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Review Paper

Impact of Climate Change on Global Health for Assessing the Rising Burden of Infectious Diseases

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Key Words	Abstract
Climate change, Global health, Cholera, Dengue, Infectious diseases, Vector-borne, Waterborne.	This study examines the critical role of global climate change in the health of the people, with a particular example given to the currently rising global disease burden attributed to infectious diseases, waterborne diseases such as Cholera, and dengue disease, which is transmitted by vectors. Changes caused by climate change, such as increased average temperatures, changes in precipitation, and more severe weather events, directly change the dynamics of transmission and increase the geographical spread of these diseases, which is a significant challenge to the health security of the whole world. The growing rate of these environmental changes dictates the need to create powerful and innovative instruments, including AI-powered disease forecasting algorithms, to proactively control the health of aquatic and terrestrial livestock and wildlife. Vibrio cholerae causes Cholera, a disease that is very sensitive to increased sea surface temperatures and variation of rainfall, both in the coastal and inland areas, resulting in a conducive environment in which the bacteria thrive, and pollutes the sources of human water. At the same time, Dengue, a significant disease spread by mosquitoes, is spreading quickly due to the accelerated breeding patterns and high rates of biting, as well as the longer life span of the Aedes vectors with the rising temperatures. The study builds on an assessment framework that integrates available epidemiological data in an attempt to measure the relative risks of Morbidity and mortality related to these climate-sensitive infections in various regions. Results highlight that the poor infrastructure and increased exposure to climate stress led to a cascading and disproportionate risk, especially in low- and middle-income areas, where co-occurring outbreaks are common. The

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study ends by showing that climate-conscious, interdisciplinary community health measures, improved surveillance based on new technology, as well as concerted international policy response, are the necessary solutions to this growing menace to human health.

Introduction and Literature Review

The twenty-first century is characterized by a cluster of diverse, interrelated world-level issues, and climate change is one of them: there is no denying the existence of a fundamental and pervasive threat to human health, socio-economic stability, and ecological balance (Kim et al., 2014). Climate change has several direct and indirect effects on human health, including heat stress, exposure to poor air quality, undermined food security, displaced human migration, and, most importantly, the ecology of infectious diseases. This study in particular deals with how changes in world climatic patterns cause the increasing number and escalating burden of two classic infectious diseases: Cholera, a waterborne disease, and Dengue, a vector-borne disease (George et al., 2024). The complex and typically non-linear processes of the association between underlying and core climatic factors, including consistent increases in temperature, randomized precipitation patterns, and the occurrence of extreme events, with the epidemiology of these specific diseases are necessary to create effective and timely responses to the challenge of the core of the population and reduce the future health crises in vulnerable populations (Chang & Li, 2024). Global climate change is an intricate phenomenon that has been characterized by an accelerated increase in temperature, among other severe weather patterns, which are some of the main predictors of the destabilization of the natural ecosystems. These environmental alterations are viewed as a threat multiplier of paramount value, which directly affects ecology and the distribution of pathogens and vectors. The altered climatic patterns and temperatures give favorable niches that increase the rate of geographical distribution as well as the season of diseases that can also be observed in not only human epidemiology, but also in aquatic and terrestrial animals (Hiko & Malicha, 2016). This sense of urgency in the cohesive teams of Health is emphasized by the interdependence weakness. This must include an environmental and animal health surveillance system that would enable control of the risk of infectious disease, as well as the stability of the ecosystem proactively.

Key Contribution

- To provide a comparative view on the climate sensitivities and health impacts of Cholera and Dengue by systematically evaluating the existing and forecasted epidemiological costs of climate change in relation to both diseases in highly populated regions around the world.
- Synthesize the particular and discrete climate-mediated pathways of the augmented incidence and geographical dissemination of both waterborne (Cholera) and vector-borne (dengue) illnesses, with a focus on the everyday upstream driver (climate change) but variable environmental intermediates.
- Emphasize the cascading risks and differential vulnerability of different

geographic/socio-economic areas to the compounding effects of environmental factors and the underlying fragility of the health system.

