

Effect of Climate Change on Vector Borne Diseases: Prevention and Control

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Abstract—The world is witnessing Climate change. This change has already started affecting air quality, food production, water supply, coastal settlement and human health. Vector-borne diseases account for over 17% of all infectious diseases. There is increasing evidence about the impact of climate change on Vector Borne Diseases. The data was collected in month of September-October 2024 from published articles, journals, reports, and books on this major issue to discuss the effects of climate change on VBDs in India through this article. Initiative taken by W.H.O. and Ministry of Health & Family Welfare (MoH&FW) has played a major role to eliminate & eradicate VBDs in India and world. Generally, the high-risk areas for VBDs are rural, tribal areas, urban slums inhabited by the poor people. This paper will briefly review the changing epidemiology of the most important vector-borne diseases in India.

Keywords— Carbon Emissions, Vector Born Diseases, Climate change, UNFCCC, GCF, GEF

I. INTRODUCTION

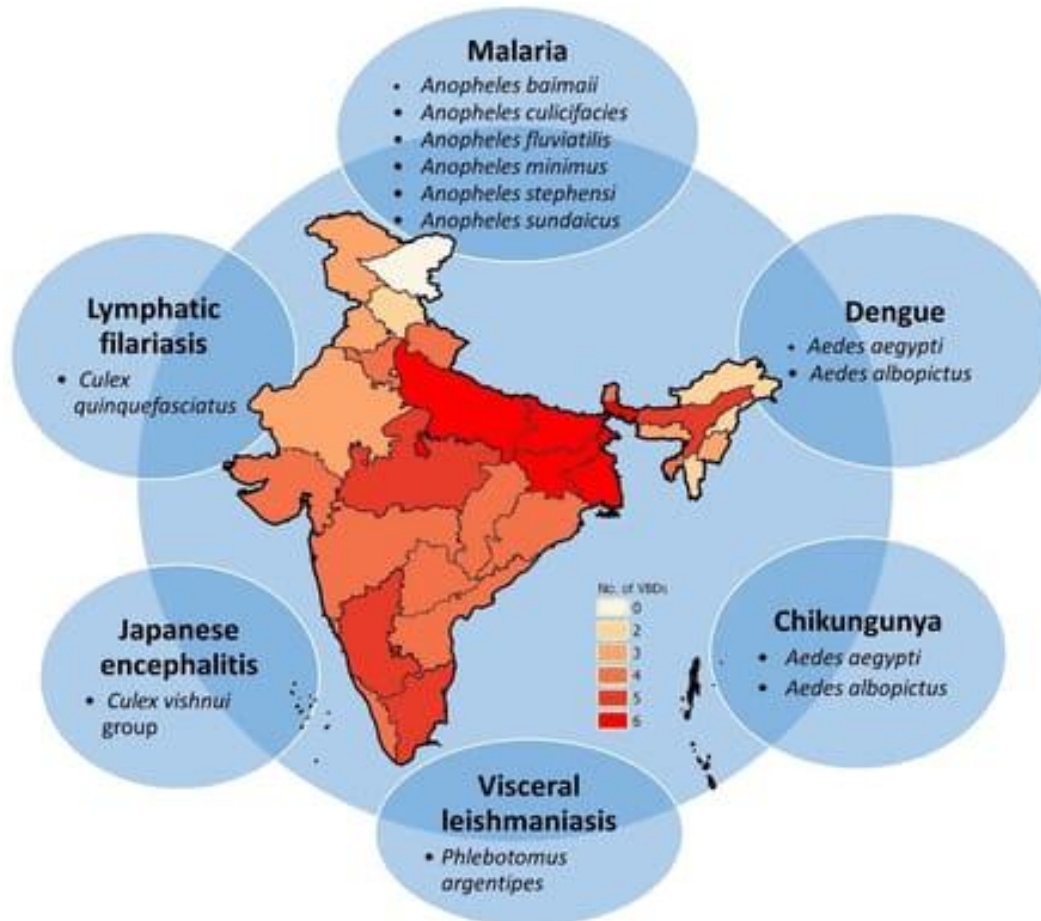
Climate Change is a serious global environmental concern and it can be due to natural internal processes or external forces such as modulations of the solar cycles, volcanic eruptions, and persistent anthropogenic influences in the composition of the atmosphere or in the land use. The United Nation Framework Convention on Climate Change (UNFCCC) defines climate change as: ‘a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods. Climate Change is primarily caused by the building up of Green House Gases (GHG) in the atmosphere.

