

The Intersection of United States Climate Change with Arthropod Disease Vectors

Audrey B. Blondin

UConn | THE GRADUATE SCHOOL

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Abstract

Climate change has become the most important issue facing our nation and its future. One of the consequences of climate change is the increase and spread of vector-borne diseases. The number of vector-borne illnesses has more than tripled in the U. S. and our country is woefully unprepared to handle this increased burden. Through a systematic literature review, this topic will examine the timely issue of climate change and its effect on vector-borne disease outbreaks here in the U.S. along with the associated issues of poverty and ethics. Proposals to combat climate change and projections for the future will be explored, with suggestions for cooperation and improvements among local, state and Federal officials. Only with increased surveillance systems and a health system that is adequately prepared to respond as needed will we be able to face the challenges existing before us.

Introduction

Climate change, particularly in the U. S., creates new risks for human exposure to vector-borne diseases (VBDs), which are transmitted to humans through the bites of arthropods, including mosquitoes, ticks, flies, and fleas. These arthropod vectors can carry disease-causing pathogens. Climate change creates new uncertainties about the spread of VBDs, such as the Zika and dengue fever viruses, the malaria parasite and the Lyme bacterium, by altering conditions that affect the development and dynamics of the disease vectors and the pathogens they carry.

Rising global temperatures can lengthen the season and increase the geographic range of disease-carrying insects. As temperatures warm, mosquitoes and other warm-weather vectors can move into higher altitudes and new latitudes farther from the Equator. Increased rainfall, flooding and humidity create more viable areas for vector breeding and allow breeding to occur more quickly, as eggs hatch faster in hotter climates.

In addition, human migration exposes people to viruses to which they are not immune, as we now see happening worldwide with the coronavirus disease, COVID-19. As populations migrate in response to climate change, they bring disease to new regions and urban areas. Infectious diseases also spread more quickly in overcrowded urban areas and areas of poverty and need.

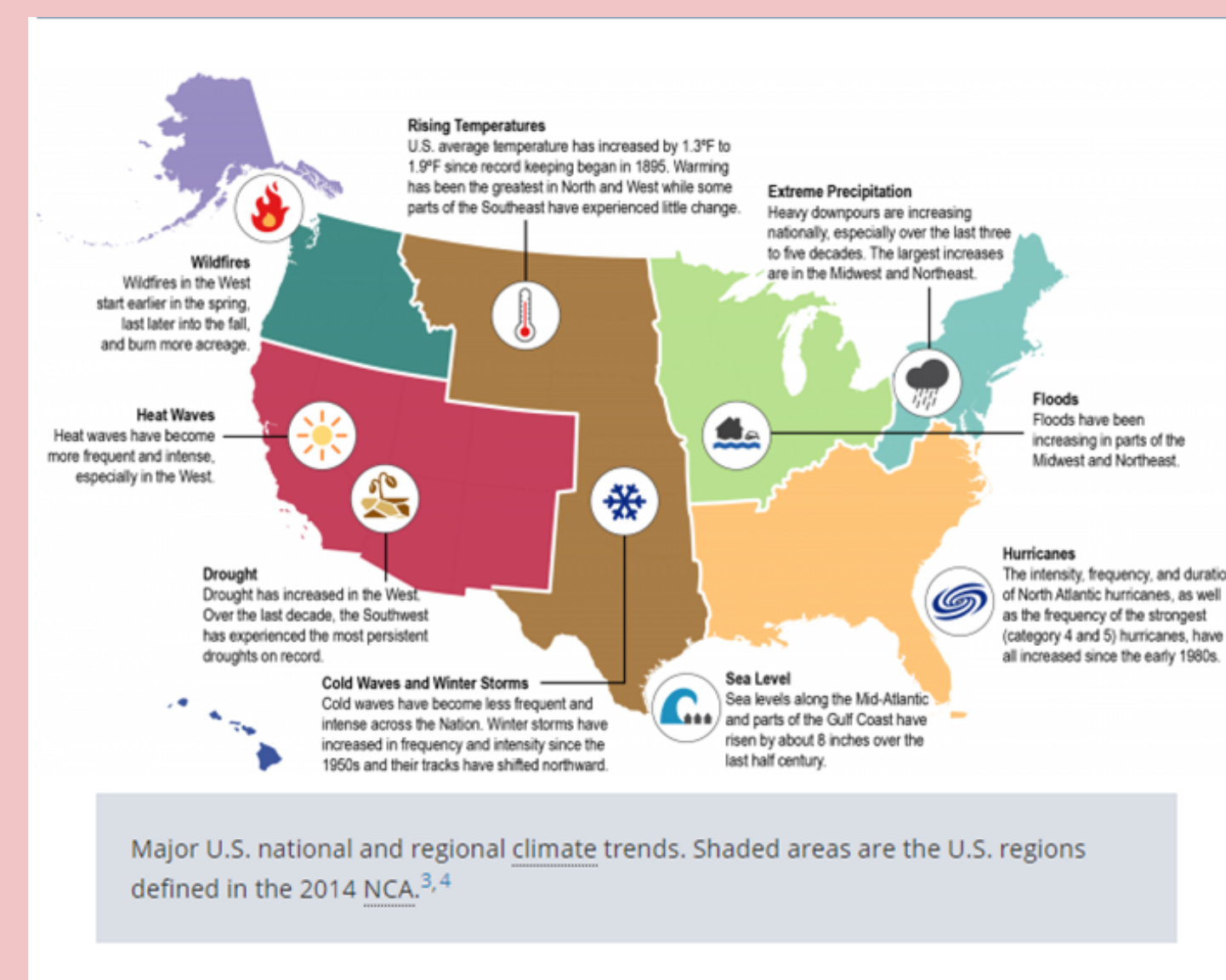
The impacts of climate change are projected to increase over the next century, while vector-borne disease health threats will intensify, and new health threats may emerge. It is important to examine how climate is changing along with an understanding of how those changes will affect vector-borne diseases here in the United States. Suggestions can then be provided to assist in making informed decisions about mitigating and reducing the amount of future climate change and its effects on populations, suggesting priorities for protecting public health, and help in identifying future research needs.

