Obstacles to Mosquito-Borne Disease Burden in the Face of Climate Change

Robert Deck*

Editorial Office, Journal of Climatology & Weather Forecasting, United Kingdom

Corresponding Author*

Robert Deck
Editorial Office, Journal of Climatology & Weather Forecasting United Kingdom
E-mail: Climatolres@journal.com

Received: 5-Dec-2022, Manuscript No. jcwf-23-21484 **Editor assigned:** 12- Dec-2022, PreQC No. jcwf-23-21484 (PQ); **Reviewed:** 20- Dec-2022, QC No. jcwf-23-21484 (Q); **Revised:** 23- Dec-2022, Manuscript No. jcwf-23-21484 (R); **Published:** 28- Dec-2022, DOI: 10.35248/2332-2594.22.10(12).350

Abstract

Cities all across the world are under increasing pressure to create mitigation plans for every sector to address the effects of climate change. By 2050, 70% of the world's population is anticipated to live in cities, making the development of robust health systems in these contexts a considerable task.Urban Heat Islands (UHI) are created when cities' surface temperatures are much higher than those of the nearby rural areas due to their physical makeup. The negative health effects of heat and pollution in cities which are related with UHI have received a lot of attention, but mosquito-borne diseases have largely gone unaddressed.

The World Health Organization, on the other hand, estimates that one of the primary consequences of global warming will be an increase in the burden of mosquito-borne diseases, many of which have an urban component to their epidemiology, and thus the global population exposed to these pathogens will steadily increase. Current health mitigation techniques, such as those for heat and pollution, may, however, be harmful to mosquito-borne illnesses.

Keywords: Climate change • Urban heat islands • Mosquito-borne disease • Mitigation strategies

Introduction

Five years after the historic Paris Agreement in 2015 to limit global warming to less than 2 degrees Celsius, global carbon dioxide emissions have continuously increased, resulting in an increase in world average temperature of 1.2°C above pre-industrial levels [1,2]. Global warming is accelerating, with the five warmest years ever recorded occurring after 2015. Climate change impacts are all around us and may be seen in a variety of sectors (agricultural, energy, water supply, coastlines, ecosystems, forests, society, transportation, and health). They are, however, unevenly dispersed around the globe, resulting in significant regional disparities in exposure, susceptibility, and adaptability to climate change, with repercussions happening disproportionally in nations not responsible for our suffering.

Climate change is already having an impact on human health, and the burden is anticipated to rise in the coming decades [3]. Droughts, floods, storms, coastal flooding, forest fires, agricultural productivity, natural water supplies, landslides, heat waves, and the growth of microorganisms and the expansion of arthropod vectors of infections are all catastrophic effects of climate change . According to studies , low-income nations would suffer the brunt of the expected health consequences. Africa and Asia, for example, carry the greatest economic burden of disease in humans [4], and the impact of climatic variability on health is already generally acknowledged.To manage health risks, health systems must be modified to become more robust. Such adaptation will be necessary for decades, with the degree of mitigation being a crucial predictor of health-care systems' ability to manage hazards expected later in the century [5]. Persisting in a business-as-usual approach to climate change would imperil lives and livelihoods, resulting in an increased health burden that could have been avoided.

While climate change occurs across decades, decision frameworks for public health professionals and regional planners must be based on significantly shorter time spans [6]. The costs of managing the health risks posed by climate variability will be significant, including not only costs associated with increased health care and public health interventions, but also costs associated with the labour sector (lost work days and lower productivity) and with maintaining well-being; the latter will be especially pronounced in urban areas. The goal of this article is to present an overview of the health challenges that are anticipated to be aggravated by climate change, notably in an urban environment, as well as why and how urban mosquito-borne illnesses should be prioritised in the implementation of mitigation methods for urban health.

Urbanization and health

The most significant anthropogenic impacts on climate are greenhouse gas emissions and land use change, particularly urbanisation, which replaces vegetation with man-made surfaces [7]. The expansion of urban populations and large-scale mobility of people between regions are among the primary defining environmental concerns of the 21st century, particularly for human health. Over half of the world's population lives in cities, and this figure is anticipated to rise to almost 70% by 2050.