The global increase in carbon dioxide concentration is primarily due to burning of fossil fuels, land use changes, deforestation and animal husbandry. Increase in emission of methane and nitrous oxide is primarily due to agriculture. Global warming is a specific example of the broader term ‘Climate Change’ and refers to the observed increase in the average temperature of the air near earth’s surface and oceans in recent decades. Its effect particularly on developing countries is adverse as their capacity and resources to deal with the challenge is limited.

Scientific studies have shown that the global atmospheric concentrations of carbon dioxide, methane and nitrous oxide which are the most important greenhouse gases have increased markedly and have exceeded pre-industrial values as a result of human activities since 1750. Global warming is expected to severely impact ecosystems, precipitation and agriculture, rendering agrarian economies particularly vulnerable. For South Asia, a decrease in the fresh water availability in river basins is projected for the 2050s while flooding risks and diarrhoeal diseases are expected to rise. In India with existing climatic conditions, a small change in monsoon rainfall pattern is projected up to 2050. However, there is an overall decrease in the number of rainy days over major parts of the country.

GEOGRAPHICAL COVERAGE

Vector-borne diseases are human illnesses caused by parasites, viruses and bacteria that are transmitted by vectors. Every year there are more than 700 000 deaths from diseases such as malaria, dengue, schistosomiasis, human African trypanosomiasis, leishmaniasis, Chagas disease, yellow fever, Japanese encephalitis and onchocerciasis.



Distribution of vector-borne diseases is determined by a complex set of demographics, environmental and social factors. Global travel and trade, unplanned urbanization, climate change and silent spread and adaptation of the vectors have all contributed to the spread of vector-borne diseases. Generally, the high-risk areas for VBDs are rural and tribal areas and urban slums inhabited by the poor, marginalized and vulnerable groups with limited access to quality health care, communication and other basic amenities in those focal areas.

The burden of these diseases is highest in tropical and subtropical areas, and they disproportionately affect the poorest populations. Since 2014, major outbreaks of dengue, malaria, chikungunya, yellow fever and

Zika have afflicted populations, claimed lives, and overwhelmed health systems in many countries. Other diseases such as chikungunya, leishmaniasis and lymphatic filariasis cause chronic suffering, life-long morbidity, disability and occasional stigmatization.

II. OBJECTIVE

The objective of the present paper is to assess the risks of vector-borne diseases in a changing world and to develop strategies and to adapt those changes. The goal is to reduce the impact of climate change on vector-borne diseases as well as (VBDs) and to improve community health.

RELATIONSHIP BETWEEN VECTOR BORN DISEASE AND CLIMATE CHANGE:

