Journal of Advances in Science and Technology
Vol. 21, Issue No. 1, March-2024, ISSN 2230-9659

DOI: https://doi.org/10.29070/b1qkbt86

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Assessing the impact of climate change on Vector-Borne Diseases: Strategies for Prevention and Control

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Abstract: Climate change is occurring on a worldwide scale. Human wellbeing, beach front networks, food creation, water supplies, and air quality are as of now being influenced by this change. Over 17% of all infectious sicknesses are vector-borne. There is growing information regarding how vector-borne diseases are impacted by climate change. In request to address the ramifications of climate change on VBDs in India through this paper, we assembled optional information in September 2022 from books, studies, diaries, and distributed articles on this significant subject. This exposition will give a speedy outline of how the main vector-borne diseases in India are evolving epidemiologically.

Keywords: change in climate, vector borne disease, Carbon Emissions, CO2 Concentrations, Temperature changes, Precipitation changes and Vectors

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INTRODUCTION

Any change in the climate after some time, whether welcomed on by human activity or regular fluctuation, is alluded to as climate change.1. It requires hundreds or maybe a long period of time for climate to change. There are two potential wellsprings of climate change: regular and human, though all through the past couple of many years, human elements appear to have offered more to the peculiarity. A characteristic nursery impact is created by normally occurring ozone harming substances (GHGs), which likewise include water fume, carbon dioxide, ozone, methane, chlorofluorocarbon (CFC), and nitrous oxide. A worldwide temperature alteration is being brought about by human movement increasing how much ozone depleting substances in the atmosphere.2. Following 420,000 years of stable levels somewhere in the range of 180 and 220 sections for every million, air carbon dioxide is at present nearing 370 sections for each million and still rising.3. The World's surface has warmed more over every one of the most recent thirty years than it has during some other ten years since 1850. The Intergovernmental Board on Climate Change (IPCC) 2013 reports that, somewhere in the range of 1880 and 2012, there was a typical a dangerous atmospheric devation of 0.85 [0.65 to 1.06] °C in view of the combined land and sea surface temperature information, as determined by a linear trend. Rising ocean levels, modified rainfall designs, higher temperatures, vanishing, and salinization of water supplies are totally anticipated impacts of climate change.

There are many different areas of human activity where the effects of climate change are felt. Because of this, climate change is becoming an unquestionably serious worldwide issue that cuts beyond national boundaries. The effects of climate change on the environment, including rising sea levels, extreme weather, and ecological disruptions, are widely known; nevertheless, the impact on public health is particularly concerning. The planet's temperature will continue to rise as a result of humans emitting an excessive amount of greenhouse gases into the atmosphere, which will highlight the complex relationship between climate and health. As long as temperatures rise, sea levels rise, and weather patterns continue to grow more unpredictable, this will unavoidably have an impact on public health.

Impact of climate change on vector borne diseases

Health is largely determined by the climate. It has been shown that the host, the infection, and the vector that carries the disease make up the majority of the epidemiological triangle for diseases carried by vectors. Vector-borne infections are caused by a multitude of reasons. Most infectious vector-borne diseases are spread by arthropods, which are especially sensitive to climate change for a variety of reasons. For example, the pathogens must finish a stage of their development in a specific species of insect vector before they can spread, and because insects are poikilothermic organisms, the pathogen's development is directly impacted by the weather outside. Additionally, as temperature rises, vector bite rates will rise until a certain point, at which point they will fall. Moreover, warmer temperatures hasten the extrinsic incubation period, or EIP, which is the length of time during which infections develop and replicate within the vector. The growth, survival, and vectorial capacity of vectors all steadily peak at comparatively higher temperatures. The scientific evidence supporting climate change and related projections for India.

