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Average Rainfall and Water Requirements of Bundelkhand Region: Causes, Consequences, and Solutions

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Abstract: ***The Bundelkhand region, receiving an annual rainfall of approximately 1000 mm, with nearly 90% occurring during the short span of July and August, is traversed by major rivers. However, this region grapples with a severe water crisis exacerbated by factors such as burgeoning agriculture, population growth, unpredictable rainfall patterns, the impact of climate change, political complexities, water mismanagement, misuse, and environmental negligence, including the neglect of traditional water sources. This abstract provides an overview of a comprehensive study on the shifting water table dynamics within the Bundelkhand region. It explores the multifaceted factors contributing to the alteration of groundwater levels, examines the far-reaching repercussions of these changes on the environment and livelihoods, and proposes sustainable solutions to mitigate the looming water crisis. Through a synthesis of scientific research and on-ground observations, this study sheds light on the intricate web of natural and anthropogenic drivers responsible for the declining water table. Furthermore, it underscores the urgent need for collective action and policy interventions to safeguard water resources, ensure agricultural resilience, and improve the quality of life for the people of Bundelkhand.***

Keywords: average rainfall, water table, bundelkhand, environment etc.

I. INTRODUCTION

The Bundelkhand region, situated in the northern part of India, has been grappling with a severe water crisis in recent years. One of the critical aspects of this crisis is the fluctuation in the water table. This article explores the changes in the water table in the Bundelkhand region, their causes, consequences, and potential solutions, drawing upon various studies and reports up to September 2021 (1). Drought encompasses various definitions and classifications, including meteorological drought, which is determined by a lack of rainfall, agricultural drought, which is determined by crop failure, and hydrological drought, which is determined by the availability of groundwater. The process of declaring a drought is a complex administrative procedure that differs at the sub-national level (3, 4). Several states in India take into account various indicators, such as a rainfall departure of above 25% from the annual average in the district or tehsil/villages, estimation of crop loss, reduction in the area of land used for crop cultivation, and migration, before officially designating and declaring a drought. Oftentimes, even if there is a significant shortfall in rainfall, drought may not be formally declared, but there can still be comparable hardship (resembling a drought condition) in the economy. In addition, the state government has the authority to officially proclaim a drought in specific locations, specifically at the sub-district level, such as tehsils or villages. The majority of Indian states adhere to the meteorological definition of drought, which is based on a lack of rainfall, in order to officially declare droughts and provide financial assistance. In 2017, the Directorate of Economics and Statistics of Uttar Pradesh and Madhya Pradesh reported that the percentage of net irrigated area to net sown area in the Bundelkhand region of Uttar Pradesh (UP-B) was roughly 56%, while in Madhya Pradesh (MP-B) it was 55% (5, 6).

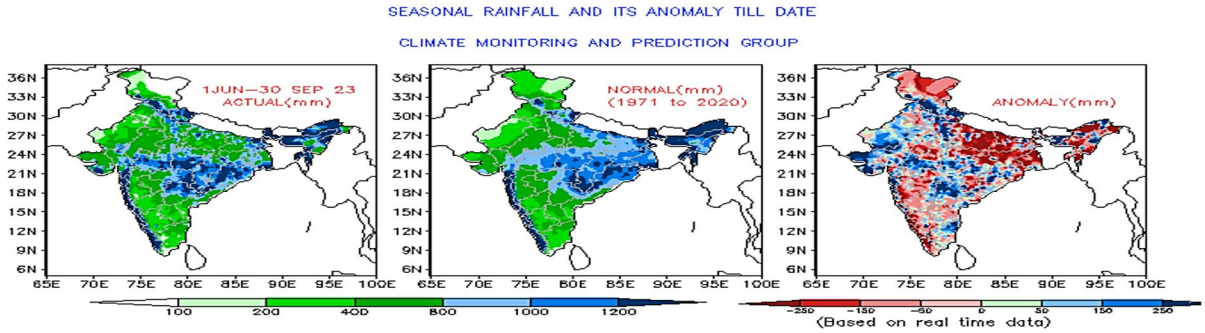


Figure 1. Map of Rainfall in India (IMD) (1, 21).

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A. Causes of Water Table Change in Bundelkhand

1) *Over-Exploitation of Groundwater:* The primary cause of the declining water table in Bundelkhand is the excessive withdrawal of groundwater for agriculture, industrial, and domestic purposes. In the absence of sustainable management practices, this over-exploitation has led to a significant drop in water levels (2).
2) *Erratic Rainfall Patterns:* Bundelkhand has experienced erratic rainfall patterns, with prolonged droughts interspersed with heavy rainfall events. These irregularities in precipitation exacerbate the region's water woes and contribute to fluctuations in the water table (7, 8).
3) *Deforestation and Land Use Changes:* Deforestation and changes in land use practices have disrupted the natural hydrological cycle in Bundelkhand. The loss of vegetation cover reduces the infiltration of rainwater, leading to reduced groundwater recharge.