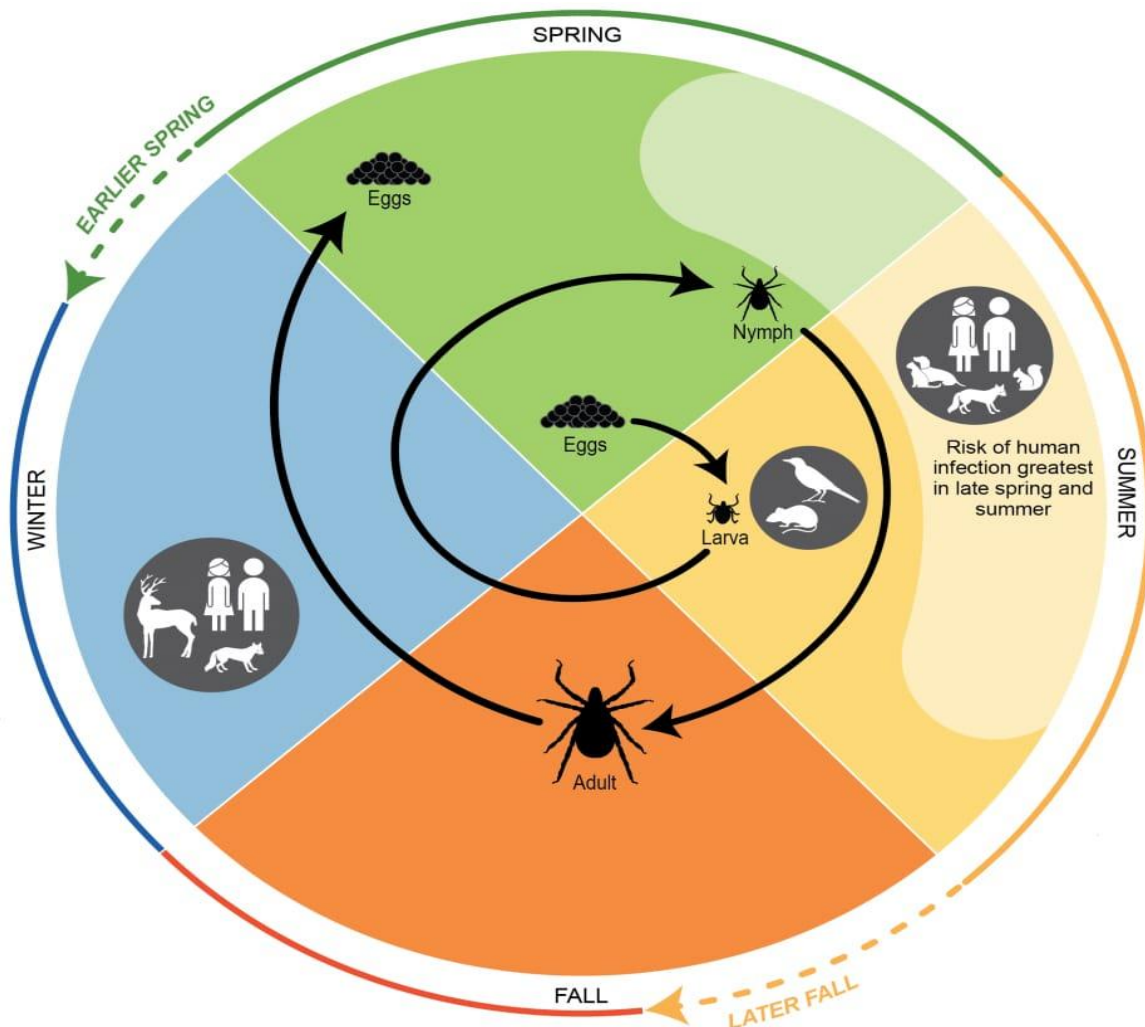
Impact of Climate Change on VBDs

1. Rising Temperatures: Increased mosquito breeding and survival.
2. Changing Precipitation Patterns: Excessive rainfall creates ideal breeding conditions.
3. Sea-Level Rise: Coastal waterlogging and increased mosquito breeding.
4. Drought: Water scarcity increases mosquito breeding and transmission.

VBDs Affected by Climate Change

1. Malaria	2. Dengue
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3. Chikungunya	4. Zika
5. Yellow Fever	6. Leptospirosis
7. Lyme Disease	8. Japanese Encephalitis



Climate Change-Driver of VBD Spread

1. Vector Range Expansion: Mosquitoes and ticks inhabit new areas.
2. Seasonal Shifts: Changes in VBD transmission seasons.
3. Increased Vector Population: Growing mosquito and tick populations.
4. Human Behavior Changes: Climate change influences human behavior, increasing VBD risk.

Mitigation Strategies:

1. Climate-Resilient Infrastructure: Eliminate mosquito breeding sites.
2. Early Warning Systems: Monitor VBD outbreaks.
3. Integrated Vector Management (IVM): Combine physical, chemical, and biological controls.
4. Public Awareness: Educate on climate change and VBDs.
5. Research and Development: Investigate climate change-VBD links.

Adaptation Strategies

1. Climate-Smart Health Systems: Prepare health systems for climate change.
2. Vector Control Measures: Implement mosquito and tick control measures.
3. Community Engagement: Involve local communities in VBD control.
4. Surveillance and Monitoring: Track VBD transmission and climate change connections.

Key Statistics:

1. 50% increase in malaria cases attributed to climate change (WHO).
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2. Dengue fever cases projected to increase 30% by 2050 (CDC).

3. Climate change may increase Zika virus transmission by 15% (Nature).

International Response

1. WHO Climate Change and Health Strategy.

2. UNFCCC Climate Change Adaptation.

3. Global Environment Facility (GEF) funding for climate change-VBD projects.

Understanding the climate change-VBD connection is crucial for developing effective mitigation and adaptation strategies.

III. DATA ANALYSIS

Data has been taken from secondary sources. These data have collected from National Centre for Vector

born Disease Control, Directorate General of Health Services, Ministry of Health and Family Welfare, Government of India. This this the analysis of five-year data from 2020-2024.

Diseases	Year- 2020 Case-Death		Year- 2021 Case-Death		Year- 2022 Case-Death		Year- 2023 Case-Death		Year- 2024 Case-Death	
Malaria	186532	93	161753	90	176522	83	227564	83	151519	34
Dengue	44585	56	193245	346	233251	303	289235	485	32091	32
Kala- Azar	1967	6	1276	8	813	3	524	4	339	1
Chikengunia	43424	6324	119070	11890	148587	8067	200064	11477	69395	3066

Source: National Centre for Vector born Disease Control directorate General of Health Services Ministry of Health and Family Welfare

This table shows that by the effect of government and other health Institutions every Vector Borne Disease and other diseases has checked and controlled in year 2024. All cases and related deaths have reduced at a large level. Awareness had played a major role like campaign swachhata hi Seva 2024, Anti Dengu Month - July 2024 and Social media awareness.