Materials and Methods Used

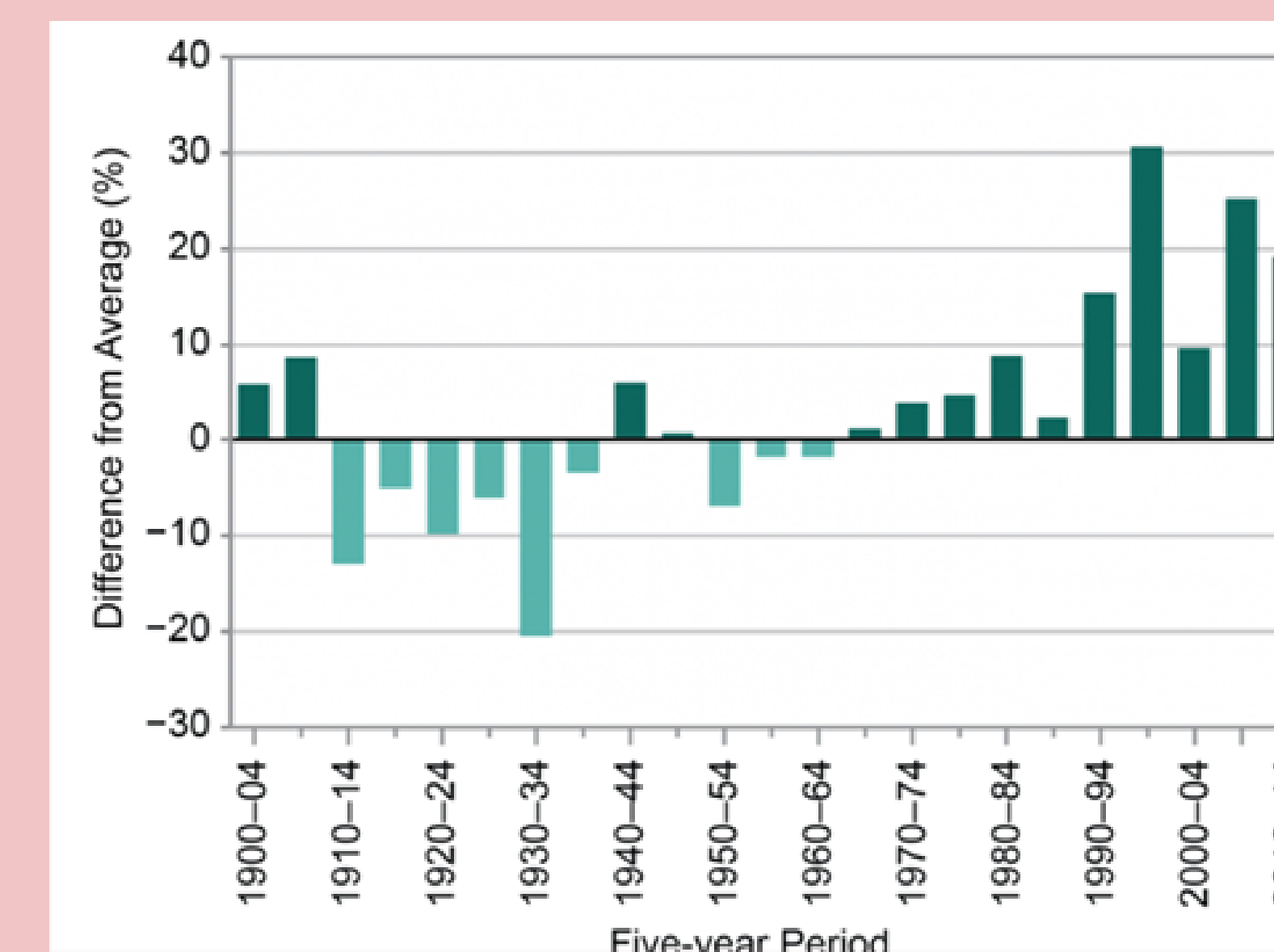
A literature search of Google Scholar was begun in 2019 for the following terms: climate change, global warming, vector-borne diseases, NOAA, weather, disease resilience, CDC, human vulnerability, infectious diseases, ethics, policy recommendations, malaria, and WHO. Some of these terms were much too broad, such as NOAA, weather, CDC, human vulnerability, ethics, policy recommendations and WHO. An in-depth, balanced preliminary review of the research literature relevant to this topic was conducted to investigate issues pertaining to this topic.

This review was helpful in examining and analyzing what is known about climate change and vector-borne diseases. It also assisted in the development of topical points to be made as a part of this research project, while examining the potential for future research and development in this field of study. Relevant research was also focused on an examination of future trends and suggestions for possible help in addressing the challenges faced herein.

In the end, I found approximately 50 publications and websites that appeared to be appropriate to my focus area. I classified them as to their appropriateness to this study. Of these, I culled 30 of which were used as cited references for this paper.



Source: <https://health2016.globalchange.gov/climate-change-and-human-health>



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Results: Climate Change