Vector-borne diseases (vbds) in India

Certain newly discovered diseases are resurfacing and spreading to formerly uninfected areas as a result of the slow changes in the climate. We'll talk about a few popular VBDs in India below:

Malaria: In India, malaria remains a serious health problem. The dynamics of malaria transmission are directly impacted by environmental factors. India is the primary home of six important malaria vector species: Anopheles culicifacies, Anopheles stephensi, Anopheles fluviatilis, Anopheles sundaicus, Anopheles minimus, and Anopheles infection. Mosquitoes and temperature interact in certain ways. Elevated temperatures accelerate the rate of blood meal digestion, which in turn speeds up ovarian development, egg laying, the decrease of the gonotropic cycle, and increased frequency of feeding on hosts, all of which increase the likelihood of transmission.

Dengue: The transmission of dengue is also significantly influenced by variations in the weather. Another significant vector-borne illness that affects people worldwide is dengue. In India, the number of dengue cases has been steadily rising over the last ten years. The primary vectors of dengue in India are Aedes aegypti and Aedes albopictus, and the virus is caused by DENV serotypes 1-4. Dengue's the study of disease transmission was first reported in Quite a while in Madras (presently Chennai) in 1780, and the country's most memorable flare-up occurred in Calcutta (presently Kolkata) in 1963. Dengue scourges have increased in recurrence and spread during the 1990s.

Chikungunya: The virus that causes chikungunya is mostly spread by the mosquitoes Aedes aegyptian and Aedes albopictus. Chikungunya has spread around the world due to a variety of factors14,16. India had its first reports of chikungunya in 1963 from Calcutta (now Kolkata), and the disease was still spreading there in 19734,15. Since its reappearance in 2005, the infection has spread to the greater part of India's southern states, and since 2006, there have been far reaching episodes of Chikungunya in different areas of the country. Delhi encountered an episode in 2016. It is probable that the disease will also move to more recent locations due to the rising warmth.

LITERATURE REVIEW

Pinto et al. (2011) utilized the Poisson relapse model (PRM) to ascertain the effect of climatic factors on dengue cases in the city of Singapore. The general gamble and ascend in the probability of an occasion were then determined using the evaluations. Principal part examination (PCA) was utilized to choose the elements influencing the ascent in dengue cases. For the years 2000-2007, week by week dengue cases were used as the reliant variable, and meteorological factors like minimum and greatest temperatures, rainfall, and relative moistness (RH) were utilized as the independent factors. Results from the PRM showed that there was a typical increase in dengue instances of 22.2 - 184.6 percent for each 2-10°C vacillation in the greatest and minimum temperature**.** In instances where the minimum temperature varied similarly, the average rise in dengue cases was 26.1-230.3 percent. The maximum temperature variation had an increased relative risk of occurrence of 1.2-2.8, whereas the minimum temperature variation had an increased relative risk of occurrence of 1.3-3.3. July saw an increase in the monthly chance of occurrence (85–95 percent) and September saw an increase (84–94 percent). The first principal component (PC1), which includes temperature, alone explained 45.4 percent of the variance, which further supported the PCA results that temperature is the strongest predictor of dengue cases in Singapore.

Depradine and Lowell (2004) found a relationship between dengue cases and climate variables in 11 parishes on the Caribbean Island of Barbados. The analysis employed weekly averages of the following variables: wind speed, vapour pressure, minimum and maximum temperatures, rainfall, and timeframe from 1995 to 2000. Because the lagged cross-correlation method accounts for the time lapse component that happens in biometeorological events, it was used to determine the statistical connection. Fume pressure was the main indicator utilized in the various relapse examination, linear model, and polynomial model that were utilized to make the prescient 21 model. The most noteworthy link between dengue cases and the minimum temperature, greatest temperature, normal temperature, and relative dampness was tracked down using cross-connection. The minimum temperature and maximum temperature had the longest lags, at 12 weeks, 16 weeks, and 4 weeks, respectively. Since high water vapor increases mosquito activity, vapour pressure, which measures the actual water vapor content of the atmosphere, demonstrated the highest correlation with a 6-week lag. In stark contrast to previous research, a seven-week lag in rainfall was found to have very little association. Merely 35% of the variance could be explained by the prediction model, indicating a stronger influence from biological and non-meteorological factors in forecasting the actual number of dengue cases.

