapping of vectors will be instrumental in designing eradication strategies.

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