B. Consequences of Water Table Change

1) *Agricultural Impacts:* The agricultural sector in Bundelkhand is heavily dependent on groundwater for irrigation. The declining water table has led to reduced agricultural productivity, increased production costs, and financial stress for farmers (9, 10).
2) *Drinking Water Shortages:* Depleting groundwater levels have resulted in acute shortages of potable water in many villages. Residents often have to travel long distances to fetch water, which disproportionately affects women and children (11, 12).
3) *Ecological Degradation:* The fluctuation in the water table has adverse ecological effects, including the drying up of rivers, wetlands, and ponds. This impacts local biodiversity and disrupts fragile ecosystems (13).

C. Solutions to Mitigate Water Table Decline

1) *Rainwater Harvesting:* Implementing rainwater harvesting techniques can help recharge groundwater and provide an additional source of water for both agriculture and domestic use.
2) *Sustainable Agricultural Practices:* Promoting sustainable farming practices such as drip irrigation, crop rotation, and reduced water-intensive crops can reduce the pressure on groundwater resources (14).
3) *Community-Based Water Management:* Encouraging community participation in water management, along with the adoption of water-efficient technologies, can help in equitable distribution and sustainable use of groundwater (15).
4) *Afforestation and Reforestation:* Reforestation efforts can improve the region's hydrological balance by enhancing groundwater recharge. Protecting existing forests is equally vital.

II. METHODOLOGY

This study mainly focused on understanding the causes of water crises, perception of the people, mechanism of maintenance of these sources, agricultural practices, etc., by conducting an extensive survey on the forest cover, floods and drought situation, water supply through other modes, traditional relevant practice, specific problems of the area, and the Governmental efforts in this direction. The source of water for drinking and irrigation was collected and evaluated along with perceptions of villages people about the roots of their water problems were also surveyed, which can mitigate or solve these problems (15, 16).

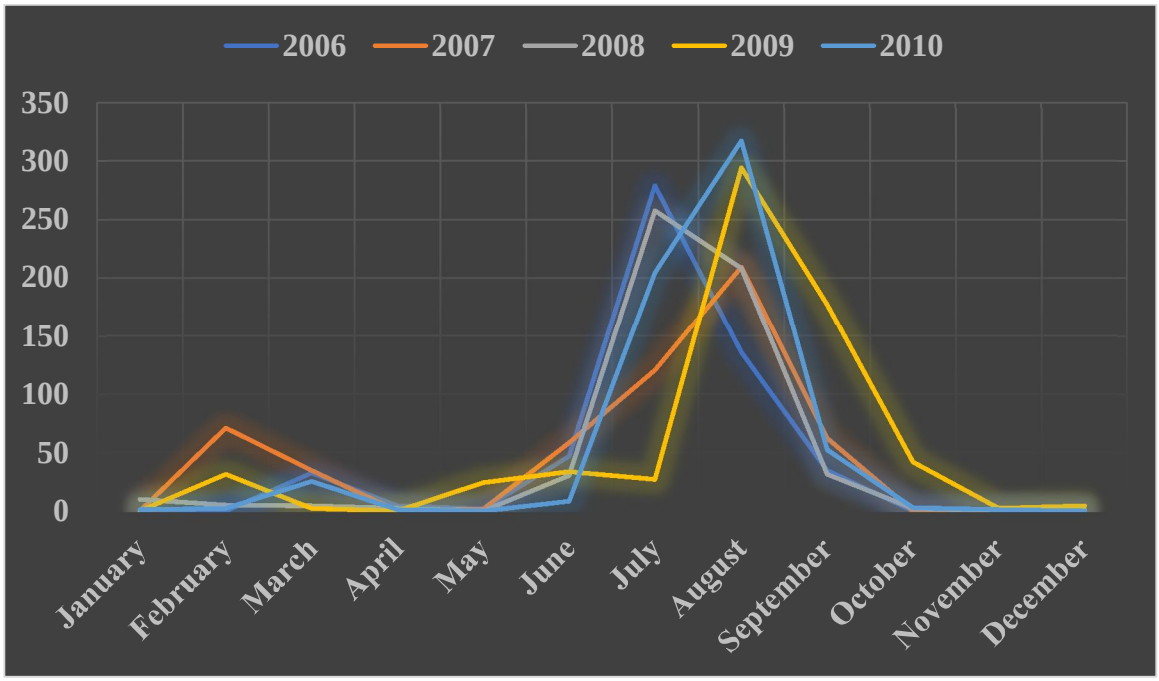
III. RESULTS

Table 1. Average rainfall (in mm) in Bundelkhand region of Madhya Pradesh Region (yearly) (1).