One of the most significant and valuable natural resources in the world, forests are essential to the ecological balance of the entire planet. The primary determinants of vegetation distribution are temperature and rainfall, both of which are impacted by climate. The vulnerability of natural ecosystems to climate change is becoming more widely acknowledged. This could lead to changes in productivity, biodiversity, and distribution patterns, among other things. Through physical, chemical, and biological processes that impact atmospheric composition, the hydrologic cycle, and planetary energy, forests have an impact on climate (Bonan, 2008; Cook et al., 2012). Studies on the relationship between forests and climate change are therefore receiving increased attention. Deforestation and degradation are responsible for 20% of global greenhouse gas emissions, according to IPCC estimates from 2007. However, research has also shown that forests have the ability to slow down the rate of present global warming by storing CO2 in the atmosphere. Furthermore, trees play a critical role in both mitigating and adapting to climate change, having absorbed 30% (2 petagrams of carbon annually) of the world's human CO2 emissions. (Bellassen & Luyssaert, 2014).

RESEARCH METHODOLOGY

September 2022 saw the collection of secondary data from books, studies, journals, and articles that have been published on this important topic. In order to determine whether climate change is having an impact on VBDs in India, this article will use and examine the relevant data.

We offer a thorough framework in this study approach for evaluating how climate change affects vector-borne illnesses. The goal of the research is to comprehend the intricate interaction that exists between climate variables and the dynamics of diseases carried by vectors like ticks and mosquitoes. Data from a variety of sources, including socioeconomic statistics, temperature data, epidemiological records, and vector habitat data, will be gathered for this study. Our goal is to find patterns, trends, and possible future scenarios through thorough data analysis, including correlation studies, time series analysis, spatial mapping, and predictive modeling, which can help guide public health policies and policy decisions. In addition, the research will incorporate ethical considerations and community engagement to guarantee its safety, ethical conduct, and relevance.

Human health is affected by climate change. There are three basic ways that climate change impacts human health:

- Direct impacts because of an increase in the recurrence of outrageous climate occasions, for example, heat waves, dry spells, and heavy deluges

- Impacts that are intensely intervened by human frameworks, like the impacts of food and water deficiencies, the psychosocial consequences for uprooted populaces, and the wellbeing impacts of contentions over admittance to fundamental assets.

- Impacts intervened through regular frameworks, like six: air contamination related wellbeing impacts, water and food-borne diseases, and vector-borne diseases.

Figure 1: The Impact of Climate Change on Human Life

Interpretation: Over the past three decades, there has been a rise in heat waves, draughts, and floods. Between 1980 and 1998, 18 heat waves were recorded in India. Heat waves in Andhra Pradesh in 2003 resulted in over 3000 deaths, while heat waves in Odisha in 1998, 1999, and 2000 are reported to have caused 2000, 91, and 29 deaths, respectively. Since 2013, there has been an increase of draughts in Maharashtra. Bihar experiences floods every year, but the 2004 floods were exceptional due to their ferocity. Coastal flooding is becoming more common; one such instance occurred in Mumbai in July 2005, which claimed about 600 lives. In 2012, Delhi saw its worst summer in thirty-three years. Figure 1.

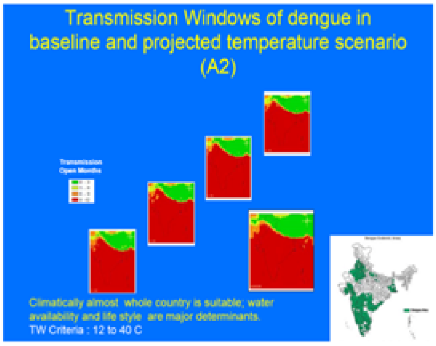

Figure 2 India's Dengue Transmission Windows (Scenario A2)

Interpretation One more significant issue has been dengue, with north of 50 episodes archived in India since 1960. Twenty The effect of climate change on dengue additionally shows that transmission increases by 2°C in northern India. It is important to reconsider the temperature and relative mugginess rules for dengue transmission within a community.21 The whole nation is suitable climatically; the main drivers are water accessibility and way of life. Transmission windows for dengue transmission (12-40°C temperature) were estimated in a review using the A2 situation of the Summary model. Graph - 2.

