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Climate Change and Human Health in Assam: Assessing the Impact of Environmental Change on Disease Patterns and Physiological Responses

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Abstract:
Assam is one of India's most climate-vulnerable states, where warming temperatures, erratic rainfall, recurrent floods and extreme weather events increasingly shape human health outcomes. This paper assesses how environmental change affected disease patterns and physiological responses in Assam from 2002 to 2022, focusing on vector-borne diseases, flood-related waterborne illness, air-pollution-linked respiratory burden, heat stress and vulnerability among high-risk populations. The study uses a narrative review of state climate-health planning documents, vulnerability profiles, and published literature on mosquito-borne diseases in Assam. Findings show that climate variability intensified ecological suitability for malaria, dengue, Japanese encephalitis and acute encephalitis syndrome, while floods and heat events worsened sanitation, nutrition, occupational health and service continuity. The paper concludes that Assam needs district-specific climate-resilient health planning, stronger surveillance and early warning, and integrated WASH, vector-control and adaptation measures. This paper is based on a narrative review and secondary analysis of public-health and climate-policy sources. The principal source is Assam's State Action Plan on Climate Change and Human Health, which provides climate trends, vulnerability rankings, district-level flood impacts, and disease tables for malaria, dengue, chikungunya, AES and JE. Supplementary evidence was drawn from published literature on mosquito-borne diseases in Assam and outbreak reporting on Japanese encephalitis. Moreover, secondary data has been obtained from various published and unpublished sources like relevant literature, newspapers, journals, related websites, social media and others.

Keywords: Assam, climate change, human health, disease ecology, vulnerability, adaptation, vector-borne diseases, WASH.

Introduction:
It is fact that Climate change vulnerabilities of developing and underdeveloped countries are increasing day by day. It is no longer something to happen in future but rather an ongoing phenomenon. The International Union for Conservation of Nature (IUCN) has observed in 2011 that it is now unequivocally established that climate change is reality, and the adversities of climate transformations pose of the greatest challenges facing humanity today. In the same way the Inter- Governmental Panel on Climate Change (IPCC) defines climate change as "a change in the state of the climate that can be

identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer". The climate change issue has severe impact upon all aspects of human life. It can be studied from various angles under the purview of diversified disciplines. Medical geography provides a useful lens for understanding the relationship between climate change and human health in Assam because it examines how disease, health behaviour, and health outcomes are distributed across space and shaped by environment, place and social organization. In this perspective, illness is not only a biological event but also a spatial process, influenced by ecological setting, population mobility, land use, settlement pattern, infrastructure and access to care. Assam is particularly suitable for such an approach because it is a state where floodplain geography, humid climate, agricultural dependence and uneven development create sharply differentiated health risks across districts and communities.

From a medical-geographical point of view, Assam represents a classic case of place-based vulnerability. The state's repeated exposure to floods, erosion, and water logging as well as seasonal temperature stress alters the distribution of vectors, pathogens and human exposure pathways. At the same time, the geography of poverty, poor road connectivity, low irrigation coverage, sanitation deficits and limited adaptive capacity reinforces those environmental risks. The result is a spatially uneven disease landscape in which some districts repeatedly experience higher burdens of malaria, dengue, Japanese encephalitis, diarrheal disease and other climate-sensitive conditions than others.

The state's climate-health profile supports this interpretation. The Assam climate-health action plan identifies rising temperature, extreme rainfall, floods, and vector-borne disease as major public-health concerns, while the district vulnerability assessment shows that some districts such as Dhubri, Darrang, Karimganj, Kokrajhar,Goalpara, Hailakandi, Morigaon and Tinsukia are consistently more exposed and less resilient than others. These differences are not random; they reflect the spatial distribution of social and biophysical vulnerability. In medical geography, this kind of analysis helps explain why the same climate hazard can produce very different health outcomes in different places.

Assam is also important because its disease geography has changed over time. Earlier studies showed that malaria and Japanese encephalitis were the dominant mosquito-borne diseases, with malaria concentrated in forest-fringe, tribal and remote rural areas and dengue more common in urban and semi-urban settings, especially Guwahati. This pattern demonstrates how disease ecology follows human settlement, land use, water management and mobility. It also shows that climate change does not simply increase disease in a uniform way; rather, it reshapes the spatial logic of transmission. In this sense, the study of climate and health in Assam is fundamentally a medical-geographical problem because it requires mapping the interaction of environment, population, and disease across space.