S. No.	Months	2006	2007	2008	2009	2010
1.	January	0	0	010.01	000.86	001.23
2.	February	0	071.02	005.00	031.06	002.21
3.	March	032.61	034.42	004.21	002.33	025.21
4.	April	004.40	0	002.11	0	000.87
5.	May	001.66	001.66	0	024.13	0
6.	June	046.53	058.23	030.12	033.60	008.35
7.	July	279.00	120.47	257.55	026.90	204.25
8.	August	135.50	209.14	208.08	294.20	317.19
9.	September	034.80	061.98	031.25	177.00	052.20
10.	October	0	0	002.12	041.80	003.02
11.	November	0	0	0	002.36	001.10
12.	December	0	0	001.22	004.53	0

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Average rainfall was recorded in mm. Average rainfall was minimum or approximately zero in January, February, March, April, May, October, November, and December. Whereas in July and August is was above 100 mm (table 1 and graph 1).



Graph 1. Average rainfall in Bundelkhand region of Madhya Pradesh.

IV. DISCUSSION & CONCLUSION

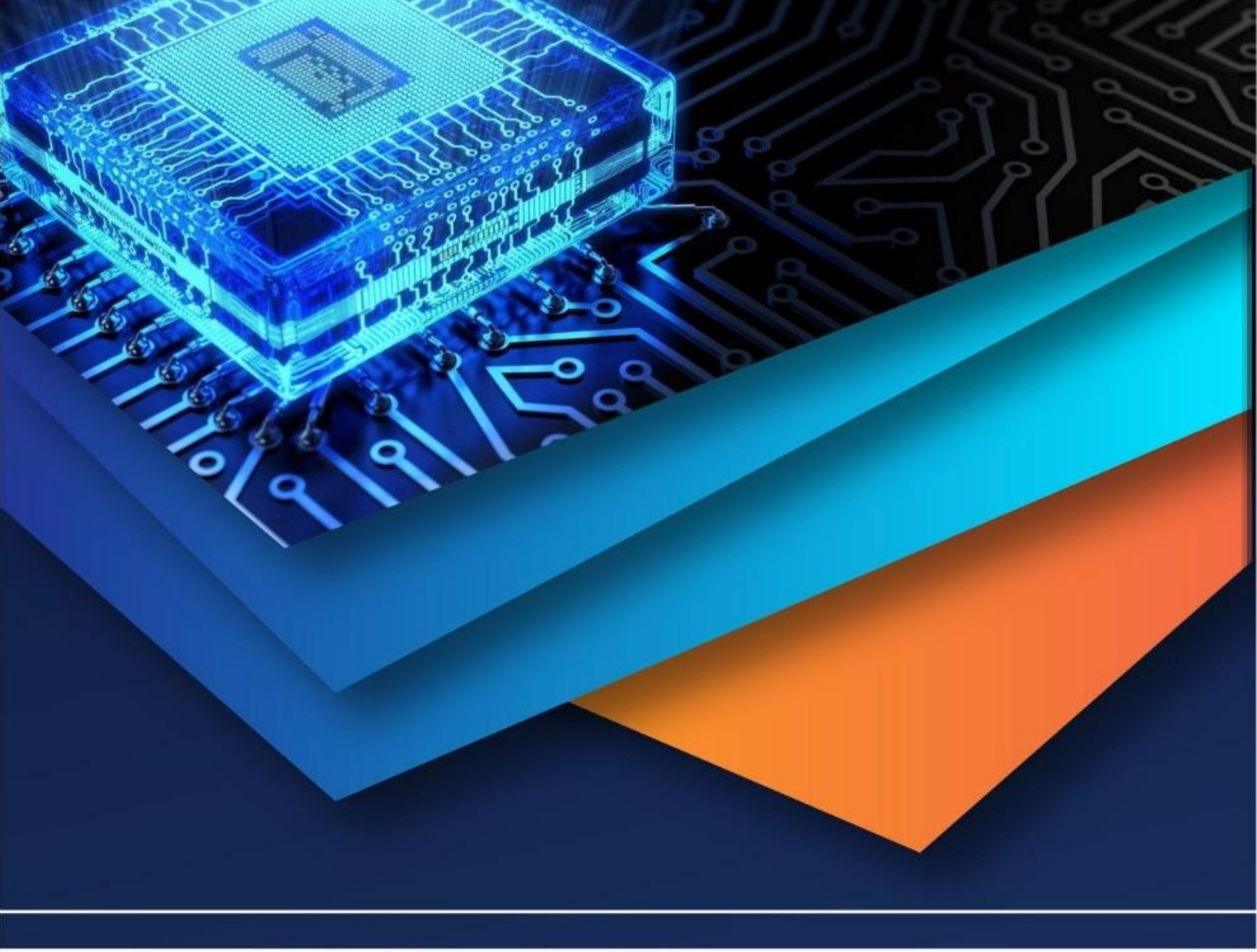
The Bundelkhand region faces a severe water crisis driven by factors like over-exploitation of groundwater, erratic rainfall, and deforestation. This has resulted in adverse consequences for agriculture, access to clean water, and the environment (18-20). Average rainfall is very low in this region and water scarcity becomes a great threat to the ecological balance of this area. To address these challenges, sustainable solutions such as rainwater harvesting, sustainable agriculture, community-based water management, and afforestation must be prioritized. Long-term planning, government intervention, and active community participation are essential to mitigate the water table decline in Bundelkhand and ensure a sustainable water future for the region.

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