



Opinion

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Range Expansion of Insect Vectors due to Climate Change

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The United Nations Intergovernmental Panel on Climate Change [IPCC] has attributed 1 oC of global warming since the Industrial Revolution to anthropogenic causes, 0.5oC of which occurred since the 1970s. The IPCC also projects that the world is likely to be an additional 1.5oC hotter in just a few decades given the current rate of greenhouse gas emissions [1]. Above a 2oC increase in mean global temperatures, the results will be catastrophic and likely irreversible [2]. The increase in global temperatures will cause natural disasters to become more frequent and severe, ecosystems to be destroyed, and forever alter the climate of certain regions around the globe [3-6]. An oft-overlooked consequence of a warmer planet is the range expansion of many insect vectors and, more importantly, their plethora of associated diseases. Many diseases will become more prevalent if global warming continues and breach areas previously considered to be safe from harm. Consider the dramatic effects of increases in the range of the common mosquito, *Aedes aegypti*, and the Asian tiger mosquito, *Aedes albopictus*. By the end of this century, almost a billion people will be newly exposed to these mosquitoes and their associated diseases [7].

Europe, eastern Africa, the United States, and Canada will bear the brunt of this increase in mosquito exposure. The Asian tiger mosquito has already been invading into new areas of the USA, with one study finding that the number of trapping sites positive for the *A. albopictus* in Connecticut increased from just 1 in 2006 to 936 in 2016 [8]. In the northeastern United States, the number of people under threat from *A. albopictus* has been projected to double by the close of the century [9]. The silver lining of this rise in mosquito populations is that they may decrease in certain parts of Africa, South America, and southeast Asia which currently have a high prevalence of both types of mosquitoes. However, considering the areas which will still suffer from mosquito-borne diseases, an estimated 3.9 billion people in 120 countries are at risk [10]. Now

consider the variety of diseases that can be transmitted by these two types of mosquitoes. Malaria outbreaks, responsible for over 435,000 deaths globally in 2017, are expected to become more prevalent [11]. Models of Zika virus, an arbovirus which causes birth defects and neurological disorders, have predicted its range to shift upwards towards North America [12].

By 2085, over half of the world's population will be at risk for Dengue virus and the debilitating fever associated with it [13]. Likewise, Chikungunya viral infections and severe joint pain will harm Chinese, North American, South American, and European populations that previously enjoyed relatively low rates of the disease [14]. Rift valley fever will spread and plague countries north of the Mediterranean and Middle East [15]. Preventative measures for these diseases are limited. Only dengue virus has an approved vaccine with a high efficacy although preliminary tests of vaccines for other viruses are currently underway [16,17]. The other viruses lack vaccines and therefore present severe threats towards newly exposed populations [18,19]. For an appreciation of the scale of this problem, consider that mosquitos are only one of many vectors for disease whose range will expand as a result of global warming. Others include kissing bugs for Chagas disease [20], sand flies for Leishmaniasis [21]. Tsetse flies for sleeping sickness [22], and Ixodes ticks for Lyme disease [23]. Beyond viruses carried by insect vectors, others that are likely to become more prevalent include the rabies virus [24] and arenaviruses which spread Lassa fever [25],

Range expansions for these vectors may not be explosive and garner much media attention. Nonetheless, they pose significant threats to the well-being of many human beings worldwide. Unfortunately, many developing countries are ill-prepared for outbreaks of these vector-borne diseases. Developing countries have mortality rates from vector-borne diseases that are 300 times greater than those from developed countries [26]. The death toll

from the developing world alone would be substantial if the range of insect vectors expands at the current rate. Even in the developed world, public health systems may struggle in the face of new threats to populations. These studies suggest that drastic action must be taken immediately to mitigate the spread of these diseases. Global CO₂ emissions must be reduced as quickly as possible through a variety of mechanisms: carbon pricing, investment into cleaner energy and carbon sequestration, moving towards plant-based eating, and sustainable development. Significant research funding must be devoted to developing vaccines and new treatments, especially for populations that will be newly exposed to these diseases.

On a smaller scale, individuals can voice their concerns to their local representatives and pressure them to sponsor greener policies. The facts of the matter are that the world is warming due to anthropogenic causes, and a warmer world will make its people susceptible to serious diseases, many of them transmitted by expanding insect vectors. It is up to us to realize the severity of the problem and take action.

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