STRATEGIES FOR PREVENTION OF VBDs

To effectively combat vector-borne diseases, a multi-faceted strategy is crucial. First, integrate vector management practices, including indoor residual spraying, larval control, and biological control. Enhance surveillance systems to monitor vector populations, disease transmission, and climate change impacts. Implement public awareness campaigns to educate communities on VBD

prevention and control measures, such as using insecticide-treated nets, wearing protective clothing, and eliminating breeding sites.

Strengthen healthcare systems through training healthcare workers, improving diagnostic capabilities, and ensuring timely treatment. Foster community engagement through participatory approaches, empowering local leaders to champion VBD control efforts. Leverage cutting-edge technologies, including GIS mapping and mobile applications, to track vector distributions and disease outbreaks. Finally, encourage intersectoral collaboration among health, environment, and education sectors to address the socio-ecological determinants of VBDs, ensuring a coordinated and sustainable response to these pressing public health threats.

Key components:

1. Integrated Vector Management (IVM)	2. Surveillance and Monitoring
3. Public Awareness and Education	4. Healthcare System Strengthening
5. Community Engagement and Participation	6. Technology Integration
7. Intersectoral Collaboration	

Effective implementation of this strategy can significantly reduce the burden of vector-borne diseases.

VECTOR CONTROL MEASURES AND INITIATIVES

Vector Control Measures:

1. Indoor Residual Spraying (IRS): Insecticides applied to interior walls and ceilings.	2. Long-Lasting Insecticidal Nets (LLINs): Nets treated with insecticides.
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3. Larval Control: Targeting mosquito breeding sites.	4. Biological Control: Introducing natural predators or parasites.
5. Environmental Modification: Eliminating breeding sites.	6. Integrated Pest Management (IPM): Combining physical, chemical, and biological controls.
7. Personal Protective Equipment (PPE): Insect repellents, clothing, and nets.	8. Spatial Spraying: Outdoor insecticide applications.

Initiatives:

1. Global Vector Control Response (GVCR): WHO-led initiative.	2. President's Malaria Initiative (PMI): USAID-funded program.
3. Roll Back Malaria (RBM): Global partnership.	4. Eliminate Dengue (ED): International program.
5. Zika Virus Response: CDC-led initiative.	6. National Vector Borne Disease Control Programme (NVBDCP): India's national program.
7. Integrated Vector Management (IVM) Program: Africa-based initiative.	8. Vector-Borne Disease Control Program: WHO Regional Office for Europe.

Technological Innovations:

1. Gene Editing (CRISPR): Modifying mosquito genetics.	2. Wolbachia: Mosquito bacteria reducing disease transmission.
3. Insecticide-Treated Nets (ITNs): Long-lasting nets.	4. Drones: Aerial spraying and surveillance.
5. Mobile Applications: Monitoring and tracking vectors.	6. Geographic Information Systems (GIS): Mapping vector distributions.
7. Artificial Intelligence (AI): Predictive modeling and analytics.	

International Partnerships:

1. World Health Organization (WHO)	2. Centers for Disease Control and Prevention (CDC)
3. United Nations Children's Fund (UNICEF)	4. United States Agency for International Development (USAID)
5. Bill and Melinda Gates Foundation	6. Global Fund to Fight AIDS, Tuberculosis and Malaria
7. World Bank	

Collaborative efforts and innovative solutions are crucial for effective vector control and disease prevention.

IV. CONCLUSION

India is a rich country about resources and demographic dividend but on other side, it has faced many challenges like malaria, dengue, chikengunia, kala azar, japanese encephalitis, etc. Many peoples have lost their lives because of vector borne diseases and other health issue. Govt of India, govt of states and other institutions have played a major role to control these diseases. Ministry of Health and family welfare is nodal agency for combat medical issue. Especially National Center for Vector Borne Diseases Control played a significant role to control many health issue as dengue, malaria, chikengunia etc.

Social media, print, electronic media and social awareness program also played a major role to combat these challenges. Malaria, dengue, japanese Encephalitis are still challenging problems in north - east, eastern state, followed by northern, central and

western part of India. Japanese Encephalitis are still uncontrollable in the wetland and rice cultivation region of India. The public health authority must have to pool the base line information on VBD hotspot region across the nation and awareness program must be continue.

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