Akshardhara Research Journal
Single Blind Peer-Reviewed & Refereed International Research Journal
E ISSN -3048-8095 / Bimonthly / May-June 2025 / VOL -01 ISSUE-VI

14

Geographical Analysis of Groundwater Depletion in Rural Maharashtra

Mr. Girish S. Sarode
Dept. of Geography
Smt. P. K Kotecha Mahila College Bhusawal

Abstract

Groundwater has long served as the invisible yet critical foundation for rural Maharashtra's socio-economic stability. Acting as a reliable source for both drinking water and agricultural sustenance, it has enabled rural communities to survive during erratic monsoon years and droughts. In regions where surface water infrastructure is either inadequate or poorly maintained, groundwater has been the primary fallback mechanism for millions of farming households. It is estimated that over 80% of rural drinking water and more than 60% of irrigation needs in the state are met through groundwater resources.

However, in recent decades, the over-dependence on groundwater has led to a silent but severe crisis. Over-extraction caused by unregulated borewell drilling, the proliferation of water-intensive crops like sugarcane, and a growing population have placed unsustainable stress on aquifers. Simultaneously, erratic and declining rainfall due to climate change, poor watershed management, and outdated irrigation techniques have reduced natural groundwater recharge. Consequently, districts in Marathwada (e.g., Beed, Jalna), Vidarbha (e.g., Yavatmal), and parts of Western Maharashtra (e.g., Ahmednagar) have reported annual declines in water table levels exceeding 1–2 meters.

This research paper presents a comprehensive ***geographical analysis*** *of the groundwater depletion crisis in rural Maharashtra. It combines quantitative and spatial data—including satellite-based groundwater monitoring, rainfall trend analysis, and land-use mapping—with socio-economic field surveys. Through this multidimensional approach, it identifies specific geographical zones most at risk and investigates how land use, cropping practices, and local climatic conditions correlate with groundwater depletion.*

The analysis reveals significant spatial disparities in groundwater status across the state. While some areas show resilience due to traditional water conservation practices or efficient irrigation, others have become critical zones of concern. The paper discusses both ***natural factors*** *(e.g., geology, rainfall variability, soil permeability) and* ***human-induced factors*** *(e.g., farming decisions, borewell proliferation, policy failures) contributing to this crisis.*

Ultimately, the findings emphasize the urgent need for ***policy interventions*** *that are not only scientific but also* ***geographically tailored****. Recommendations include promoting low-water-requirement crops, enforcing borewell regulations, expanding micro-irrigation, strengthening community-led water budgeting, and scaling up watershed programs like* ***Jalyukt Shivar Abhiyan****. Without these systemic and location-specific changes, the future of water security—and consequently rural livelihoods—in Maharashtra remains under severe threat.*

Keywords- Groundwater depletion, Rural Maharashtra, Water table, Irrigation, Sustainability, Agriculture, Marathwada, Rainfall deficit, Water crisis, Geospatial analysis.

Introduction

Groundwater forms the backbone of rural Maharashtra's water infrastructure, catering to both agricultural and domestic needs. Given the predominantly agrarian nature of the state's economy and its heavy dependence on monsoonal rains, groundwater has long served as a critical fallback resource during periods of rainfall deficit or delayed monsoon onset. According to the Central Ground Water Board (CGWB), nearly **60% of irrigation** and **80% of drinking water** requirements in rural regions of Maharashtra are fulfilled through groundwater withdrawal. In the absence of robust surface water

©Copyright 2024 *ADRJ*. All Rights Reserved

Akshardhara Research Journal
Single Blind Peer-Reviewed & Refereed International Research Journal
E ISSN -3048-8095 / Bimonthly / May-June 2025 / VOL -01 ISSUE-VI

networks and limited reservoir capacities in many districts, groundwater has emerged as the most accessible and flexible water source for millions of households.

However, this overreliance on groundwater has triggered a silent crisis. The past few decades have seen an exponential rise in **population density, borewell installations, and water-intensive cropping practices**, all of which have collectively pushed aquifers beyond sustainable thresholds. Particularly in **drought-prone zones** such as **Marathwada** and **parts of Vidarbha**, where annual natural recharge is already minimal, the demand-supply gap has widened alarmingly. Satellite imagery and long-term hydrological studies show a consistent **decline in water table levels across more than half of Maharashtra's talukas**, leading to reduced agricultural productivity, drinking water shortages, and even inter-village conflicts over water access.