Cities occupy just 3% of the land area [8], yet they contribute around 80% of global GDP, consume approximately 78% of global energy, and emit more than 60% of total CO_2 emissions. The predicted tremendous growth in urbanisation forbids extrapolating from our existing inadequate understanding of urban health to the future, particularly when important remedies take into consideration severe demographic, socioeconomic, environmental, and climatic variation. Socially disadvantaged people living in cities have been identified as a key population at risk of the negative health implications of climate change, which would increase already existing urban health inequalities.

Both the massive production of greenhouse gases and urbanisation raise surface temperatures and can result in Urban Heat Islands (UHIs), which are metropolitan regions that are much warmer than the surrounding rural areas. Many factors contribute to the formation of UHIs, including population density, percent built-up area and density, reflectivity (albedo), thermal bulk properties of man-made surfaces, including impervious surfaces (roads, pavements), lack of vegetation areas and water bodies, anthropogenic thermal mass (transportation, industry), and urban morphology (high-rise building, variation in building height, sky view factor, and so on) [9].

The negative consequences of severe temperature conditions, air pollution, worse water quality, and overall discomfort have been directly linked to the public health impact of UHIs. Temperature rises will ultimately result in hotter days, more frequent and longer heatwaves, and an increase in heat-related mortality. An increase in particle pollution is also expected, owing in part to an increase in wildfires. This will raise the prevalence of Chronic Obstructive Pulmonary Disease and Cardiovascular Disease. Finally, air quality will deteriorate in terms of airborne allergens, particularly pollen from plants, resulting in a rise in allergy illnesses such as asthma and rhino-conjunctivitis.

Aside from the obvious impact on agriculture in rural regions, 90% of cities are coastal, thus a rise in extreme weather events, such as floods and storms, would have a disproportionately large influence on the urban environment. Mental health will suffer as a result of the cumulative impacts of rising heat, which will be felt most acutely in metropolitan areas. In addition to the harmful effects of global warming on non-infectious diseases, infectious diseases, particularly in cities, are a source of worry.

With the expansion of germs and a rise in bacterial and viral contamination of water and food, global warming will reduce water quality and food safety. Last but not least, as discussed further below, urban mosquito-borne illnesses represent a unique concern that is not being adequately addressed by the World Health Organization's (WHO) Urban Health Initiative for integrating health into urban and territorial planning [10]. There is an expanding body of evidence linking increased dengue risk to intra-urban UHIs, which are caused by high population density and built-up area, disproportionately harming the socioeconomically vulnerable population. This is most likely true for all mosquito-borne illnesses.

Urban mosquito-borne diseases

Many of the most serious health problems are mosquito-borne, most notably malaria and arboviral illnesses (caused by viruses from the Flaviviridae, Bunyaviridae, and Togaviridae viral families). According to the WHO, one of the primary implications of global warming would be a rise in the burden of such vector-borne illnesses. Many mosquito-borne illnesses that are now restricted to the tropics and subtropics are expected to expand their existing geographical ranges and infiltrate more temperate regions [11]. Globalization and increased international travel and commerce will allow the unintentional importation of invasive mosquito vectors and mosquito-borne illnesses from endemic areas into previously disease-free areas, given that infections caused by many such pathogens can be symptom-free [12].

This potential for mosquito-borne disease transmission into temperate regions has already occurred, with dengue or chikungunya virus transmission detected sporadically in France , Madeira , and Croatia , as well as frequent outbreaks in the United States , where historically both malaria and yellow fever epidemics occurred frequently until the middle of the twentieth century [13].

Temperature changes can have a significant impact on the epidemic potential of mosquito-borne illnesses directly by influencing the maturation rates of both the mosquito and the pathogen within the mosquito, as well as insect survival. The question of whether climate change has a role in disease dissemination remains debatable. However, the amount to which global warming affects the mosquito-borne illness load may be irrelevant in an urban situation.

