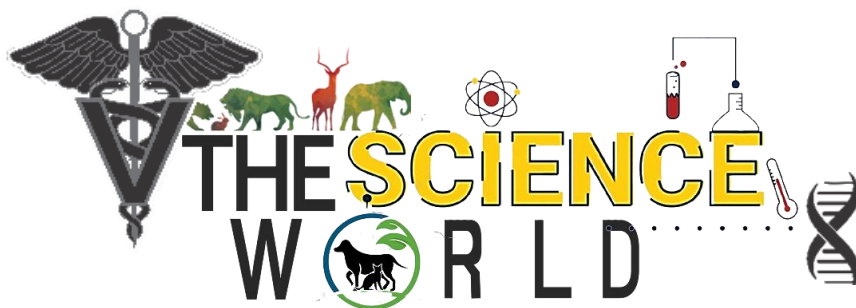




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Climate Driven Vector-Borne Parasitic diseases in animals

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Abstract

The changing climate, including shifts in temperature, inconsistent rainfall, and humidity, creates new opportunities for important disease vectors like mosquitoes, ticks, fleas, and flies to move into new areas and spread disease more often. These ecological changes favour the evolution of the pathogen and bring vector-borne parasitic diseases to unprepared areas, threatening livestock and human health. The emerging crisis calls for a holistic strategy that includes integrated vector management, improved surveillance, and climate-resilient health systems.

INTRODUCTION

In the 21st century, climate change is one of the defining environmental crises and is having an increasing impact on public health, including through vector borne diseases, that is increasingly impossible to ignore. According to the Intergovernmental Panel on Climate Change (IPCC), rainfall patterns are changing, temperatures are rising and more extreme weather events are already changing the map of where disease vectors live and how fast they multiply. This will be felt most acutely in low- and middle-income countries, which have far less capacity to absorb the shock in their health systems. Mosquitoes, ticks and fleas don't work in a hoover. Their life cycles and where they can breed and wander are affected by local climate,



and they are extremely sensitive to that climate. Warmer winters and extended growing seasons have allowed the infamous Lyme disease vector, *Ixodes scapularis*, to slowly expand its range northward across North America. The relationship between climate change and vector-borne disease is not a simple one, but conditioned by human behaviours and land use, as well as the socioeconomic conditions on the ground. And so urban sprawl and clear cutting put animals and humans right in the way of the vectors. Higher chances of infection and new places to breed. Add systemic barriers — poverty, patchy or no healthcare — and vulnerable communities have little buffer against vector-borne diseases.

CORE ELEMENTS OF VECTOR ECOLOGY

Habitat Preferences - Mosquitoes seek out standing water, and ticks prefer thick brush. It is those local environmental requirements that determine where they will be found and how quickly their numbers will boom.

Life Cycle and Reproduction - You can't mount an effective intervention unless you dissect how these vectors reproduce. Each stage requires a different control tactic. A method that kills the larva does little to the mature adult.

Host-Feeding Behaviour – Disease risk depends on the habits of the vector. “Being able to identify these feeding patterns, whether they are feeding on humans or animals, or whether they are feeding at night versus in the daylight, is critical to being able to predict outbreaks and get ahead of transmission.”

Seasonal Activity – Vector populations rarely remain constant throughout the year. The population booms as temperatures rise and conditions are ideal for breeding and survival. They directly influence the timing of outbreaks.

Disease Transmission Dynamics - Vectors are key to disease transmission, but their impact depends on their biology. The actual danger of a tick depends on the frequency of bites, its lifespan, and its ability to carry and transmit pathogens (Tohit et al., 2024).

KEY VECTOR DISEASES

Mosquitoes: Three genera of mosquitoes—*Aedes*, *Culex*, and *Anopheles*—carry some of the world's most important pathogens. They hit livestock and vertebrates alike with everything from filarial worms to parasites and viruses. In non-human filarial nematodes (*Onchocercidae*), mosquitoes are the vectors of *Wuchereria* and *Brugia* to primates, *Dirofilaria* to carnivores (dog heartworm), and *Dipetalonema* to camelids (Duvall et al. 2015). They also transmit *Setaria* to cattle, *Oswaldofilaria* to horses and reptiles, *Foleyella* to amphibians and chameleons, *Cardiofilaria* to birds. The *Plasmodium* genus infects an enormous range of hosts,



29 species target primates, 30 hit birds, 12 strike rodents and 29 infect reptiles. (Pagès et al., 2018).

Ticks: Ticks are carriers of a deadly cocktail of pathogens: bacteria (*Borrelia*, *Anaplasma*), viruses such as tick-borne encephalitis, and parasites such as *Babesia* and *Theileria*. Most of the diseases they cause are zoonoses, in which humans are simply accidental, dead-end hosts for the microbe (Boulanger et al., 2019).