The period 2002–2022 is especially relevant because it captures both environmental intensification and policy transition. During these two decades, Assam experienced repeated flood disasters, changing rainfall patterns, and increasing concern over heat stress, respiratory illness, and vector-borne disease. At the same time, the state and central governments began to strengthen surveillance, early warning, and adaptation planning for climate-sensitive health risks. Yet the persistence of outbreaks and the concentration of vulnerability in particular districts indicate that response efforts have not fully closed the gap between environmental risk and public-health capacity.

This paper therefore adopts a medical-geographical framework to examine how climate change affected disease patterns and physiological responses in Assam from 2002 to 2022. It treats disease as spatially embedded and socially produced, and it analyses how climate stressors interact with vulnerability, mobility and livelihood and health-system access. By combining climate data, disease trends and district vulnerability profiles, the study aims to show that health impacts in Assam are best understood not as isolated medical events but as outcomes of a changing human-environment system.

Objectives:

The objectives of this paper are:

- To assess how climate variability and environmental change affected disease patterns in Assam from 2002 to 2022.
- To examine physiological and occupational health responses to floods, heat, air pollution, and infectious disease exposure.
- To identify vulnerable districts and population groups.
- To propose a climate-resilient health adaptation framework for Assam.

Materials and Methods:

This paper is based on a narrative review and secondary analysis of public-health and climate-policy sources. The principal source is Assam's State Action Plan on Climate Change and Human Health, which provides climate trends, vulnerability rankings, district-level flood impacts, and disease tables for malaria, dengue, chikungunya, AES and JE. Supplementary evidence was drawn from published literature on mosquito-borne diseases in Assam and outbreak reporting on Japanese encephalitis.

A full empirical version of this study would benefit from a mixed-method design. That design should combine meteorological data, district health surveillance records, flood data, hospital admissions and household or qualitative interviews. The most suitable analytical approaches are time-series analysis, spatial epidemiology and vulnerability indexing and qualitative interpretation of adaptation gaps. Such a design is especially appropriate for Assam because health risks vary by district, season, livelihood and flood exposure.

Limitation of the Study:

It is true that during the last several decades lots of dedicated scientific studies have been done in Assam and outside Assam covering the topic climate change and human health. It is true that climate change is no longer something to happen in future but rather an ongoing phenomenon. It is now unequivocally established that climate change is reality, and the adversities of climate transformations pose of the greatest challenges facing humanity today (IUCN, 2011). Among the broad discussion there is also lots of discussion about the impact of environmental change on disease patterns and physiological responses. Because of the limitation of words and time constraint the study is limited to a definite time frame from the year 2002 to 2022.

Climate Context:

Assam's climate has warmed measurably over time, and the state action plan reports an increase of 0.59°C in annual mean temperature over the last 60 years, along with projected further warming and more extreme rainfall events. The document also states that Assam is highly vulnerable to floods, with a large share of the state's land area classified as flood-prone and repeated exposure in many districts. Flooding in Assam is not a one-off disaster; it is a recurrent structural hazard that shapes disease ecology and health service delivery.

District-level vulnerability varies sharply. The Assam Climate Change Management Society profile identifies Dhubri, Darrang, Karimganj, Kokrajhar, Golaghat,Goalpara, Hailakandi, Morigaon and Tinsukia among the more vulnerable districts. Other reporting notes that 15 of India's 25 most climate-vulnerable districts are in Assam, including Karimganj, Goalpara, Dhubri, Darrang, Sonitpur, Golaghat, Cachar, Barpeta, Kokrajhar, Tinsukia, Baksa,Morigaon, Dibrugarh, Sivasagar and Hailakandi. This pattern reflects interactions among socioeconomic conditions, infrastructure, rain-fed agriculture, and road density rather than climate alone.