Earth has warmed over the last century. U.S. average temperatures have increased by 1.3 °F to 1.9 °F since recordkeeping began in 1895, with most of this increase occurring since 1970. According to the National Oceanic and Atmospheric Administration (NOAA), 2019 was the second hottest year on record for Earth, just behind 2016. The world's five warmest years have all occurred since 2015, with nine of the ten warmest years occurring since 2005.

Climate change results from both human activities and natural causes. Human activities include the emission of heat-trapping greenhouse gasses, such as carbon dioxide and methane, into the atmosphere and changes in land-use patterns, such as agriculture and urbanization. Natural causes range from regular pattern shifts in the dynamics of our oceans and atmosphere, such as *El Nino/La Nina*, to volcanic eruptions that emit large amounts of carbon dioxide and aerosols into the atmosphere, to long-term changes in the Earth's orbit around the sun, to variations in the amount of energy from the Sun that reaches the Earth.

Climate change is expected to cause mass migration and conflict as people flee flooded homes or arid farmland and fight over scarce resources. It may also mean economic slowdown as industries are affected and societies spend money to adapt to a changing world.

Vector-Borne Diseases

Climate change greatly impacts the spread of VBDs, such as the Zika virus, dengue fever, malaria and Lyme disease by altering conditions that can affect the development and dynamics of disease vectors and the pathogens that they carry.

