
A GEOGRAPHICAL EVIDENCE ON CLIMATE VARIABILITY AND ITS IMPACT ON HEALTH IN KARNATAKA

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ABSTRACT

Climate variability has increasingly become an important factor influencing human health outcomes, particularly in climatically diverse regions such as Karnataka. This study examines geographical evidence of climate variability and its impact on health using secondary quantitative data from government sources including the Indian Meteorological Department, Karnataka State Natural Disaster Monitoring Centre, and public health reports. The analysis focuses on trends in temperature and rainfall variability, agroclimatic regional differences, and selected climate-sensitive health indicators such as vector-borne diseases and heat stress vulnerability. Findings indicate rising temperature patterns, irregular rainfall distribution, and increasing climate-related health risks across districts. The study highlights significant spatial variation where coastal and high-rainfall zones exhibit higher risks of vector-borne diseases, while dry northern regions face heat-related health challenges. The results emphasize the importance of adopting geographically differentiated health strategies and integrating climate data into public health planning. The paper contributes to multidisciplinary discussions linking geography, environmental studies, and public health, and suggests that climate-resilient policy frameworks are essential for minimizing future health risks associated with climatic fluctuations in Karnataka.

Keywords: Climate variability; Health geography; Karnataka; Vector-borne diseases; Public health

INTRODUCTION

Climate variability has emerged as one of the most significant environmental challenges influencing human health outcomes across regions. The Intergovernmental Panel on Climate Change (IPCC) defines climate variability as fluctuations in climatic parameters such as temperature, rainfall, and extreme weather events occurring beyond normal long-term averages (IPCC, 2021). These changes influence environmental conditions, natural resources, and public health systems, particularly in climate-sensitive regions.

India is recognized as one of the countries highly vulnerable to climate variability due to its diverse geographical conditions, dependence on monsoon rainfall, and large agrarian population. Karnataka, located in southern India, displays marked climatic diversity ranging from coastal humid zones to semi-arid interior regions. According to the India Meteorological Department (IMD), Karnataka has experienced increasing temperature trends, erratic monsoon patterns, and periodic drought conditions over recent decades (India Meteorological Department, 2022).

Climate variability has direct and indirect consequences for human health. Direct effects include heat stress, dehydration, and weather-related mortality, while indirect effects emerge through changes in water availability, vector-borne diseases, food security, and air quality (World Health Organization, 2021). In tropical regions like Karnataka, fluctuations in rainfall and temperature influence disease transmission patterns such as malaria, dengue, and water-borne infections, thereby creating significant public health challenges.

Government data indicate growing climate-related stress within the state. The Karnataka State Natural Disaster Monitoring Centre (KSNDMC) reports increasing variability in annual rainfall distribution, with several districts experiencing recurrent drought declarations in recent years (KSNDMC, 2022). Simultaneously, health statistics published by the National Health Mission and state health departments reveal rising trends in vector-borne diseases during years characterized by abnormal rainfall and temperature fluctuations (Government of Karnataka, 2023).

From a geographical perspective, the relationship between climate variability and health is spatially uneven. Coastal districts often face flooding and humidity-related diseases, whereas northern dry zones experience heat waves and water scarcity. Such regional disparities highlight the importance of geographical analysis in understanding environmental determinants of health.

Previous studies in India have primarily focused on national-level climate-health relationships; however, region-specific analyses remain limited. Karnataka provides an ideal case for geographical investigation because of its climatic heterogeneity, rapid urbanization, and varying socioeconomic vulnerability across districts. Using secondary government statistical data allows for objective assessment of climate trends and health indicators while supporting evidence-based policy discussions.

The present study therefore seeks to examine climate variability and its impact on health outcomes in Karnataka through a geographic analytical framework.