Disease Patterns:

Climate-sensitive disease burden in Assam during 2002–2022 was dominated by malaria, dengue, Japanese encephalitis, acute encephalitis syndrome, diarrheal disease and respiratory illness associated with poor air quality. A review of mosquito-borne disease in Assam found that malaria and JE were the most important and widespread infections, dengue was concentrated in urban and semi-urban areas and lymphatic filariasis persisted in tea-garden communities. These patterns are consistent with the state's climate-health action plan, which treats vector-borne disease as a priority climate-sensitive issue.

Malaria remained endemic, especially in forest-fringe, tribal, hill, and remote districts, but state totals declined in later years. Assam's NVBDCP data show malaria cases falling from 66,293 in 2010 to 7,754 in 2015, indicating improved control but continued endemicity. Dengue showed a different trajectory, with major concentration in Guwahati and other urbanizing areas, suggesting the role of changing rainfall patterns, water storage and urban ecology. Japanese encephalitis and AES remained serious throughout the decade, with persistent mortality and district clustering.

Table1. Malaria cases and deaths in Assam, 2010–2015

Year	Malaria cases	PF cases	Deaths	API
2010	66,293	48,330	36	2.11
2011	47,397	34,707	45	1.80
2012	30,940	20,615	13	0.92
2013	19,542	14,969	7	0.59
2014	14,540	11,210	11	0.43
2015*	7,754	6,489	—	—

*2015 data up to 18 September

*Source:*https://dhs.assam.gov.in/schemes/national-vector-borne-disease-control-programme-0

Table2. Dengue positive cases and deaths in Assam, 2009–2015

Year	Dengue positive cases	Deaths
2009	0	0
2010	237	2
2011	0	0
2012	966	5
2013	4,526	2
2014	85	0
2015*	92	1

*2015 data up to 18 September.
Source: https://www.adb.org/sites/default/files/linked-documents/59241-001-craa.pdf

Table3. AES and JE cases and deaths in Assam, 2008–2015

Year	AES cases	AES deaths	JE cases	JE deaths	JE CFR (%)
2008	319	100	157	33	21.01
2009	643	109	218	46	21.10
2010	495	117	155	41	26.62
2011	1,491	280	543	115	21.17
2012	1,387	254	488	107	21.92
2013	1,311	286	502	134	26.69
2014	2,194	360	761	165	21.68
2015*	1,253	260	582	134	—

*2015 data up to 18 September.
Source: https://www.adb.org/sites/default/files/linked-documents/59241-001-craa.pdf

Table4. JE cases and deaths in Assam, 2018–2024

Year	JE cases	JE deaths
2018	509	94
2019	642	161
2020	320	51
2021	218	40
2022	456	96
2023 (P)	525	34

Source: https://ncvbdc.mohfw.gov.in/index1.php?lang=1&level=2&lid=4001&sublinkid=5917
Assam remained among the highest-burden states for JE during this period.

Physiological Responses:

Environmental change affects health through direct physiological stress and through indirect pathways. Heat exposure can produce dehydration, heat exhaustion and heatstroke, while also worsening cardiovascular, respiratory and renal conditions. Assam's climate-health action plan specifically identifies heat-related illness as a growing concern and calls for surveillance and preparedness.

Floods contribute to physiological burden through contaminated water, poor sanitation, displaced living conditions, and interruption of food access. The state action plan notes that flooding affected thousands of villages, hundreds of health institutions, and millions of people in 2022 alone, with large numbers treated in medical camps. Such events can increase diarrheal disease, skin infection, under-nutrition and psychosocial stress, especially among displaced households, children, pregnant women and older adults. The health effects are therefore not limited to infection; they also include physical exhaustion, reduced productivity, and mental strain.

Vulnerable Groups:

Climate-health risk in Assam is highly uneven. Char and floodplain communities, rural agrarian households, tea-garden workers, pregnant women, children, older adults, tribal populations and the urban poor are particularly vulnerable. Their vulnerability stems from higher exposure, lower adaptive capacity, fragile housing, weak WASH access and limited healthcare access.

The state action plan identifies multiple districts and communities as priority groups for climate-health intervention, and it links vulnerability to both geographical exposure and social conditions. For example, flood-prone districts such as Dhemaji, Dhubri, Dibrugarh, Lakhimpur, Morigaon, Darrang and Barpeta are repeatedly affected by extreme weather and service disruption. This confirms that vulnerability in Assam is place-based and cumulative.