- Recommendations: Integrated forward-looking and robust surveillance, risk prediction, and coordinated global response through advanced methods to be used in the future to mitigate climate-related pandemics.

The study is divided into seven independent sections that are interrelated and meant to develop a cogent argument on the climate-health nexus. Section 2, after this collective Introduction and Literature Review, outlines the biological and ecological processes that occur in particular ways to describe the manner in which key climate drivers influence the disease transmission pathways. Part 3 then moves on to discussing the modeling methods and measures that need to be conducted to evaluate the disease burden and predict future outbreaks. Synthesized findings containing comparative burden data and regional case studies are presented and thoroughly discussed in Section 4. Section 5 details the necessary mitigation and adaptation measures of public health required during global preparedness. Lastly, Section 6 gives the conclusion and sets priorities for the future interdisciplinary research and policy interest.

Climate-Health Nexus in context

The main goal of the review is to critically establish the scientific basis in the connection of climate change to the emergence and re-emergence of infectious diseases, initially described on a systematic level within the health domain in the mid-1990s (Patz et al., 1996). The second priority is to bring together the substantial body of evidence demonstrating the unique but similar effects of climatic changes on Cholera and Dengue, which are good proxies of two different significant types of transmission, waterborne and vector-borne, that can be broadly and comparatively analyzed in terms of the climate-health nexus. The third goal is to conduct a review of the existing frameworks and innovative models that are now being applied to quantitatively measure and project the risk and burden of these climate-sensitive diseases in a constantly shifting environment.

The literature already supports beyond any doubt that climate change is a statistically significant and accelerating factor in the dynamics of infectious diseases. Although the underlying connection is firmly established in the case of both Cholera and Dengue, there still exists an essential weakness in the capacity to incorporate comparative risk analysis in various disease types in a single and practical framework, particularly in relation to the highly diversified regional risks and the calculating or compounding effect of risk when multiple climate-sensitive threats occur together (Campbell-Lendrum & Woodruff, 2006). This is where the integrated approach suggested in this research is needed.

