



Impact of Climate Change and Water Resources in India

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Abstract

Significantly depleting India's water resources, climate change is therefore hurting agricultural and socio-economic stability. This paper combines few current studies to evaluate their impact on coastal areas, groundwater and rainfall. Results point to falling yearly rainfall and increasing temperatures, which aggravate groundwater depletion and irrigation needs. Uneven rainfall in Northeast India is causing more water scarcity, which endangers food security. Rising sea levels and frequent floods in coastal areas put pressure on water management systems and cause climate-related migration. Extreme weather occurrences disturb agricultural calendars and hydrological cycles considerably more. Balancing water demand and supply calls for urgent adaptation actions such as precision irrigation, integrated water resource management (IWRM) and climate-resilient infrastructures. This study emphasizes the need of regional research and adaption plans. Sustainable water policies and better forecasts can help to protect water resources and national food security by strengthening resilience. Navigating the country's climate and water sustainability issues calls for cooperative action.

Keywords: Climate change, Monsoon variability, Rainfed agriculture, Water resources

Introduction

India's freshwater resources are becoming more and more strained because of sudden climate change, which is remaking weather trends, hydrological cycles and agriculture. As the nation is faced with erratic rainfall and rising temperatures, surface and groundwater systems are coming under threat, having an effect on water availability and quality over large regions (Deo, 2024). Agriculture, as the economic backbone of India and the major source of livelihood for more than half the population, is most susceptible to such changes. Rainfed agriculture, which contributes the largest share of crop production, is affected by erratic monsoon patterns, leading to unpredictable yields and increased water stress (Parwin *et al.*, 2023).

Recent studies have shown that climate change not only impacts precipitation patterns but also aggravates evapotranspiration, thus enhancing the water requirement for crops during a period when water supply is reducing

(Chakraborty *et al.*, 2025). Areas like Northeastern India, which are characterized by receiving almost twice the national average rainfall, have still witnessed a high degree of seasonality negatively impacting rainfed agriculture. At the same time, deltaic and coastal areas are facing the double threat of sea level rise and rising occurrences of flooding, which are threats to infrastructure as well as human habitation (Beri *et al.*, 2024).

Given these problems, it is critical to create and implement adaptive water management strategies. Solutions through the introduction of climate-resilient irrigation systems, improved strategies in water productivity and integrated water resources planning are the hour of need. The rest of this paper discusses climate change impacts on the water resources of India through reviewing major studies, determining upcoming trends and outlining adaptive measures that are able to reduce these negative impacts.

India's climate change is felt through changing regimes

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of precipitation and temperature extremes that disrupt hydrological processes and crop production. It is established in studies that, on average, India is losing mean rainfall with a rising trend of temperature, which together lower the water availability and raise the demand for irrigation (Parwin *et al.*, 2023). This section gives an overview of the main effects on water resources, considers regional differences and discusses possible adaptive measures.

Changing Rainfall Patterns and Hydrological Impacts

Recent studies in Northeastern India suggest a significant decline in winter and monsoon-season rainfall (Chakraborty *et al.*, 2025). Northeastern India has higher annual rainfall than the country's average, but intra-annual variability includes excess and deficit periods. Decreases in light and moderate rainfalls, as well as increases in heavy rainfalls, make water storage and management challenging. Besides this, increased temperature has elevated evapotranspiration rates and consequently the crop water demand at important growth stages. The trend is more marked under rainfed crops, where saving water becomes more difficult (Chakraborty *et al.*, 2025).

Implications for Agricultural Water Use

Indian agriculture is highly climate-sensitive. The upward trend in temperature directly influences the crop evapotranspiration and causes a significantly high rise in irrigation demand. For example, the reference evapotranspiration (ET_0) is increasing due to higher temperatures as reflected in studies involving the FAO CROPWAT model and, consequently, the crop water requirement increases (Parwin *et al.*, 2023). The augmented irrigation requirement in a situation of declining rainfall further puts additional pressure on accessible water resources, further intensifying the competition between non-agricultural and agricultural sectors. Koushal *et al.* (2024) highlighted that water productivity could be increased with better irrigation methods and precision agriculture to avoid over-exploiting water resources during the next two decades.