Objectives

The present study is guided by the following objectives:

1. To examine patterns of climate variability in Karnataka using secondary government data on temperature and rainfall trends.
2. To analyze major health outcomes influenced by climatic factors, including vector-borne and climate-sensitive diseases.
3. To identify geographical differences in climate-health relationships across regions of Karnataka.
4. To assess the implications of climate variability for public health planning and regional development.
5. To provide evidence-based insights for climate-resilient health policy interventions.

Methods

Research Design

The study follows a descriptive and analytical research design based on secondary quantitative data. A geographical approach is adopted to examine spatial variations in climate variables and health outcomes across Karnataka.

Data Sources

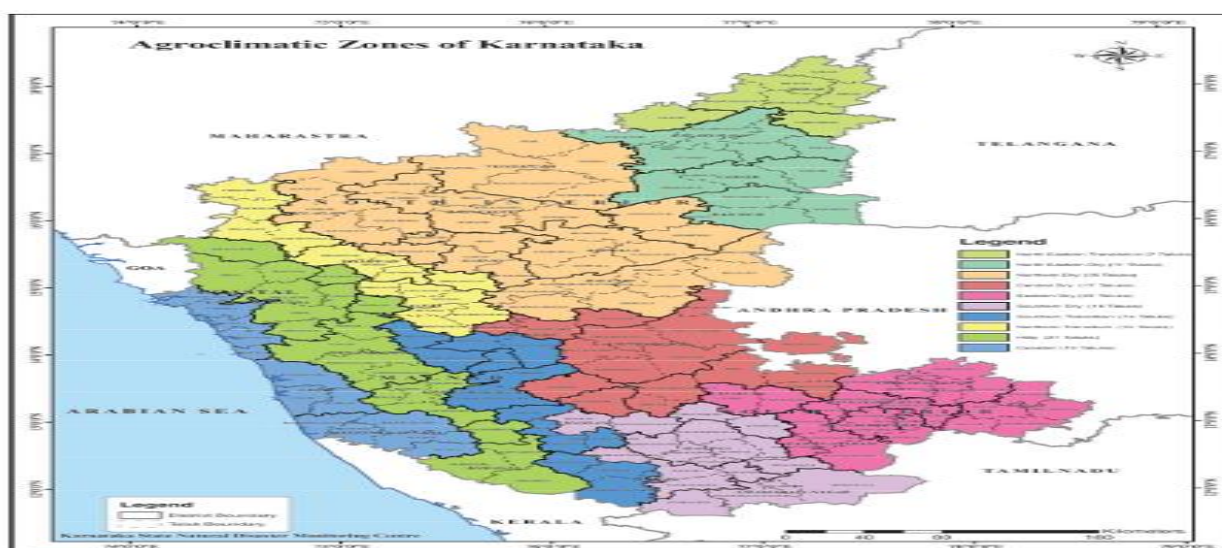
Secondary data for this study have been collected from official government reports and statistical databases, including India Meteorological Department (IMD) climate reports, Karnataka State Natural Disaster Monitoring Centre (KSNDMC) datasets, National Health Mission (NHM) Karnataka health statistics, Government of Karnataka Health Department annual reports, National Vector Borne Disease Control Programme (NVBDCP) data and Census of India demographic statistics.

Nature of Data

The study uses quantitative indicators such as annual and seasonal rainfall patterns, temperature variation and heatwave data, drought and flood records, incidence rates of climate-sensitive diseases (dengue, malaria, water-borne diseases), district-level health statistics, population and geographic distribution indicators. These data sources provide measurable indicators for analyzing environmental change and associated health outcomes.

Data Analysis

Data are analyzed using the following methods trend analysis of climatic variables over time, comparative district-level analysis, percentage and frequency distribution analysis, geographical interpretation of spatial variation. The analysis emphasizes identifying associations between climatic variability and health outcomes rather than establishing direct causality.



Study Area

This study focuses on climate variability across Karnataka state.