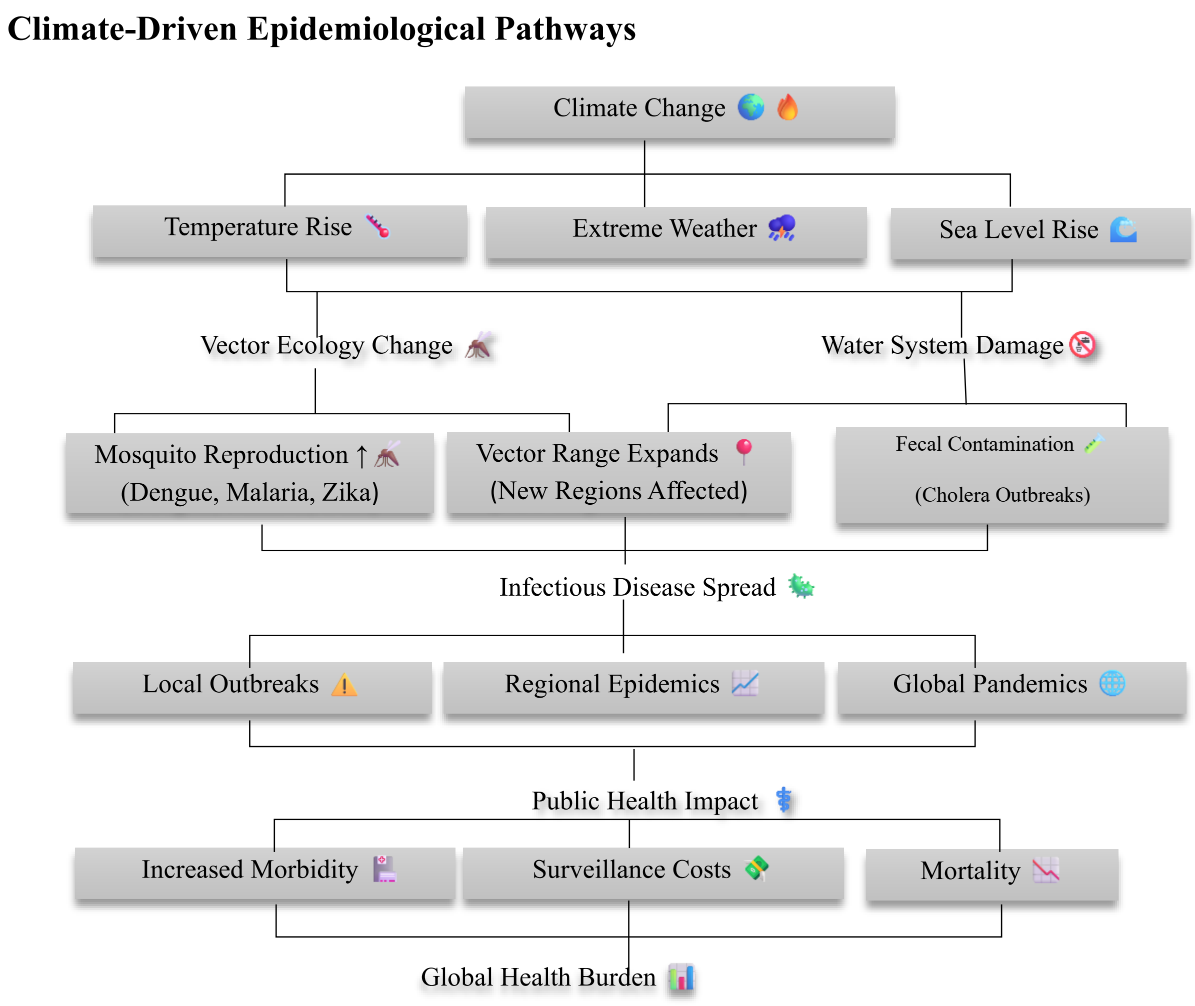

Figure 1: Conceptual Flowchart of Climate Change Pathways to Global Infectious Disease Burden

Figure 1 shows how climate change drivers have a hierarchy with respect to the global health burden. Temperature Rise, Extreme Weather, and Sea Level Rise have two cascades that start. Warmer temperatures foster Vector Ecology Change, which causes the Mosquito Reproduction to increase faster and the Vector Range to expand, causing disease outbreaks such as Dengue and Malaria. Water System Damage caused by extreme Weather and rise in the sea level leads to Fecal Contamination and outbreak of Cholera (Rayan et al., 2021). The net upshot of all these effects is that the Infectious Disease Spread due to local outbreaks is becoming a global pandemic, which ultimately causes a serious Public Health Impact in terms of increased Morbidity, mortality, and increased health costs, thus constituting the Global Health Burden.

Both Cholera and Dengue have an exceptionally high sensitivity to environmental and other particular climatic variables, which are the most important determinants when it comes to dictating the distribution, seasonality, and epidemiological potential of the diseases. In the case of Cholera, an acute diarrhea virus, which is caused by the bacteria Vibrio cholerae, rising sea and air surface temperatures create the best conditions that allow the bacteria to survive, reproduce, and persist in the water bodies, especially in complex coastal and estuarine environments (Lipp et al., 2002). Moreover, heavy rainfall, including monsoonal rain, hurricanes, and severe flooding, often overwhelms and damages the old sanitation systems, which causes the massive Contamination of municipal drinking water sources and widespread distribution of the pathogen among people in a short period of time. This established association between variability of climatic conditions and frequent cholera outbreaks has been reviewed systematically, proving the critical and dose-response nature of climate in changing disease occurrence and prevalence among various continents (Christaki et al., 2020).