Health System Stress:

Assam's health system has faced recurrent climate stress during the study period. Floods damaged hundreds of health institutions in 2022 and disrupted service delivery across many districts. Relief camps, medical camps and emergency logistics became necessary substitutes for routine primary care during major events.

Policy response has improved, but operational resilience remains uneven. The state action plan calls for disease forecasting, integrated surveillance, health-facility retrofitting, and district-level preparedness. It also emphasizes the need for coordination between health, disaster management, water and sanitation, and climate institutions. This indicates that climate adaptation is no longer only a health-sector issue; it is a cross-sector governance challenge.

Discussion:

The findings of this study show that climate change in Assam has functioned less as a single environmental shock and more as a persistent risk amplifier that reshapes disease ecology, health-system capacity, and population vulnerability over time. The 2002–2022 period reveals a clear convergence of warming temperatures, erratic rainfall, recurrent flooding, and changing land-use pressures, all of which interacted with existing inequalities in sanitation, housing, livelihood security, and healthcare access. In Assam, therefore, climate-health risk is not evenly distributed; it is produced through the intersection of ecology and social disadvantage.

A major result of this interaction is the continued prominence of vector-borne diseases. Malaria remained endemic across forest-fringe, tribal, and remote rural settings even as state totals declined in the later years of the period, suggesting partial success in control but continued ecological suitability for transmission. Dengue, by contrast, became increasingly visible in urban and peri-urban environments, especially around Guwahati, where urban expansion, water-storage practices, construction activity, and seasonal rainfall create conditions favourable to Aedes breeding. This spatial differentiation is important because it indicates that Assam's climate-health burden is not uniform across the state; it has distinct rural, peri-urban and urban geographies.

Japanese encephalitis and acute encephalitis syndrome represent another layer of climate-sensitive burden. Assam has long been recognized as a major JE-endemic region, with the disease linked to a complex ecology involving paddy cultivation, standing water, mosquito vectors, and animal reservoirs. The persistence of JE over the study period, including later outbreaks, suggests that climate variability may be intensifying rather than replacing older disease ecologies. In other words, climate change in Assam does not simply create new health threats; it also reinforces long-standing ones by expanding the seasonal window and geographic reach of transmission.

Flooding is the most visible climate hazard in Assam, but its health effects extend far beyond immediate injury or displacement. Recurrent inundation damages latrines, contaminates drinking water, interrupts household food systems, and delays access to health care, thereby increasing diarrheal disease, skin infection, malnutrition and psychosocial stress. The state action plan's emphasis on flood disruption to health institutions highlights the fact that public health vulnerability is also institutional vulnerability. When primary care centres, referral routes, or supply chains are disrupted, the population becomes more exposed not only to infection but also to untreated chronic and acute conditions.

The physiologic burden of climate change in Assam is also likely to be intensifying. Heat exposure can produce dehydration, heat exhaustion, and heatstroke, but its broader effect is to reduce work capacity and increase physiological strain among people engaged in outdoor labour, especially agriculture, construction, transport, and tea-garden work. This is especially relevant in Assam because a large share of the workforce depends on climate-sensitive livelihoods and performs physically demanding labour under humid conditions. Heat stress therefore has both health and economic consequences: it reduces productivity, increases accident risk and may worsen cardiovascular and renal burdens among already vulnerable adults.

The vulnerability profile published for Assam helps explain why the burden is concentrated in particular places. High-vulnerability districts such as Dhubri, Darrang, Karimganj, Kokrajhar,Goalpara, Hailakandi, Morigaon and Tinsukia combine flood exposure, fragile infrastructure, lower adaptive capacity, and socioeconomic disadvantage. The identification of road density, women's workforce participation, rain-fed agriculture, and sanitation access as major vulnerability drivers is especially important because it demonstrates that climate risk is mediated through development conditions, not climate alone. This means that climate adaptation in Assam must go beyond disease control and address basic development deficits that shape exposure and resilience.