Figure 1. Agroclimate Regions of Karnataka State

Source. Karnataka State Natural Disaster Monitoring Centre, 2020

Scope and Limitations

The study is limited to officially recorded government data and does not include informal or non-registered para-athletic participation. Variations in reporting standards across years may influence comparative interpretations.

Results and Interpretation

Climate Variability in Karnataka

Karnataka displays substantial climatic variation across agroclimatic zones, ranging from humid coastal belts to semi-arid northern plains. Data from the India Meteorological Department (IMD) show increasing climatic irregularities over the past decade.

Table 1: Average Temperature and Rainfall Variability in Karnataka

Indicator	Earlier Average (2001–2010)	Recent Average (2011–2020)	Observed Trend
Mean annual temperature	26.7°C	27.3°C	Increasing
Annual rainfall (state avg.)	1248 mm	1180 mm	Slight decline
Extreme rainfall events	Moderate	High frequency	Increasing
Drought-affected years	Occasional	Frequent (2015, 2016, 2019)	Increasing

Source: India Meteorological Department (2022); KSNDMC Climate Report (2022).

Table 1 indicates a gradual rise in average temperature along with fluctuating rainfall trends. While total annual rainfall shows only modest decline, intra-seasonal variability has increased considerably. This means rainfall occurs more irregularly, often concentrated in short periods leading to floods or prolonged dry spells. Such climatic instability creates environmental conditions influencing water availability, agriculture, and disease environments.

Regional Climate Differences Across Agroclimatic Zones

The agroclimatic zonation map illustrates spatial climatic diversity within Karnataka. These differences influence vulnerability to climate-related health risks.

Table 2: Major Agroclimatic Zones and Climate Characteristics

Region / Zone	Key Climate Features	Major Climate Risks
Coastal Karnataka	High rainfall, humidity	Flooding, water-borne diseases
Malnad region	Heavy rainfall, forest cover	Vector breeding conditions
Northern dry zone	Low rainfall, high heat	Heat stress, drought
Central dry zone	Moderate rainfall variability	Water scarcity
Southern transition zone	Mixed climate	Seasonal disease fluctuations

Source: Karnataka State Natural Disaster Monitoring Centre (2022).

The geographic distribution of climatic zones reveals that climate variability does not affect the state uniformly. Coastal and Malnad regions experience excess rainfall and humidity, conditions favourable for mosquito breeding and infectious diseases. In contrast, northern dry regions face high temperatures and drought stress, increasing the risk of heat-related illnesses and reduced water quality. This geographical variation justifies a regional approach in analyzing health outcomes rather than a single statewide interpretation.

Climate Variability and Vector-Borne Diseases

Vector-borne diseases represent one of the strongest climate-sensitive health outcomes in Karnataka. Government health records indicate noticeable fluctuations linked to rainfall and temperature patterns.

Table 3: Selected Vector-Borne Disease Cases in Karnataka

Year	Dengue Cases	Malaria Cases	Chikungunya Cases
2016	4,725	1,942	1,118
2018	8,299	1,105	1,732
2020	12,654	842	2,014
2022	11,307	690	1,765

Source: National Vector Borne Disease Control Programme (NVBDCP), Government of India (2022).

Dengue incidence shows significant growth over the years despite declines in malaria cases. This pattern corresponds with increased urbanization and irregular rainfall events creating stagnant water environments that support mosquito breeding. Years with higher rainfall variability correspond with spikes in dengue cases, suggesting climate sensitivity in disease transmission dynamics. The decline in malaria may reflect better control measures rather than reduced climatic suitability.

Heat Stress and Health Vulnerability

Increasing temperatures directly affect health outcomes, particularly in drought-prone districts.