The key climatic mechanism that increases the transmission risk in Dengue, an arbovirus that is predominantly spread by the highly adaptable Aedes aegypti and, to a minor degree, Aedes albopictus mosquitoes, is increasing ambient temperatures (Yadav & Upadhyay, 2023). Exceptionally high temperatures not only significantly reduce the extrinsic incubation period of the virus in the mosquito (the time taken before the virus becomes infectious), but also boost the reproductive cycle of the mosquito and its frequency of blood feeding (biting), hence exponentially increasing the overall mosquito vectorial capacity. Alterations in the water cycles are also of paramount importance: during dry periods, the population may be forced to conserve water, which will unwillingly provide a large number of breeding places, and at times of sudden, excessive rainfall, the pools may fill out or be formed in due course, providing ideal breeding places. The reported and the foreseen geographical spread of the competent Aedes transmission agent, usually to previously moderate areas, is a direct and instrumental consequence of global warming, which essentially gives the seasonal window and the geographical range of potential spread, and aids the reported increasing global prevalence of the disease.

Modeling and Metrics

In order to overcome mere qualitative risk assessment and make genuine policy impact, the discipline needs to be equipped with robust information-driven systems of quantifying the existing and forecasting the future burden of these climate-sensitive infectious diseases. This paper recommends the application of an integrated assessment framework that systematically integrates the products of climate modeling, remote sensing, environmental science, and classical epidemiological information to come up with probabilistic forecasts of the health effects of different future climatic conditions (Chan et al., 1999). Comprehensive burden assessment has its core metrics generally going beyond simple incidence rates to include morbidity rates, mortality rates, and, most importantly, the Disability-Adjusted Life Years (DALYs) that give a single and holistic measure of the years of life lost to premature death and years of life lived with the functional disability that is the disease.

To model the future cost and allocation of Dengue, advanced spatial epidemiology and mathematical models are regularly used, and commonly, annual variations in surface temperatures, land cover information, and precipitation indices are associated with documented disease incidence in various ecological domains. These models play a significant role in forecasting the future changes in the geographical range, the length of the transmission season, and the total capacity of the vectors, all of which are essential elements to come up with adequate early warning and response mechanisms. Predictive models in Cholera are often a combination of intricate data on sea surface temperature, chlorophyll concentration (as a proxy of plankton, a natural habitat of Vibrio), and critical hydrological factors of river flow and extreme Weather to predict the possible outbreaks. The modern implementation of sophisticated technologies, including weather-sensitive Internet of Things (IoT) systems and highly advanced Artificial Intelligence (AI)-based disease prediction systems, is becoming a vital, ground-breaking tool that would enhance the accuracy and the lead time of such health predictions, particularly in the context of managing the health status of aquatic ecosystems and terrestrial animals susceptible to the same weather-associated hazards (Rahim, 2024).

Results and Discussion

The summary of our synthesis of the contemporary epidemiological research across various regions shows a definite and statistically significant trend of increasing the absolute and relative burden of both Cholera and Dengue, with outbreaks strongly correlated with multiple indicators of changes in climate, hence confirming the prescient warnings of the emergence of infectious diseases decades ago. As suggested by the experts in the field of public health, a comparative risk assessment approach reveals that climate-related exposure to such factors as extreme heat, disturbed water supply, and extreme Weather also plays a substantial and growing proportion in the total global burden of diseases, usually exacerbating underlying socio-economic risks. It is interesting to note that the spread of Dengue can be traced through the dramatic poleward and altitudinal migration of the Aedes vector, so that previously untouched areas have become endemic, and risks of Cholera are highly concentrated and dramatically high in flood-susceptible and densely populated areas along the coast and deltas in Africa as well as Asia (Kaseya et al., 2024; Nurhayati, 2025).

Table 1: Comparative Climate Sensitivity of Waterborne and Vector-borne Diseases

Disease	**Primary Climate Driver(s)**	**Key Impact Pathway on Disease**
Cholera	Sea Surface Temperature, Heavy Rainfall	Water Contamination: Increased Vibrio aquatic life and dissemination through compromised sanitation
Dengue	Air Temperature, Rainfall Variability	Vectorial Capacity: Accelerated vector lifecycle, reduced extrinsic incubation period, expanded geographic range.