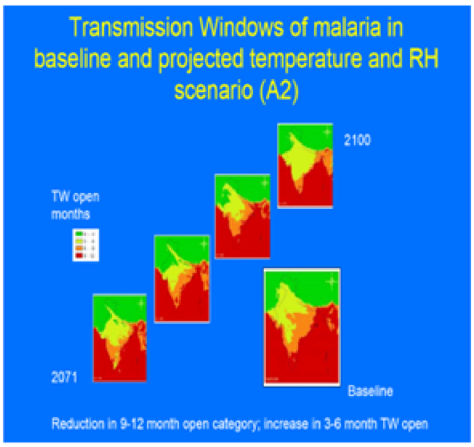

Figure 3: Malaria Transmission Windows (Scenario A2) in India

Interpretation: Using the A2 and A1B situations of the Providing Local Climate for Effect Study (Summary) model, examination of baseline and estimate climate boundaries for dengue and jungle fever was led at the public level. Research on jungle fever using the A2 situation led in India shows that the transmission window for the disease might shrink in Odisha, Andhra Pradesh, and Tamil Nadu, while it is probably going to expand transiently by 2-3 months in northeastern states, Punjab, Haryana, and Jammu and Kashmir. Accordingly, the Transmission Window (TW) open will develop to 3-6 months and the 9-year open class will diminish. Figure Three.

Table 1. Climate change in India and the emergence of Dengue and Chikungunya as vector-borne diseases

Disease	Year	Case	Death
Malaria	2008	10 million	1024
	2015	1005036	336
	2018	500015	50
Kala azar	2006	300972	100
	2015	5996	nil
	2018	2469	nil
Japanese Encephalitis	2008	5497	650
	2019	1556	270
	2016	2168	110
Dengue	2008	30098	115
	2013	13500	250
	2022	33974	55
Chikungunya	2003	45685	Nil
	2005	51498	Nil
	2015	21654	Nil
Filariasis	2010	564million (total burden)	Nil

Interpretation: An overview of the prevalence of multiple vector-borne illnesses throughout a range of years, including the number of cases and fatalities reported, is given in the table. Malaria had 10 million illnesses and 1,024 deaths in 2008; by 2018, that number had drastically dropped to 500,015 cases and 50 deaths. Comparably, the number of cases of Kala Azar dropped from 300,972 in 2006 to 2,469 in 2018, with no deaths recorded in the latter year. Dengue incidence grew from 30,098 in 2008 to 33,974 in 2017, with a decrease in mortality. Japanese encephalitis cases varied, with 5,497 in 2008, 1,556 in 2019, and 2,168 in 2016. Over time, the number of cases of Chikungunya fluctuated, but no deaths were documented. In 2010, there were 564 million cases of filariasis worldwide, but no deaths were reported. The data shows that the prevalence and mortality of diseases have changed over time, indicating that these diseases are dynamic and that continuous monitoring and intervention techniques are crucial.

CONCLUSION

The variable rainfall distribution areas (VBDs) of India have been affected in either way by the changing climate. There has been an increase in the number of cases of Dengue and Chikungunya, although the burden of Malaria has showed a minor decline for the time being. The Transmission Window for Dengue has widened as a result of risk factors regarding the availability of water, storage techniques, and lifestyle choices, which has made the entire country vulnerable during the entirety of the year. Likewise, it is necessary to decide. In accordance with the findings of the INCCA research, a particular emphasis should be placed on the four different vulnerable sectors. The early warning system for the prevention of epidemics is a necessity that must be met as part of the adaption measures. The overall population should be made mindful of the human exercises that are contributing to rising concentrations of ozone depleting substances in the climate, which in turn are driving an Earth-wide temperature boost. All in all, as well as implementing integrated vector control measures for the motivation behind combating the issue of vector-borne diseases, it is totally important to give the greatest possible level of need to addressing issues associated with climate change.

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