Even in the worst-case scenario, the UHI effect can produce local temperatures that are much beyond any expected global temperature rises. There are an increasing number of fine scale studies linking higher dengue incidence and mosquito vector density with land surface temperature, vegetation indices, and intra-urban vertical cities [14]. As a result, for a number of reasons, urbanisation will be linked with higher local temperatures when compared to nearby rural regions, with an influence on the local burden of mosquito-borne illnesses.

Climate-related variations in precipitation are also likely to have a disproportionate impact on the availability of mosquito oviposition sites, with urbanisation known to provide various aquatic habitats for mosquito larvae. Several mosquito-borne illnesses are especially concerning since the mosquito species in issue have adapted to the urban environment. This is true for Aedes aegypti, the vector of the dengue, Zika, chikungunya, and yellow fever viruses, *Anopheles stephensi*, the vector of urban malaria (caused by *Plasmodium falciparum* or *Plasmodium vivax*), and *Culex* spp., the vector of West Nile virus. These diseases are wreaking havoc on the world's health. In over 100 countries, more than 3.5 billion individuals are at risk of Dengue Virus (DENV) infection, and current estimates show that 390 million DENV infections occur each year, with 100 million causing clinical symptoms.

UHI mitigation strategies: In response to the rising and anticipated problem of UHIs, much effort has been made to create mitigating techniques. Singapore has taken the most comprehensive approach, developing over 80 distinct solutions. Vegetation, urban geometry, water bodies, materials and surfaces, shading, transportation, and energy are the seven categories. Strategies centred on vegetation have been identified as very beneficial, as well as cost effective and reasonably easy and quick to execute when compared to the other categories. As a result, vegetation has been widely adopted as a UHI mitigation method across the world in many ways at the micro (e.g., vertical gardens, planting trees along transport axes to create green corridors) and mesoscales (e.g., increasing urban parks and encouraging urban agriculture).Planting plants minimises the influence of incoming solar radiation via shade, and its comparatively high albedo also reduces heat buildup. The shade effect can diminish not only the sensible but also the latent heat flow. Green corridors not only provide shade from trees, but also lessen turbulent vertical air movements caused by heated surfaces, enhancing convection efficiency. However, in tropical climates with excessive humidity, vegetation can exacerbate heat discomfort. In such humid regions, the amount of green coverage required to mitigate the temperature disparity (of UHIs vs rural areas) would cause significant thermal discomfort.

Another concern with overgrown vegetation is that it contributes to another health problem: mosquito-borne illness. Inner city parks and green zones may significantly lower local surrounding temperatures [12], while also providing home for less urbanised mosquito species, such as those described above. The dengue outbreak in Tokyo, with its core in Yoyogi Park and vectored by *Aedes albopictus* mosquitoes, is a great illustration of this outside of the tropics.

Even where the urban vector *Aedes aegypti* predominates, inner city parks have been linked to increased dengue risk for persons living in close proximity to such green areas. In the midst of severe metropolitan temperatures, such green spaces may provide a safe sanctuary for adult mosquitos of all species. Furthermore, because mosquito vectorial ability for *arboviruses* and malaria parasites is temperature dependent, cooling green zones may have unforeseen effects on transmission rates.

Optimal temperatures for pathogen growth and transmission seem to be between 25°C and 35°C, depending on humidity and diurnal temperature variations [15]. Extremely hot temperatures in the tropics can thus provide sub-optimal circumstances, and green cooling zones may accidentally boost conditions for the disease. As a result, green zones may improve transmission, both in terms of greater habitat for less urbanised invasive species and cooling for vectorial capacity.

How can present mosquito control techniques change in the face of the likelihood of UHI mitigation strategies being widely developed internationally to tackle, in particular, the non-infectious illness burden? Mosquito management in metropolitan areas is difficult, not least because of the environment's complexity and the abundance of man-made containers that might serve as oviposition sites for mosquitoes . Current integrated vector management approaches emphasise source reduction through improved environmental hygiene (eliminating solid waste that provides potential oviposition sites), the use of larvicides in stored water objects (vases, urns, storage jars, overhead tanks, and so on) to eliminate immature mosquitoes, and adulticides to kill adult mosquitoes. One of the most difficult aspects of targeting juvenile mosquito stages is the inability to locate and treat an abundance of possible breeding places. One novel strategy for Aedes aegypti control is to utilise mature female mosquitos to disperse the pesticide (auto-dissemination), with the idea that she will discover oviposition locations better than humans . While this has been demonstrated to work for both *Aedes aegypti* and *Aedes albopictus*, at least in terms of mosquito population reduction, urban geometry has a considerable influence on efficacy, for the simple reason that mosquitoes do not fly over high walls and will not travel very far.