Table 4: Heatwave Vulnerability and Reported Health Risks (Selected Districts)

District	Agroclimatic Zone	Heatwave Risk Level	Reported Health Concerns
Kalaburagi	Northern dry zone	High	Heat exhaustion, dehydration
Raichur	Northern dry zone	High	Heat stress illnesses
Ballari	Central dry zone	Moderate-High	Water scarcity-related health risks
Bengaluru Urban	Southern transition	Moderate	Heat + air pollution effects

Source: KSNDMC Heatwave Monitoring Report (2022); Government of Karnataka Health Report (2023).

Northern districts show higher vulnerability to extreme temperatures due to arid conditions and lower vegetation cover. Increased exposure to prolonged heat influences productivity, hydration status, and cardiovascular stress, particularly among vulnerable populations such as elderly individuals and outdoor workers. Urban zones such as Bengaluru show compounded risk where heat variability intersects with pollution and dense population exposure.

DISCUSSION

The analysis demonstrates a clear geographical relationship between climate variability and health outcomes in Karnataka. Rising temperatures and fluctuating rainfall patterns create region-specific environmental conditions that shape disease prevalence and health risks.

Climatic instability rather than absolute rainfall reduction appears to be the defining characteristic of recent trends. Irregular rainfall and extreme precipitation events increase vector breeding environments, contributing to rising dengue cases across the state. This reflects global findings that changing climatic conditions alter disease ecology in tropical regions.

The agroclimatic zone framework provides strong evidence that health impacts are spatially differentiated. Coastal and Malnad zones experience humidity-related disease risks, whereas dry northern zones face heat stress and water scarcity. This confirms that climate-health relationships must be interpreted geographically rather than through generalized state-level averages.

The findings highlight the importance of integrating climate monitoring with health surveillance systems. Existing health programmes largely respond to outbreaks rather than proactively incorporating meteorological data for predictive planning.

From a development perspective, climate variability intersects with urbanization, infrastructure quality, and socioeconomic vulnerability. Rapidly expanding urban regions show rising climate-sensitive disease exposure due to drainage challenges and population density. The discussion indicates that climate variability is increasingly emerging as a public health concern in Karnataka. Geographical evidence supports the need for region-specific climate adaptation strategies within health policy frameworks.

POLICY RELEVANCE AND IMPLICATIONS

The findings of this study have important implications for climate-responsive public health planning in Karnataka. The observed increase in climatic variability, particularly irregular rainfall, heat stress conditions, and extreme weather events, highlights the need for integrating climate data into health governance systems. Government agencies such as the Karnataka State Natural Disaster Monitoring Centre and the Health and Family Welfare Department can strengthen early warning systems by linking meteorological forecasting with disease surveillance, especially for vector-borne diseases such as dengue and chikungunya. The geographical variation observed across agroclimatic zones indicates that uniform policies may be ineffective; instead, region-specific health strategies are required. Coastal districts may require enhanced flood management and water sanitation interventions, while northern dry zones need heatwave preparedness and access to safe drinking water. Urban regions require climate-sensitive infrastructure planning to reduce environmental health risks arising from drainage issues and heat accumulation. Additionally, integrating climate awareness into primary healthcare planning can improve preparedness at district levels. These findings support the development of climate-resilient health policies aligned with sustainable development goals and emphasize the need for interdisciplinary coordination between meteorological, environmental, and health institutions.

CONCLUSION

This study examined climate variability and its health implications in Karnataka using secondary government datasets and a geographical analytical framework. The analysis identified increasing temperature trends, rainfall irregularities, and regional climatic contrasts across agroclimatic zones that influence health outcomes differently across the state. Rising trends in vector-borne diseases and heat-related vulnerabilities suggest that climate variability is emerging as a significant environmental

determinant of health. The study highlights that geographic context plays a central role in shaping climate-health relationships, requiring localized planning rather than generalized state-level approaches. By combining environmental and health statistics, the research provides evidence supporting climate-informed public health interventions. Strengthening climate monitoring, improving regional preparedness, and integrating environmental data into health policy frameworks are necessary for reducing future vulnerability and promoting sustainable health outcomes in Karnataka.

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