



Perspective

Mosquitoes and Ticks Will Adapt and Thrive in a Changing Climate: Health Systems Urgently Need to Prepare

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Abstract: Changing weather patterns because of climate change are altering the health burden of potentially hundreds to vectorborne diseases; any disease that is seasonal may be affected. Climate change has accelerated since 2015, worsening the situation. Changing weather patterns will continue for decades, at least, with regional variability in the rate and extent of warming temperatures and consequent changes in precipitation patterns and extreme weather and climate events. Health researchers and practitioners should be on the forefront of generating the evidence required to inform health-related policies and programs, including in other sectors, to prepare for and manage the risks.

Keywords: health; vector borne diseases; climate change; adaptation

Climate change is a stress multiplier, exerting pressure on communities and health systems at all scales. Tasks for researchers and health systems [1] include to quantify the extent to which recent changes in the geographic range and seasonality of vectorborne diseases were because of climate change, and to project how future climate change could alter the burden of vectorborne diseases.

Surveillance and monitoring are critical for understanding how climate change is affecting the burden of climate-sensitive infectious diseases. For example, the Lancet Countdown is tracking the transmission dynamics of dengue, malaria, West Nile, leishmaniasis, and Vibrios [2]. For dengue, the estimated basic reproductive number for R_0 for *Ae albopictus* and *Ae aegypti* mosquitoes increased 48.5% and 11.6%, respectively, between 1951–1960 and 2015–2024, while that for West Nile virus for three key *Culex* species was 0.7% higher in 2015–2024 versus 1951–1960. This and other evidence highlight the urgent and immediate needs for individuals, communities, and health systems to understand and prepare for shifts in the geographic range, seasonality, and intensity of transmission of vector-borne and other infectious diseases [3].

Detection and attribution studies provide the strongest evidence that climate change has altered a health burden [4]. There is growing literature in this area, such as Childs et al. who used detection and attribution methods to quantify the extent to which climate change altered the burden of dengue fever in the Americas and Asia [5]. Analysis of 1.5 million dengue incidence reports from 21 countries reported a nonlinear relationship between temperature and dengue incidence, with historic climate change increasing current dengue incidence by 18% and with projections to mid-century suggesting a potential increase of 40% to 57%, depending on the greenhouse gas emission scenario. This information can be used to improve planning in health systems and to advocate for adaptation funding to modify current and develop new programs, and for mitigation funding to rapidly reduce greenhouse gas emissions.

Modeling of the health risks of climate change is moving beyond simple projections that focus only on climate impact drivers to incorporate critical changes in socioeconomic variables important for disease outbreaks, including demographic change, extent of urbanization, and economic growth, as represented in the Shared Socioeconomic Pathways. These are in the process of being extended for health, with the global narratives recently available [6]. For examples, projections of heat-related risks incorporating demographic change show that



population aging will likely be more important than climate change to mid-century, informing the emphasis of heat action plans in the short term.

Effective adaptation requires understanding and incorporating into interventions the magnitude and pattern of future health risks. Recent advances in integrating implementation science into health adaptation are identifying opportunities for bridging the research-practice gap; examining the implementation of health adaptation; and developing, scaling up, and evaluating interventions such as early warning and response systems [7]. This integration not only identifies determinants and stages of implementation, but also the barriers and facilitators that affect the readiness of public health agencies for implementation. For example, among Pacific Island Countries and Territories, public health agencies report challenges with balancing competing priorities, limited compatibility between health adaptation and health programs, and the need for partnerships with non-health agencies [7]. Funding can be a barrier and incentive. More important than climate-health data were supportive leadership, well-established organizational infrastructure, and effective coordination and collaboration.

Other priorities in climate and health research and implementation include estimating the costs of climate variability and change for individuals and health systems, and estimating the health co-benefits of mitigation policies. The 2023 UNEP Adaptation Gap report estimated that only 6% of adaptation projects focused on human health and well-being [8]. Costs of US\$11 billion annually were estimated for interventions to control increases in malaria, dengue, and diarrheal diseases to mid-century and to address increases in heat-related mortality; costs to increase disease surveillance; and costs to make WASH and health resilience. These estimated costs only cover a fraction of the health risks of climate change, so are a significant underestimate. Further, costs are expected to accelerate with increasing impacts from additional climate change over coming decades.

The benefits to health and well-being from mitigation policies and technologies are well documented. For example, a systematic review explored the health impacts of climate policies in pathways for net-zero emission scenarios [9]. Pathways that explicitly considered air quality, physical activity, and dietary changes reduced median mortality by 1 to 5%. National or sub-national studies found substantial local air quality benefits with net zero policies, independent of actions in other countries. Decarbonization levers, modelling approach, and location affected the magnitude and pattern of co-benefits. Quantifying health co-benefits can inform policies for adaptation and mitigation at local to international scales. This includes reducing greenhouse gas emissions from the health sector. Worldwide, healthcare is responsible for about 5.5% of all emission.

An important opportunity for health researchers in 2026–2027 is the developing El Nino that will start affecting weather patterns worldwide by mid-2026 [10]. It could be a record-breaking event lasting into 2027. Evidence is increasing that El Nino events adversely affect human health [11]. Now is the time to evaluate health programs for their level of preparedness for potential disasters by ensuring health surveillance systems collect data on impacts and effectiveness of early warning systems and other interventions [12]. Hazard contingency plans, including risk communication, should be updated to enhance preparedness for water- and vector-borne disease outbreaks, potential food insecurity, and other impacts. In regions prone to flooding, pre-positioning resources will be valuable for managing potential surges in vectorborne and other infectious diseases and for preparing for potential disruptions to supply chains and access to healthcare.

Continued emissions of greenhouse gasses and deforestation, combined with the inherent inertia in the climate system, mean the health sector urgently needs to increase preparedness for a world in which mosquitoes, ticks, and other vectors will thrive. Climate-resilient and environmentally sustainable health systems may not be able to stop vectors from increasing their geographic range and seasonality but can be prepared so that outbreaks do not occur as the overall burden of infectious diseases declines with efficient and effective policies and programs. Health research and implementation, supported by health sector leadership and investment, are critical for promoting health and wellbeing while navigating the challenges ahead.

Conflicts of Interest

The author declares no conflict of interest.

Use of AI and AI-Assisted Technologies

No AI tools were utilized for this paper.

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