Geographic Trends in Dengue Fever: Projections for Mass Illness in the Face of Climate Change

I. Introduction

Dengue fever, an increasingly common mosquito-borne viral infection, poses a significant public health threat globally—particularly in regions that are unaccustomed to dealing with tropical maladies. The disease is characterized by high fever, severe headaches, joint and muscle pain, which is why it is often called break-bone fever.

Understanding the future geographical distribution of dengue fever is critical, as it is growing alarmingly in frequency, correlating closely with the increasing humid-heat levels driven by climate change. The expansion of dengue presents a dual challenge: not only must healthcare systems contend with rising case numbers in traditional hot zones, but they must also prepare for potential epidemics in new, previously unaffected regions.

Effective public health planning and response strategies hinge on accurately predicting future dengue hotspots. This becomes ever more vital as warmer temperatures create favorable conditions for the subspecies of mosquitoes which transmit the virus.

II. Objective

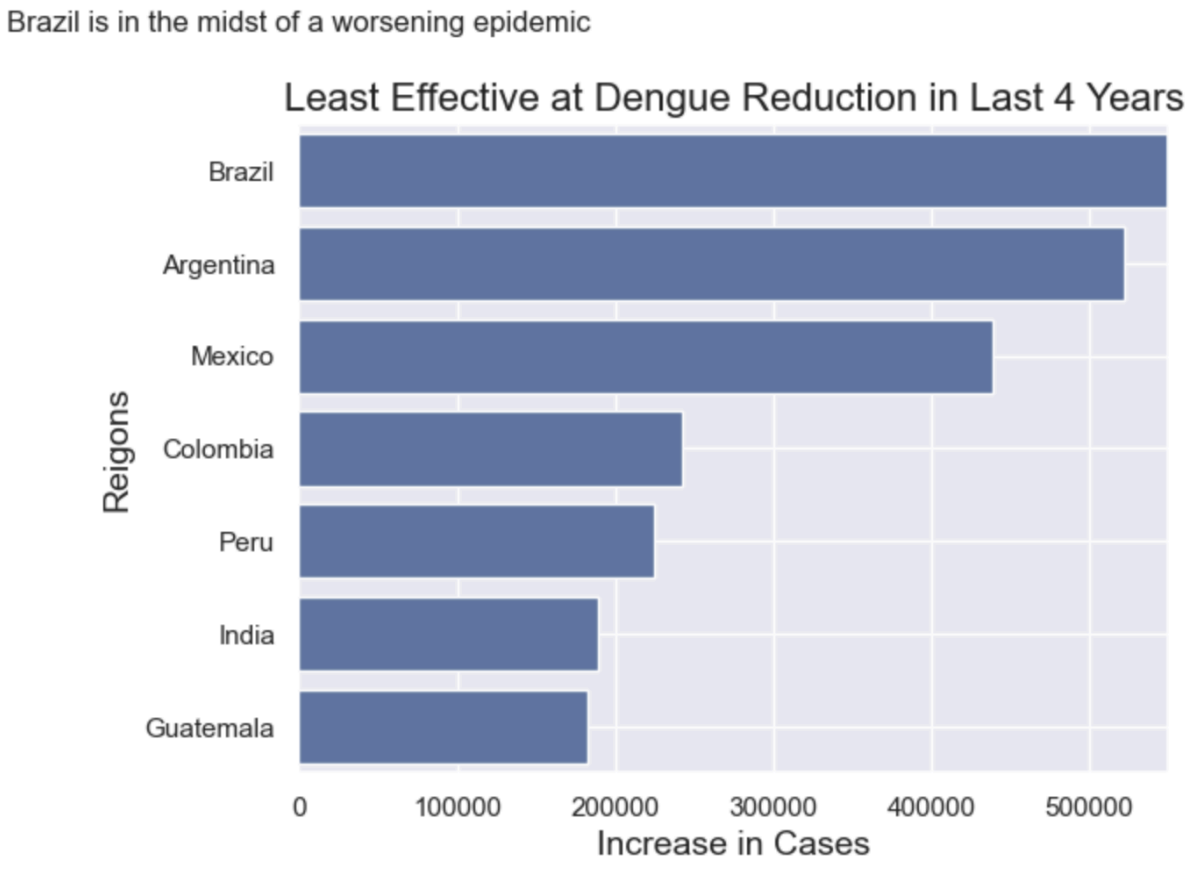
The main objective of this research is to clarify the current and future challenges posed by dengue fever across the globe. Specifically, to identify which countries are presently facing the most significant dengue burdens and to project where dengue fever is likely to become even more prevalent in the coming years. As countries become aware of their risk levels, they can implement targeted interventions, and allocate more resources to scaling up existing medical solutions such as the two vaccines already available to the public.