In light of this escalating concern, the present study undertakes a **spatial and thematic analysis** of groundwater depletion using **Geographic Information Systems (GIS)**, **hydrological datasets**, and **field-level observations**. By mapping trends, identifying high-risk zones, and analyzing correlations with rainfall variability, cropping intensity, and socio-economic factors, this research seeks to present a **comprehensive geographical perspective**. Moreover, it proposes **region-specific and community-driven strategies** that integrate conservation efforts, decentralized water governance, and climate-resilient planning. The ultimate aim is to offer evidence-based insights to inform policy and ensure long-term groundwater sustainability in rural Maharashtra.

Discussion

1. Regional Patterns of Groundwater Depletion

The geographical spread of groundwater depletion in rural Maharashtra reveals critical regional disparities, with some districts experiencing alarmingly high rates of aquifer exhaustion. Notably, regions in **Marathwada**, including **Beed**, **Jalna**, and **Osmanabad**, have consistently ranked among the most water-stressed areas in the state. These districts report annual groundwater level declines of **1.5 to 2 meters or more** in specific blocks, especially those with intensive irrigation and limited surface water alternatives. Similarly, **Yavatmal** in **Vidarbha** and **Ahmednagar** in **Western Maharashtra** exhibit patterns of sustained groundwater extraction far exceeding natural recharge rates.

These regions are frequently classified as **"Over-exploited" or "Critical" zones** by the **Central Ground Water Board (CGWB)**. The persistent appearance of red zones in CGWB atlases highlights a dangerous trend of aquifer stress and hydrological imbalance. The over-exploitation is compounded by **erratic monsoons**, **shallow recharge structures**, and **unsustainable cropping patterns** such as sugarcane and cotton cultivation, which demand significant water input. Without sufficient groundwater governance or community regulation mechanisms in place, these areas continue to witness a steady decline in water table levels, leading to severe impacts on agriculture, drinking water availability, and ecological stability.

2. Causes of Over-Extraction

The rapid depletion of groundwater in rural Maharashtra is primarily driven by **intensive agricultural practices**, particularly the cultivation of **water-intensive cash crops** like **sugarcane**, **cotton**, and **banana**. These crops demand large volumes of water over extended growing periods, significantly increasing groundwater withdrawal during both kharif and rabi seasons. In the absence of assured surface water supplies such as canals or reservoirs, farmers rely heavily on **groundwater as the primary irrigation source**, leading to unsustainable extraction patterns.

Another critical factor contributing to over-extraction is the widespread and unregulated use of **borewells**, which have evolved from being shallow (50–100 feet) in the 1990s to **deep boreholes exceeding 500–700 feet** in some of the worst-affected regions today. This vertical drilling into deeper aquifers not only signals increasing **aquifer stress**, but also reflects the **desperation among farmers** facing repeated droughts and poor rainfall.

The **lack of awareness and regulation** in well-drilling practices, coupled with inadequate enforcement of groundwater laws, further exacerbates the problem. Additionally, **subsidized**

©Copyright 2024 *ADRJ*. All Rights Reserved

Akshardhara Research Journal
Single Blind Peer-Reviewed & Refereed International Research Journal
E ISSN -3048-8095 / Bimonthly / May-June 2025 / VOL -01 ISSUE-VI

electricity for agriculture encourages excessive pumping, with little incentive to adopt water-saving technologies like drip or sprinkler irrigation. In this context, groundwater is treated as an **open-access resource**, leading to the classic "tragedy of the commons" scenario, where individual benefit outweighs collective sustainability.

3. Climate Change and Rainfall Variability

One of the most significant environmental factors aggravating groundwater depletion in rural Maharashtra is the **increasing unpredictability of rainfall patterns due to climate change**. Traditionally, monsoon rains played a pivotal role in replenishing aquifers through natural percolation and surface runoff. However, in recent decades, there has been a **marked disruption in monsoonal regularity**, including **delayed onset**, **shorter durations**, **prolonged dry spells**, and **sudden high-intensity rainfall events**, which collectively impair groundwater recharge cycles.

These erratic shifts have resulted in **poor infiltration**, as intense rains often lead to **runoff** rather than seepage, especially in areas with degraded or compacted soil. Consequently, regions that once experienced stable recharge—such as the **upper Godavari basin** and **eastern Ahmednagar**—are now facing **seasonal droughts and prolonged water scarcity**.