Water resource management is expected to become a severe issue, particularly in metropolitan areas, because insufficient permanent access to water leads to water storage practises that allow mosquito populations to proliferate and illness to spread. Lack of piped water has been demonstrated to be a risk factor for dengue fever, and this is likely to be true for urban malaria as well. In this situation, water-supply-improvement efforts may result in sectoral co-benefits. It is also an obvious source of worry for the overall quality of drinking water.

Focusing on access to water would thus result in cross-sectoral advantages. Improving environmental hygiene is critical for minimising pollutants and preserving a healthy urban environment. Mosquito breeding grounds are abundant in solid trash.

Conclusion

Despite the critical relevance of understanding the extent and patterns of climate impacts for priority and resource allocation to safeguard populations, the health research community works mainly in isolation from the other sectors. This is also true in the health sector when it comes to non-infectious vs. infectious health concerns. However, in order to maintain long-term growth, all aspects of urban public health must be incorporated in climate change policies and climate services across sectors. The Inter-Sectorial Impact Model Inter-comparison Project has strengthened multi-sectoral collaboration in recent years, although health, unlike other sectors, has been only vaguely and irregularly involved in this endeavour.

References

1. Watts, N, et al. "The 2020 report of the Lancet Countdown on health and climate change: responding to converging crises." *The Lancet* 397.10269 (2021): 129-170.
2. Murray, et al. "IPCC special report on managing the risks of extreme events and disasters to advance climate change adaptation (SREX)." *J Epidemiol Community Health* 66.9 (2012):760.
3. McMichael, et al. "Globalization, climate change, and human health." New England Journal of Medicine 368.14 (2013): 1335-1343.
4. Christopher, B., et al. Climate change 2014–Impacts, adaptation and vulnerability: Regional aspects. Cambridge University Press, 2014.
5. Woodward, et al. "Climate change and health: on the latest IPCC report." *The Lancet* 383.9924 (2014): 1185-1189.
6. Watts et al. "Health and climate change: policy responses to protect public health." *The lancet* 386.10006 (2015): 1861-1914.
7. Friel, et al. "Global health equity and climate stabilisation: a common agenda." *The lancet* 372.9650 (2008): 1677-1683.
8. Martin, L., et al. "Assessing the costs of adaptation to climate change: a review of the UNFCCC and other recent estimates." (2009)..
9. Sachs, et al. "The economic and social burden of malaria." *Nature* 415.6872 (2002): 680-685.
10. Ligsay, et al. "Challenges to mitigating the urban health burden of mosquito-borne diseases in the face of climate change." *International Journal of Environmental Research and Public Health* 18.9 (2021): 5035.
11. McCarthy, et al. Climate change 2001: impacts, adaptation, and vulnerability: contribution of Working Group II to the third assessment report of the Intergovernmental Panel on Climate Change. *Cambridge University Press,* 2001.
12. Cash, et al. "Links between tropical Pacific SST and cholera incidence in Bangladesh: Role of the eastern and central tropical Pacific." *Journal of Climate* 21.18 (2008): 4647-4663..
13. Ebi, et al. "Health risks and costs of climate variability and change." *Disease Control Priorities* 7 (2017)..
14. Liming, et al. "Evidence for a significant urbanization effect on climate in China." *Proceedings of the National Academy of Sciences* 101.26 (2004): 9540-9544.
15. Walter, et al. "An evidence-based review of impacts, strategies and tools to mitigate urban heat islands." *International journal of environmental research and public health* 14.12 (2017): 1600.

Cite this article: Deck. R. Obstacles to Mosquito-Borne Disease Burden in the Face of Climate Change. J Climatol Weath Forecast. 2022, 10 (12), 001-003