Fleas: Cats can be infected with *Haemoplasma* by cat fleas (*Ctenocephalides felis*) and dogs with *Dipylidium caninum* by dog fleas (*Ctenocephalides canis*). *Acanthocheilonema reconditum* occasionally crosses species boundaries. This filarial worm is transmitted by *C. felis*, *C. canis* and *Pulex irritans*. *Tungiasis*, however, is a parasitic skin disease with endemic reservoirs in dogs, cats and rats, and is a heavy burden in poor communities in sub-Saharan Africa, South America and the Caribbean (Iannino et al., 2017).

Other Vectors : Flies such as sandflies and blackflies also drive substantial disease spread, alongside mosquitoes, ticks, and fleas. *Leishmaniasis* is caused by protozoan parasites of the genus *Leishmania* and transmitted by sandflies. Their activity and distribution are highly correlated with the temperature and humidity variations of a warming climate. Blackflies transmit river blindness (*onchocerciasis*), a disease caused by the parasitic worm *Onchocerca volvulus*. Their breeding sites are fast-flowing rivers and streams, and so any climate-driven changes to rainfall or water flow directly change their territory.

EFFECT OF CLIMATE VARIABLES

- i. **Temperature:** Heat is driving the vector biology. Warmer temperatures accelerate the larva-to-adult transformation. In primary malaria vectors such as the *Anopheles* mosquitoes, it reduces development times, which can quickly lead to higher population densities and transmission rates. As temperatures rise, *Aedes* mosquitoes, which spread dengue and Zika, replicate viruses faster. This shortens the extrinsic incubation period and significantly increases the risk of human transmission.
- ii. **Rainfall :** Mosquitoes need standing water to lay their eggs and develop their larvae. Harder rains leave more pools behind, increasing their numbers and the risk of outbreaks. Drought cuts both ways as well. As water vanishes, vectors congregate around the dwindling water sources, bringing them into closer contact with people. Rainfall also affects tick numbers, including those of the Lyme disease-causing species, because ambient humidity dictates whether they survive and how actively they seek out hosts.



- iii. **Moisture:** Humidity dictates how long vectors survive and how aggressively they feed. Moist air prevents mosquitoes from drying out—allowing *Anopheles* and *Aedes* to stick around longer, bite more frequently, and increase transmission. Dry air does the opposite, damping activity and slowing spread. The likelihood of a bite is directly controlled by ambient moisture, because ticks also require humid microclimates to prevent desiccation during questing. More heat can increase the number of insects but only to a point. At a certain point heat surpasses biological limits, at which point survival and reproduction stop. Rainfall is just as erratic; one week heavy rains may create new breeding sites, the next they may wash them out.

PUBLIC HEALTH IMPLICATIONS AND STRATEGY

A warming planet is changing the vector playbook and global health systems feel the strain. Rising case counts require much more dramatic, full-scale adaptation and mitigation plans as ranges expand and behaviours shift.

i) Public Health Consequences

- a) **Increased Disease Burden:** Expanding territory and faster transmission rates will increase cases of malaria, dengue, Lyme disease and chikungunya will increase, stretching healthcare systems thin. Worse, regions that were once protected by cooler climates are now susceptible to new outbreaks—leading to a rise in both disease and death.
- b) **New Disease Hotspots:** When vectors invade new areas, the Untrained, Unprepared, and Unexperienced will be the new hotspots and there will be no clinical infrastructure to fight back. That means missed diagnoses, botched treatments and bungled efforts to control the disease, and more fallout on the ground.
- c) **Economic Impact:** When caseloads soar, the financial cost is steep, and developing economies with tight budgets pay the highest price.
- d) **Social and Environmental Disruption:** Vector-borne diseases are indifferent to social composition and impact the social scenario and livelihoods of communities that depend on farming. At the same time, climate-induced shifts in vector behaviour and distribution might affect entire ecosystems – stripping away biodiversity and unravelling the vital natural services they offer.

Mitigation and Adaptation Strategies : Improved Surveillance and Monitoring, Integrated Vector Control Management (IVM), Climate-Resilient Health Systems, Public Health Education and Communication, Research and Innovation, International Collaboration.



CONCLUSION

Climate change is spreading disease vectors, a serious and growing threat to global public health, animal health and local economies. The interactions between climate variables and vector biology are non-linear and are not sufficiently addressed by conventional disease control measures. “Proactive surveillance, global collaboration and resilient healthcare infrastructure are essential to prevent future outbreaks moving forward.

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