VBDs are illnesses that are transmitted by vectors, which include mosquitoes, ticks, flies and fleas. These vectors can carry infectious pathogens, such as viruses, bacteria and protozoa, which can be transferred from one host carrier to another.¹¹ In the U.S., there are currently 14 vector-borne diseases that are national public health concerns. These diseases account for a significant number of human illnesses and deaths each year and are required to be reported to the National Notifiable Diseases Surveillance System at the Centers for Disease Control and Prevention (CDC).

Lyme disease, caused by the bacterium *Borrelia burgdorferi*, accounts for more than two-thirds of all U.S. vector-borne disease cases and, despite the reported national statistics, probably causes more than 300,000 human illnesses each year.¹³ The bacterium is transmitted to people through the bite of an infected blacklegged tick (*Ixodes scapularis*) (commonly referred to as "deer ticks" in the Eastern and upper Midwestern United States).

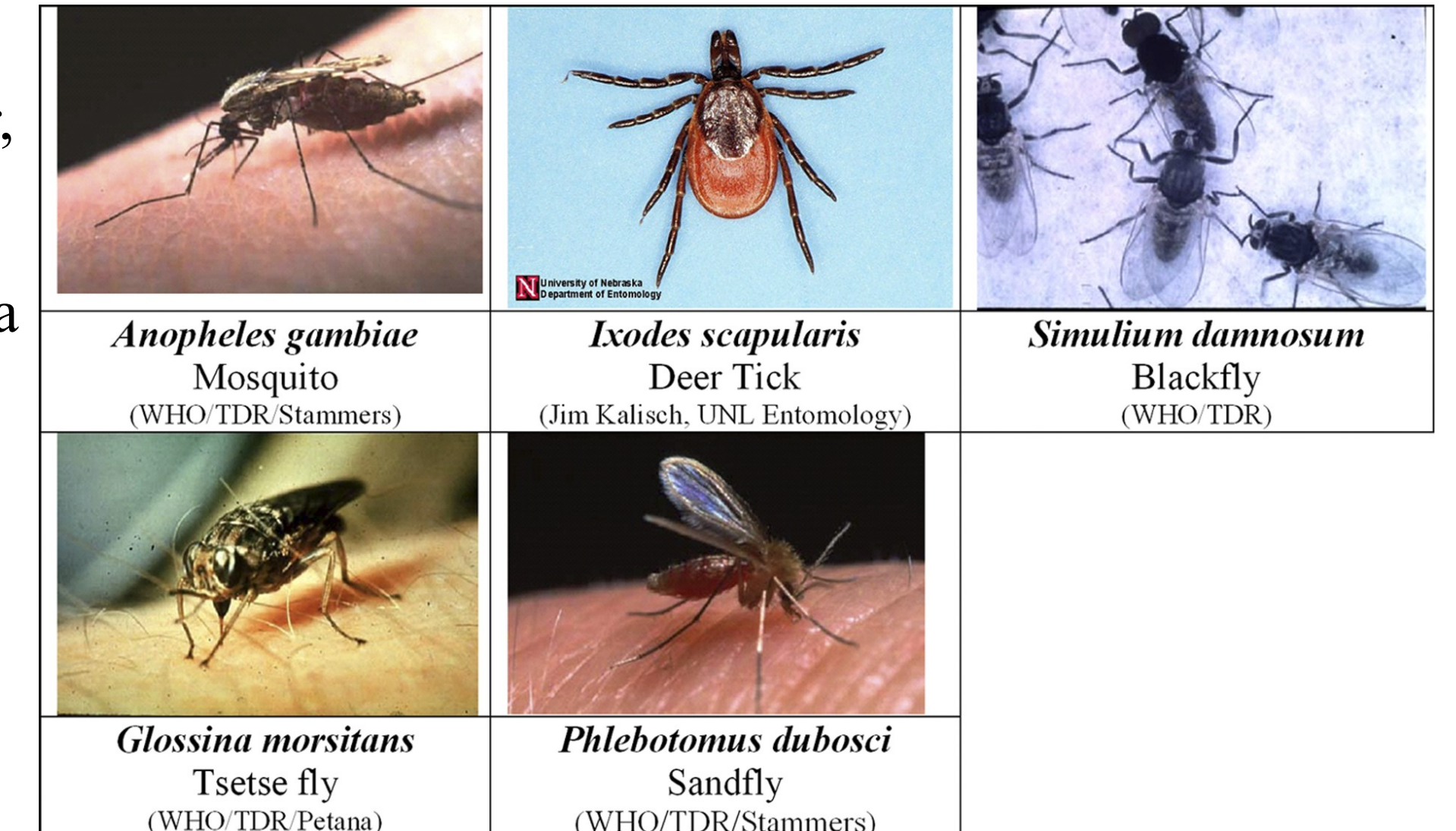
Climate variables have been shown to be strong predictors of geographic locations in which ticks will reside.¹¹ Today, these ticks live in 44 percent more counties than they did in 1996, spread over 43 states. Changes in climate increase the risk of tick activity and the expansion and prevalence of mosquito-borne diseases, while there is also an expectation among experts that new vector-borne pathogens could emerge.