While the primary driving factor behind dengue's expansive geographical reach is climate change—meaning that individuals have little control in the grand scheme of things—this research still aims to better illustrate the degree of risk in various geographical locations so that individuals and communities can take the most appropriate course of action available to them, no matter what their situation.

In light of the fact that there is an ongoing dengue epidemic in Brazil, and another in Yemen only a few years prior, the time to act is now.

III. Key Findings

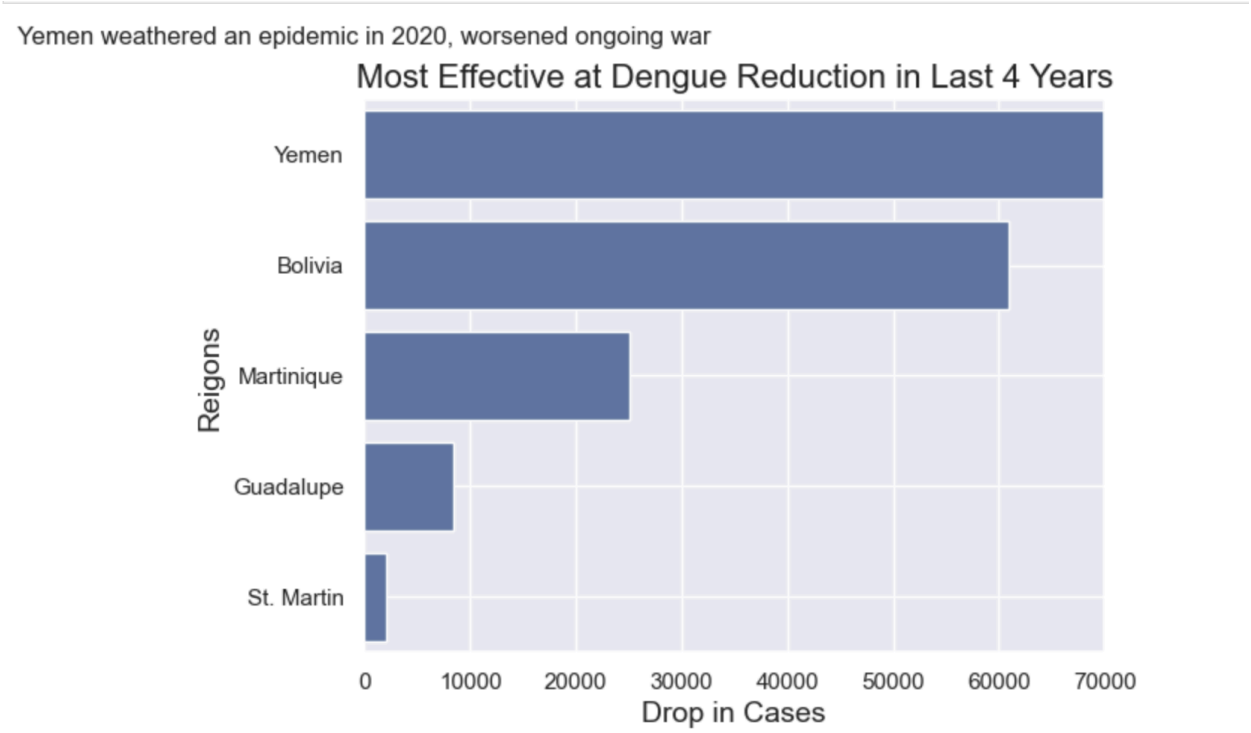
Brazil is currently experiencing the worst dengue levels on record, with over *10 million* cases reported in 2024[1]. This staggering figure underscores the acute public health crisis facing the nation and highlights the urgent need for effective control measures. Other countries grappling with notable increases in dengue incidence since 2020 include Argentina and Mexico. This points to a broader regional vulnerability. While dengue has always been rife in the tropics, the machine-produced clustering of dengue outbreaks shows an alarming jump in rates of illness today compared to previous years.