Coastal and Riverine Vulnerabilities

India's river basins and coastal regions are also among the most susceptible to the impacts of climate change. Sea level rise is expected to lead to frequent coastal flooding as well as incursions of salts, which contaminate freshwater sources as well as drinking water sources (Beri *et al.*, 2024). The increasing frequency and intensity of cyclonic occurrences are other reasons contributing to these issues, leading to extensive damage to infrastructure and population displacement losses. This threat is also heightened in highly populated coastal areas where current water resources management frameworks are insufficient to counteract the sudden changes. Hence, climate resilient water infrastructure development and integrated coastal zone management become essential to protect these vulnerable areas (Beri *et al.*, 2024).

Groundwater Depletion and Sustainability Challenges

Decline in groundwater level is another vital issue associated

with climate change. As agriculture accounts for about 78% of national water consumption, over-extraction with less recharge caused by lesser rainfall leads to widespread groundwater loss (Deo, 2024). This unmanageable method collapses future aquatic security while damaging rural enterprises which rely on groundwater resources for water supply and cultivation. To address this issue, policymakers and water managers have to assign the highest priority to measures such as water-saving technology promotion, regulation of groundwater extraction and artificial recharge.

Adaptive Strategies and Policy Responses

In order to alleviate the harmful effects of climate change on water resources, a number of adaptive measures have been suggested. The use of precision agriculture techniques that ensure optimal water usage efficiency is one of the major suggestions. The utilization of emerging technologies such as remote sensing and decision support systems can help in improving irrigation scheduling and monitoring crop water status (Koushal *et al.*, 2024). Besides, promotion of integrated water resources management (IWRM) is important that aligns the water interests of various stakeholders. For this purpose, irrigation practice has been improved, but investment in climate-resilient water infrastructure for flood risk reduction and equitable water distribution is necessary.

Policy-wise, regional climate modeling and regional impact assessments are being stressed more. They enable region-specific adaptation strategies that take into consideration the peculiar climatic and hydrological characteristics of various regions. For example, region-specific studies in Northeast India have pointed to adaptive strategies that manage both high rainfall variability as well as the increasing temperature trends (Chakraborty *et al.*, 2025). In addition, increasing coordination among government institutions, research centers and communities is essential to achieving resilience to climate-induced water scarcity.

Socio-Economic Implications and Future Directions

The intersection of climate change with water resources is not only environmentally impactful but also socioeconomically important. Rural societies, especially those with agriculturally based economies, are most susceptible to revenue losses, out-migration and food insecurity. As rising water demand and groundwater depletion are a catastrophic threat on the horizon, policy action is required to tackle both the environmental and social aspects of water scarcity (Deo, 2024). Upcoming research needs to aim for the establishment of solid, local-scale models to predict water availability across different climate situations and support sustainable water resource management. Research reviewed here demonstrates that climate change is reshaping the hydrology of Indian water resources. The risks cover not just a reduction of available water from reduced rainfall and increased evapotranspiration but also increased risks in riverine and coastal areas and improper utilization of groundwater. The adaptive measures incorporating innovative farming practices, resilient infrastructure and effective policy frameworks are necessary to reduce these

effects and ensure India's water future.

Conclusion

In summary, the chemistry of water management and climate change in India is a reason for growing worry. With the increasingly unpredictable rainfall patterns and still-rising temperature, the influence on surface and groundwater resources spells an enormous risk to rural livelihood and agricultural yields. The article proposes the imperative of adaptive measures, such as the creation of resilient water systems, efficient irrigation and the use of integrated water resource management systems. The issues are highly intricate, with intra-regional differences requiring customized solutions that are sensitive to local conditions. While programs by the government such as “*Jal Shakti Abhiyan*” set the foundations for improvement, long-term investment in research and development, technology and social outreach will be required to achieve long-term resilience. Eventually, India's water resources will have to be guarded through the efforts of policymakers, researchers and local communities alike to prevent the ill impacts of climate change and provide access to water resources in the years ahead.

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