Table 1 elaborates on the unique ways in which climate change contributes to the increasing burden of Cholera and Dengue, which act as models of waterborne and vector-borne infections, respectively. In the case of Cholera, Sea Surface Temperature (SST) and Heavy Rainfall are the main agents of the soaring survival and growth of the Vibrio bacteria in water bodies, and consequently cause a surge in water pollution in the event that the sanitation systems are overstretched (Asadgol et al., 2020). Conversely, Air Temperature and Rainfall Variability are the main risk factors of Dengue because they significantly enhance the Vectorial Capacity of the Aedes mosquito by stimulating its life cycle and the rate of virus replication (time spent in the extrinsic stage is minimized) (Mendoza-Cano et al., 2023). These particular climate-disease associations are essential to understand in order to create a shift in climate-sensitive methods of preventing health at the population level.

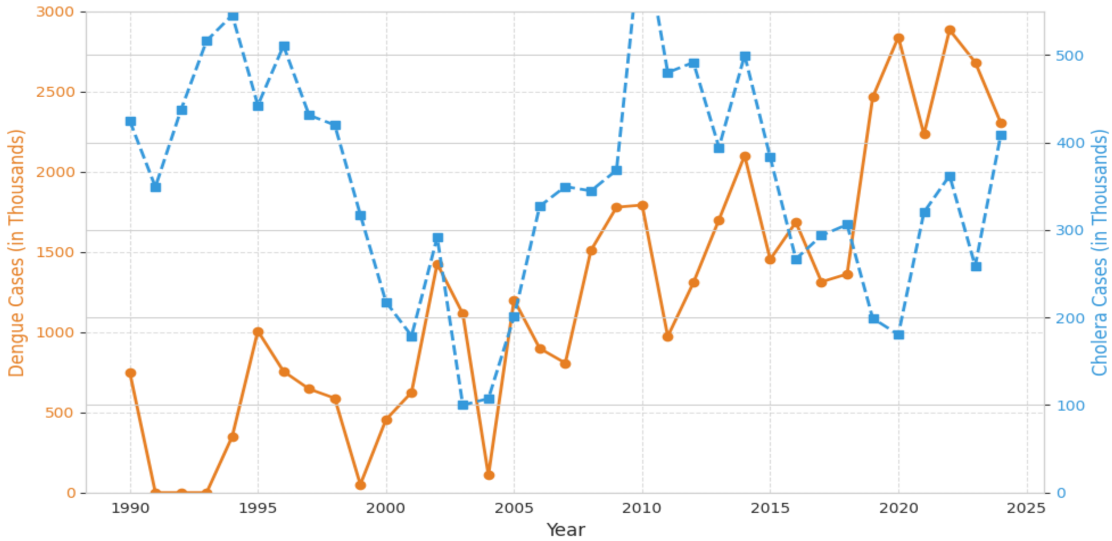

Figure 2: Global Trend in Estimated Cases for Dengue and Cholera (1990–2024)

The trend of cases of two climate-sensitive diseases between 1990 and 2024, estimated on a global scale, is graphically described in Figure 2. Dengue Cases are plotted in the orange line, with an evident, exponential growth since the late 90s, which implies its fast worldwide spread and growing load as a result of a rapidly increasing ecology of vectors (George et al., 2024). The blue line is the Cholera Cases, which has a high, consistent volatility, with high annual variations, but tends to be high due to extreme weather conditions, which diminish water safety and sanitation systems. Although the trends between Dengue, with a rapidly growing trend, and Cholera, with an acutely fluctuating pattern, confirm that climate change is accelerating the threat of infectious diseases on the planet, requiring immediate action on the part of the populations, the pattern varies.