A further implication of the findings is that climate-sensitive health burdens in Assam are becoming increasingly differentiated by settlement type. Rural floodplain and char populations are highly exposed to waterlogging, sanitation breakdown, and vector breeding, while urban residents face dengue, heat stress, and air-pollution-related illness. Tea-garden workers and other plantation labourers represent a distinct occupational risk group because of crowded housing, limited service access, and prolonged outdoor exposure. Such differentiation matters for policy because one uniform intervention cannot address all climate-health risks in the state. Assam requires place-specific adaptation: flood management and WASH in riverine areas, vector surveillance and environmental management in cities and occupational health protection in labour-intensive rural and plantation settings.

The health-system dimension is equally important. The state plan indicates that floods have repeatedly affected hundreds of health institutions, revealing how environmental shocks can weaken service continuity. This is not merely a temporary administrative inconvenience; in a climate-sensitive setting it becomes a recurring determinant of preventable illness and mortality. When infrastructure is damaged or staff cannot travel, early diagnosis and timely treatment become harder, particularly for malaria, JE, dengue, diarrheal illness and maternal emergencies. The challenge for Assam is therefore not only to reduce disease incidence but also to ensure that the health system remains functional during climate shocks.

The policy transition visible over the study period is encouraging but incomplete. Earlier disease-control approaches focused primarily on vector control and outbreak response, while recent plans have begun to incorporate climate surveillance, early warning and health-facility resilience. This shift reflects a more integrated understanding of climate-health risk. However, implementation remains the key issue. Surveillance systems need stronger district-level data integration, local health workers need training to recognize climate-sensitive illness and coordination between health, disaster management, WASH, agriculture and urban development must become routine rather than exceptional. Without this, adaptation will remain document-based rather than operational.

The study also highlights a research gap. Although official documents provide useful state-level indicators and some district vulnerability data, more detailed longitudinal analysis is needed to connect specific climate variables with disease outcomes. Monthly or weekly case data for malaria, dengue, JE, and diarrheal disease could be linked to rainfall, temperature, humidity, and flood occurrence using spatial and time-series methods. That approach would help identify lag periods, high-risk districts, and seasonal triggers with greater precision. It would also clarify whether observed disease shifts are due to climate change itself, improved reporting, urbanization, or interactions among these factors.

Overall, the Assam case shows that climate change and health are deeply intertwined through ecological, physiological, and structural pathways. The most important lesson from 2002–2022 is that adaptation must be geographically targeted and socially inclusive. The state's greatest climate-health vulnerabilities occur where high exposure meets low adaptive capacity, especially in flood-prone and marginalized communities. Any effective response therefore needs to combine disease surveillance, infrastructure resilience, WASH, vector control, occupational protection and district-level social development. In that sense, climate-health policy in Assam must be conceived not only as public health planning, but as a broader strategy of resilience-building and environmental justice.

Adaptation Framework:

A climate-resilient health strategy for Assam should include five priorities:

- Weather-linked disease forecasting and early warning for malaria, dengue, JE, diarrhea, and heat illness.
- Flood-resilient health facilities with safe water, backup power, elevated critical equipment, and protected supply chains.
- Stronger WASH, sanitation, and vector-control interventions in char, floodplain, tea-garden, and peri-urban settlements.
- Targeted protection for vulnerable groups, including women, children, workers, and displaced populations.
- District-level integration of health, climate, agriculture, and disaster-management planning.

These measures are consistent with Assam's own health action priorities, which emphasize awareness, capacity building, surveillance, resilience and interdepartmental coordination. They also align with the district vulnerability evidence produced for Assam.

Conclusion:

Climate change has already changed the health geography of Assam during 2002–2022, and emerging evidence suggests that these changes are likely to intensify if warming and climate variability continue unabated. The most important effects identified in this period were shifts in vector-borne disease patterns, recurrent flood-related health disruption, rising heat stress, sanitation-related illness, and the growing physiological burden carried by vulnerable and marginalized populations. Together, these pathways demonstrate that climate is not acting alone; it interacts with land use, water systems, health infrastructure and social inequality to produce distinct spatial patterns of risk across the state.

Assam's experience shows that climate–health risk is shaped simultaneously by ecology, infrastructure, and inequality, and that districts with fragile embankments, poor drainage, limited clinical capacity and high poverty tend to bear a disproportionate share of the burden. These spatial disparities point to the need for climate-resilient health systems, including surveillance that can detect emerging hotspots, primary care that can function during extreme events and public health communication tailored to local languages and risk profiles. Integrating climate information (rainfall anomalies, flood forecasts, heat-wave alerts) into routine health planning would help officials anticipate where disease burdens may spike and allocate resources accordingly.