Discussion of Project Relevance to Interprofessional Public Health Practice

Populations of Concern

Climate change is already causing and is expected to continue to cause a range of health impacts that vary across different population groups in the U. S. In the U. S., there is a largely hidden burden of diseases caused by a group of chronic and debilitating parasitic, bacterial, and congenital infections known as the neglected infections of poverty. Which disproportionately affect impoverished and under-represented minority populations. The major neglected infections include the vector-borne infections Chagas disease, leishmaniasis, trench fever, and dengue fever. These diseases occur predominantly in people of color living in the Mississippi Delta and elsewhere in the American South, in disadvantaged urban areas, and in the U.S.–Mexico borderlands, as well as in certain immigrant populations and disadvantaged white populations living in Appalachia.

Socioeconomic and educational factors, limited transportation, limited access to health education, and social isolation related to language deficiencies collectively impede their ability to prepare for, respond to, and cope with climate-related health risks. These populations also may have limited access to medical care and health insurance, and may not be able to afford medications or other treatments. For undocumented persons, high poverty rates, language and cultural barriers, and citizenship status often limit access to and use of health care and other social services, and make these groups more hesitant to seek out help that might compromise their immigration status in the U. S.



Ethical Issues

VBDs raise unique ethical issues because pathogens are transmitted between humans by a third party, the vector, and because of the unique aspects of vector control. Because VBDs are often associated with poor and vulnerable communities, they are ethically problematic because, as neglected diseases, when research and control activities are not proportional to disease burden, the consequences include avoidable harm, particularly for the poor, and failure to predict and prepare for epidemics or today's COVID-10 pandemic. Because the burden of VBDs is inequitably distributed among the poor, pregnant women and children are often at highest risk. This vulnerability in terms of the social determinants of VBDs is compounded by existing negative environmental factors. When the influence of climate change increases VBD burden among the worst-off groups, existing global injustice is exacerbated.

Conclusions and Next Steps

The magnitude of climate change beyond the next few decades will depend primarily on the amount of greenhouse gasses emitted globally. Without significant cuts to emissions, annual average global temperatures will almost certainly rise beyond 2 °Celsius (3.6 °F) by the end of the century.

Controlling diseases from mosquitoes and ticks requires five core competencies. Local health departments and vector control organizations must be able to:

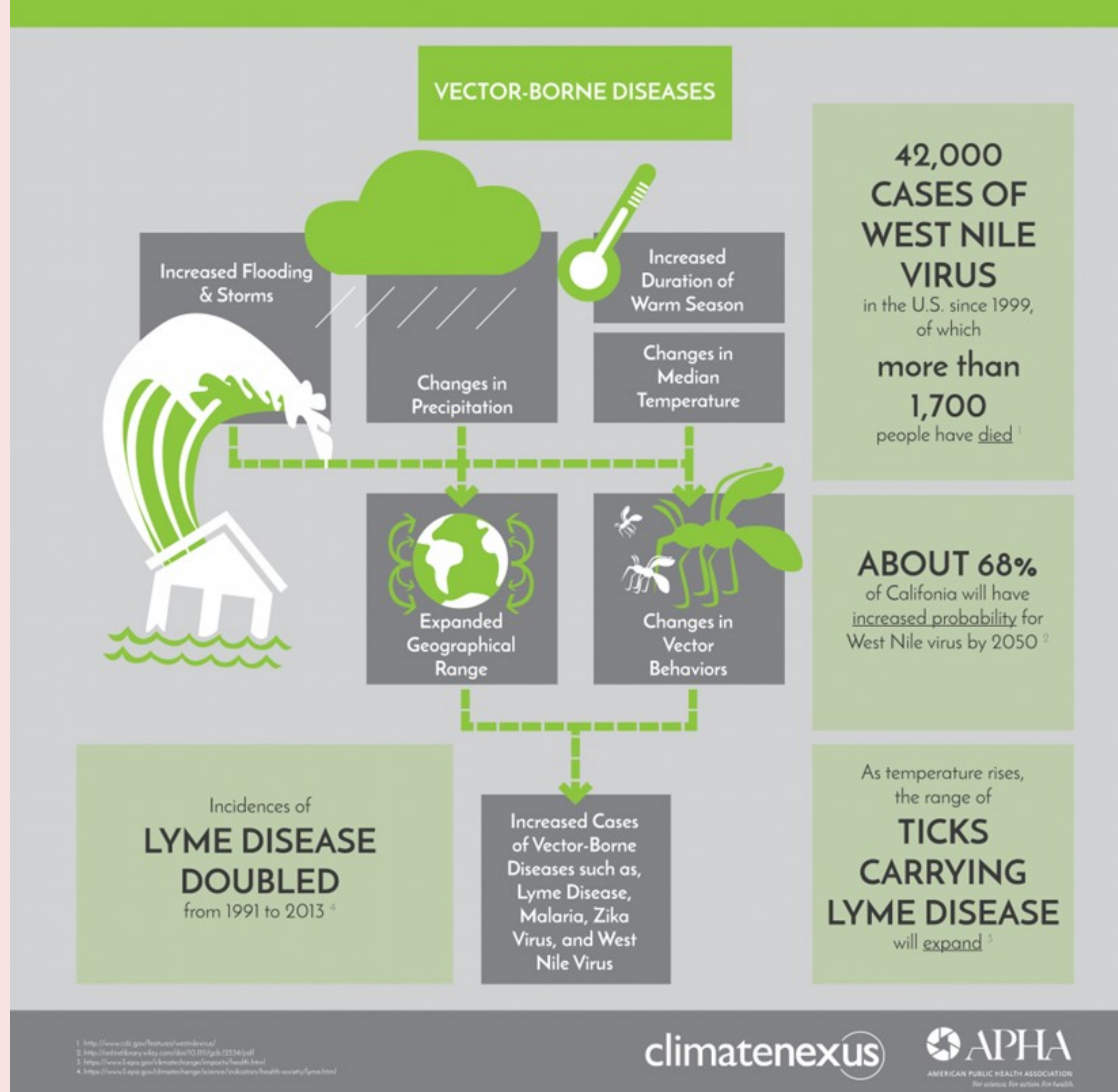
- Monitor and track mosquitoes and ticks locally.
- Use data to drive local decisions about vector control.
- Have an action plan to kill mosquitoes and ticks at every life stage.
- Control vectors using multiple types of methods.
- Conduct pesticide-resistant testing.

To efficiently prevent VBD transmission, an adequate surveillance system must be put in place for reporting and analyzing the health and immune status of the human populations, but also a continuing a good surveillance system requires adequately trained personnel to collect, identify, and report on the different stages of the vectors of interest. Further, since vectors can easily cross borders, surveillance systems need to be developed through cross-border collaborations, with an exchange of information between countries and regular meetings to coordinate interventions. Health and climate professionals must continue to coordinate, brainstorm and implement side-by-side strategies to address and combat the current and future effects of climate change.

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HOW CLIMATE CHANGE AFFECTS YOUR HEALTH



Source: <https://climatenexus.org/climate-issues/health/climate-change-and-vector-borne-diseases/>