South America is struggling in general, but dengue is still a considerable problem in India

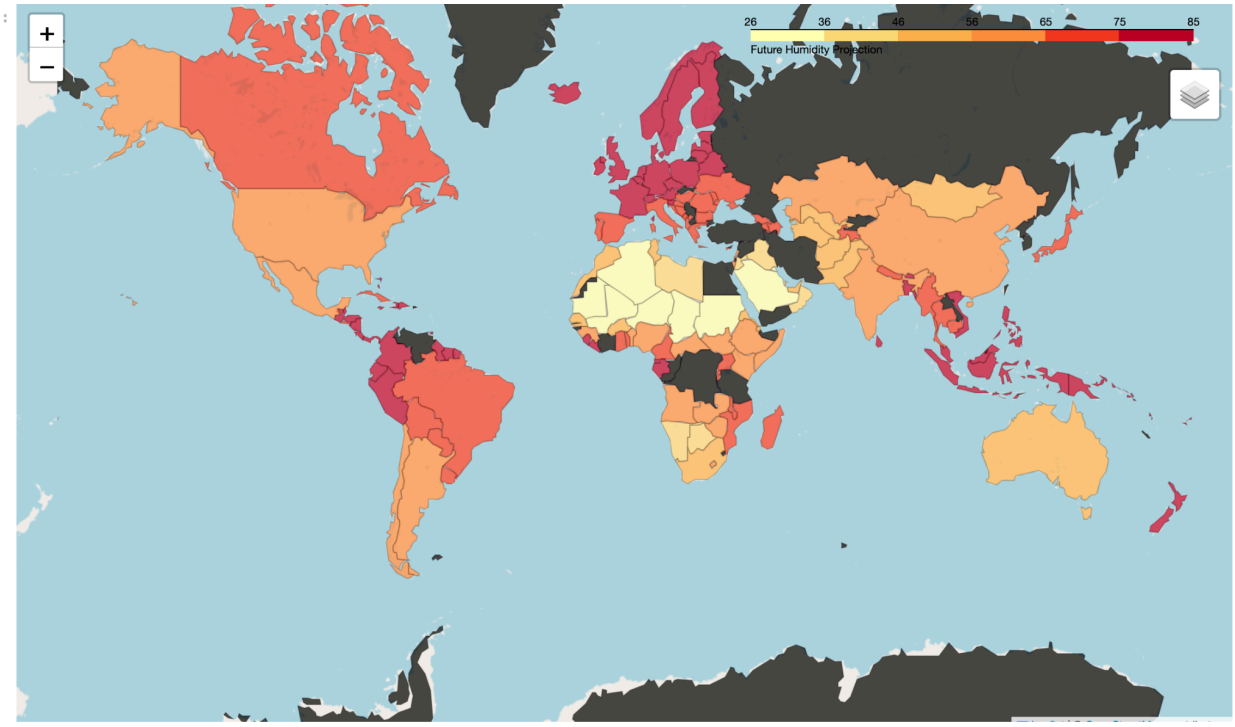
[1] According to the *World Health Organization*

On a more hopeful note, regions such as Bolivia and Martinique have shown promising signs of declining dengue prevalence, demonstrating that concerted public health efforts can yield significant results. Notably, access to dengue data is limited; currently, not all regions openly share comprehensive statistics, which hampers effective decision-making. Currently, Australia remains the only continent providing full public dengue statistics.