Future research should therefore move beyond aggregate state-level statistics and employ district-level time-series and spatial methods—such as GIS-based hotspot analysis, spatial regression and panel data models—to quantify climate–disease links more precisely and to capture local heterogeneity. Such evidence can guide adaptation policy, including targeted vector control, climate-resilient water and sanitation infrastructure, and social protection for high-risk communities. By making health geography central to climate planning, Assam can shift from reactive disaster response to proactive risk reduction and protect vulnerable populations from mounting climate stresses.

REFERENCES:

1. Agrawala, S, Ota, T, Ahmed, A. U, Smith, J, and Aalst, M. V., (2003). *Development and Climate Change in Bangladesh: Focus on Coastal Flooding and the Sundarbans*, OECD, Paris, France.
2. Assam National Health Mission. (n.d.). *National Vector Borne Disease Control Programme*. Government of Assam.
3. Bettini G. (2017) *Where next? Climate change, migration, and the (Bio) Politics of adaptation*,. Glob Policy 8:33–9 Feb.
4. Bordoloi, S., Saharia, D. (2015). "Mosquito-borne Diseases in Assam, North-East India: Current Status and Key Challenges". *WHO South-East Asia Journal of Public Health*, *4*(1), 20–29. World Health Organization Regional Office for South-East Asia.
5. Dick, Philip K. 2004 (1968). Do Androids Dream of Electric Sheep? In *Five Great Novels*. London: Gollancz.
6. Edelman, Birgitta. (2002). "Rats Are People, Too!" Rat-Human Relations Re-Rated. *Anthropology Today* 18 (3): 3–8.
7. Hageman, Andrew. (2012). The Challenge of Imagining Ecological Futures: Paolo Bacigalupi's *The Windup Girl*. *Science Fiction Studies* 39 (2): 283–303.
8. Harraway, Donna J. (2008). *When Species Meet*. Minneapolis: University of Minnesota Press.
9. Hayles, N. Katherine. (1999). *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature, and Informatics*. Chicago: University of Chicago Press.
10. Ensor J, Harvey B. (2015) "Social learning and climate change adaptation: evidence for international development practice". *Wiley Interdisciplinary Rev Climate Change*; 6 (5):509–22.
11. Government of Assam. (n.d.). *Assam Climate Change Knowledge Portal*. Assam Climate Change Management Society.
12. Gharphalia B J, Deka R L, Islam A N, Dutta P and Medhi K (2018). "Variability and Trends of Rainfall Events in the Brahmaputra Valley of Assam, India", *International Journal of Current Microbiology and Applied Sciences 7 (11)*, 1902-1912.
13. Guhathakurta P, Sreejith O P and Menon P A, (2011). "Impact of Climate Changes on Extreme Rainfall Events and Flood Risk in India", *Journal of Earth System Science*. 120, No. 3, 359 373.
14. Guhathakurta P and Rajeevan M, (2008). "Trends in Rainfall Pattern over India" International Journal of Climatology, 28: 1453–1469
15. Rajora, C. (2019). *Climate Change Vulnerability Assessment with a Focus on Agriculture Sector: A District Level Study of Assam and Odisha* [Master's dissertation, TERI School of Advanced Studies]. CG Space.
16. National Centre for Vector Borne Diseases Control. (n.d.). *AES/JE Cases and Deaths in the Country Since 2018*. Ministry of Health and Family Welfare, Government of India.

17. PubMed. (2012). *Dengue Vectors in Urban and Suburban Assam, India: Entomological observations*. *WHO South East Asia Journal of Public Health*.
18. P. Mitchell, T., Van Aalst, M., & Silva Villanueva, (2010) "Assessing progress on integrating disaster risk reduction and climate change adaptation in development processes".
19. UNDP, (2001). *Human Development Report: 2001*. United States Development Program (UNDP), Oxford University Press, New York.
20. https://accms.org.in/page/vulnerability
21. https://dhs.assam.gov.in/schemes/national-vector-borne-disease-control-programme-0
22. https://accms.org.in/page/document
23. https://iris.who.int/handle/10665/329669