Risks and Socio-Economic Disparity Cascading

The increased, climate-induced disease burden of these infectious diseases provokes significant cascading threats in various sectors of society, such as the public health infrastructure, the economic stability in the region, and long-term food and water security (Semenza et al., 2022). This is specifically challenging and difficult in resource-limited environments like most of the countries in Africa and Southeast Asia, where climate events commonly cause simultaneous epidemics of various types of diseases, including malaria, Dengue, and Cholera, that in turn flood the already weak and under-resourced healthcare systems. These macro environmental changes have long-term consequences that require a proactive and intensive attention to both primary prevention and strategic adaptation of global health, since the cost of not taking action in global health is far greater than the cost of early and extensive action (Bloom & Cadarette, 2019). Moreover, it is essential to assume that climate change is not only a local problem but an extensive global challenge to the health of the environment, which promotes the active spread of infectious agents, and, therefore, requires a multinational, multilateral, and scientifically-grounded cooperation action on the level of international interaction.

Mitigation Strategies

This requires a strong and interrelated dual approach, including aggressive global climate mitigation and resilient adaptation of the health of the populace, to effectively address the increasing and climate-related burden of infectious diseases (St. Louis & Hess, 2008). Climate Mitigation is the direct, combined, international action to reduce the volume of greenhouse gas emissions significantly, and consequently has a direct impact in lessening the long-term, structural causes of disease growth and severity. Public Health Adaptation, in its turn, encompasses the setting up of specific, climate-sensitive approaches to be able to prepare to react to the consequences that are already inevitable.

The first adaptation approach is the institution of highly efficient climate-informed early warning systems, which are fully operational and capable of using real-time meteorological prediction (temperature, rainfall, sea surface temperature) and integrating it with local epidemiological surveillance data. This ensures that the health agencies preemptively and strategically deploy resources, e., emergency water purification supplies and sanitation kits, in the event of impending cholera outbreaks and predicted mass community-based vector control events in case of favourable climatic conditions, as predicted. Locally, initiatives should be laser-targeted on strengthening water, sanitation, and hygiene (WASH) infrastructure to successfully interrupt the cycle of waterborne dissemination, as well as on the establishment of sustainable and community-based vector control interventions based on the respective local Aedes ecology of Dengue (Patz & Olson, 2006). Noteworthy, due to the magnitude and severity of the infectious disease threat in the twenty first century, the world has been in dire need to enhance the overall response with better and more equitable access to vaccines, increased cross-border surveillance systems, and long-term international research cooperation to achieve collective resilience. Ethical and social aspects of interactions between humans and animals also require a One health approach, which is the combination of human health, animal health (livestock), and environmental management (Rahim, 2024).

Conclusion and Future Directions

The evidence aggregated throughout this paper is that climate change is an overwhelming, continuous, and accelerating factor in the growing burden of infectious diseases around the globe, with Cholera and Dengue being strong examples of a compelling case. The witnessed, climate-conditioned variations in ambient temperature, extreme weather conditions, and hydrological cycles provide optimum, extended environmental conditions to allow the survival of pathogens and the growth of vectors, which is bound to cause and result in the increase in the range of diseases and the threatening exaggeration of outbreaks all around the world. The growing environmental health threat is a significant threat to health equity in the world since the burden is disproportionately and severely concentrated on people with the lowest resources and the weakest public health systems. The research of the future, therefore, needs to focus on the evolution and broad implementation of the state-of-the-art technologies, especially in the fields of Artificial Intelligence and sophisticated epidemiological models, to allow more precise, highly localized, and actionable disease forecasting and eventually shift to an indeed predictive model of public health. Finally, the best way to respond to the increasing number of such climate-sensitive infections is an immediate, integrated, and sustained intervention that thoughtfully merges strong global climate change mitigation policies with multi-sectoral, long-term, and holistic approaches to the comprehensive adaptive requirements of the broadly spread human health sector to the increasing and threatening onslaughts of the changing global environment. These results highlight the importance of animal and environmental health to support studies on the interspecific and ecological forces on climate-sensitive infectious diseases. Finally, this has to involve popularizing a genuinely healthy approach because planetary health and ecosystem stability are the basic conditions of animal well-being and health security.

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