Bolivia is doing great, by South American standards

Using historical data, a regression-based projection shows that dengue cases are expected to surge across most regions by 2026, further exacerbating public health challenges. Climate projections from the World Bank indicate that from 2035 to 2039, the majority of countries will fall into humidity ranges that are ideal for the proliferation of Aedes mosquitoes, the primary vectors of dengue.



This is the true range of dengue when accounting for future temperature. More red implies higher risk.

To enhance accessibility to this critical information, two classification algorithms were developed to indicate whether specific regions are currently at *high* or *low* risk for dengue without the need for maps or extensive data interpretation.This multifaceted approach not only highlights the current state of dengue prevalence but also sets the stage for effective public health interventions based on clearly articulated data and trends.

IV. Methodology Overview

To estimate the number of dengue cases per region, a supervised machine learning algorithm was developed, capable of analyzing vast amounts of data—approximately 75 years worth from 100 regions worldwide, courtesy of the OpenDengue Project[2]. This approach allowed for the consideration of both the scale of the dataset and its inherently unbalanced nature. The model employed statistical weights to compensate for the fact that some areas reported a staggering number of cases, while others reported close to zero.

[2] (www.opendengue.org)

Further analysis included a detailed examination of geographical trends, illustrated through a series of helpful charts and maps, many of which have been included in this report. To further simplify understanding of current dengue risks, a second algorithm was developed, classifying countries based on their existing risk levels for dengue. This classification offers a quick way to gauge risk without wading through extensive data.

	Year	Country	Actual_Class	Predicted_Class
192	2024	SLV	Low	Low
307	2024	IND	High	High
358	2024	PER	High	High
435	2024	ATG	Low	Low
534	2024	TTO	Low	Low

V. Societal Impact

The findings in this report are, more than anything, a warning. The vast majority of communities across the globe will need to increase their dengue-preparedness, especially in non-tropical countries that may not currently have the infrastructure to respond to such outbreaks. The looming threat posed by dengue as it pushes into new geographical territory contradicts the common belief that tropical illnesses remain confined to warmer climates in the Global South.

Moreover, tackling dengue fever necessitates global cooperation. Knowledge sharing and collaborative research initiatives can lead to better collective outcomes. It is crucial that more countries and regions start adding their data to OpenDengue. It is equally important to destigmatize disease-reporting and fund public health research. Any model is only as good as the data provided to it and the people who have set aside the time to build it. The same is true for any other tool, from medicine to climatology.

VI. Call to Action

While individuals face understandable limitations in combating the broader issue of climate change, there are still actions that can still be taken on an individual level to reduce the impact of dengue fever.

Vaccination stands out as the most effective means of prevention, particularly for vulnerable populations such as children, the elderly, and the immunocompromised. There are currently two vaccines available for public use, and they are available in many countries including the United States. Readers are encouraged to use the model to assess their local and travel risk factors and take appropriate action as tolerated. The World Health Organization has also released guidelines on their website for how to reduce personal exposure to mosquitoes. Relocation also remains an option—though it is less viable in the long term given the global nature of climatic shifts.

On a societal level, as discussed above, the only way forward is a mass public-health response and improved international communication around dengue tracking efforts.

VII. Conclusion

Numerous models suggest a dangerous geographic expansion, and uptick in cases of dengue fever. This emphasizes the need for preparedness on an international level, even in non-tropical areas. Understanding which countries will be the most impacted through a combination of statistical models and data analysis offers an opportunity to mitigate the problem.

While there is no individual solution to climate change, which remains a big factor, there is still hope. By adopting a proactive stance, equipping healthcare systems with adequate resources and data, and de-stigmatizing illness reporting and vaccination efforts, we can collectively work toward limiting dengue. .