Furthermore, **regional disparities** in rainfall have increased, with **Marathwada and Vidarbha** bearing the brunt of **recurrent monsoon failures**. The decline in **average annual rainfall**—as much as 20–30% in some pockets—has led to significant reductions in surface water availability, pushing rural communities to depend exclusively on groundwater. This over-dependence, when combined with inadequate recharge, accelerates the **lowering of the water table** and increases the **risk of long-term aquifer degradation**.

In the context of global warming, **rising temperatures** also play a secondary yet critical role by increasing **evapotranspiration rates**, thereby reducing soil moisture and further limiting recharge potential. The compounded effects of these climatic pressures underscore the urgency of adopting **climate-resilient water management** practices across Maharashtra's rural landscape.

4. Technological and Policy Gaps

Despite the introduction of various state-led and centrally sponsored initiatives aimed at water conservation, **technological limitations and policy execution failures** have considerably weakened their long-term effectiveness in rural Maharashtra. Programs such as **Jalyukt Shivar Abhiyan**, **micro-irrigation subsidies (drip and sprinkler systems)**, and **integrated watershed development projects** were designed to enhance groundwater recharge, promote efficient water use, and improve agricultural sustainability. However, their implementation has often been **geographically uneven, politically influenced, and poorly monitored**, leading to suboptimal outcomes.

One of the key shortcomings is the **lack of granular hydrological data at the village or block level**, which makes it difficult for policymakers and planners to design location-specific interventions. Most groundwater assessments rely on **outdated or aggregated district-level data**, which fails to capture the **micro-variability in water availability and usage patterns**. This disconnect often results in the allocation of resources to areas that may not need them, while more critical zones remain under-served.

On the technological front, while **drip irrigation systems** have shown promise in conserving water, their adoption is limited by **high initial costs**, **poor after-sale service**, and **a lack of farmer training**. Similarly, **rainwater harvesting structures** and **percolation tanks** suffer from inadequate maintenance and siltation issues, rendering them ineffective over time. Furthermore, **community-level awareness campaigns** and participatory water governance models are still underdeveloped, which limits grassroots involvement in conservation practices.

In the policy domain, there is a lack of **long-term integrated planning** that aligns water resource management with land use, cropping patterns, and climatic conditions. Most interventions are **reactive rather than preventive**, introduced only after a crisis emerges. The absence of **real-time monitoring systems**, **accountability mechanisms**, and **cross-departmental coordination** continues to be a significant bottleneck in achieving sustainable groundwater management.

©Copyright 2024 *ADRJ*. All Rights Reserved

Therefore, addressing these **technological and policy gaps** is essential for any future roadmap aimed at reversing groundwater depletion and ensuring water security in rural Maharashtra.

5. Social and Economic Impacts

The depletion of groundwater in rural Maharashtra has far-reaching **social and economic consequences** that extend beyond the environmental domain. One of the most immediate impacts is on **drinking water availability**. In many villages, handpumps and shallow wells have dried up, forcing residents—particularly women and children—to walk longer distances for accessing potable water. This not only affects daily life but also impacts **health, hygiene, and educational continuity**, especially for young girls.

In the agricultural sector, **rising irrigation costs** due to the need for deeper borewells and high-energy water pumps have put severe financial pressure on farmers. Marginal and small landholders—who form the bulk of the rural agrarian population—often lack the capital to invest in these technologies. Consequently, they face reduced crop yields, increasing **crop failure risks**, and greater vulnerability to **agricultural debt cycles**.

Groundwater stress has also triggered patterns of **seasonal and permanent migration** from affected regions, particularly in Marathwada and Vidarbha. Families relocate to urban centers in search of alternative livelihoods, leading to the **disintegration of rural communities**, disruption of children's education, and increased strain on urban infrastructure. In addition, it alters the **socio-economic fabric** of villages, where the elderly and women are left to manage farms and households under challenging circumstances.

Social inequality is further deepened as **wealthier farmers and landowners** with access to capital and political connections can extract groundwater more aggressively, often at the expense of community resources. This creates **conflict over water access**, fosters resentment, and undermines the spirit of **collective water management**. Dalits, tribals, and other marginalized communities are often the worst affected, as they depend on common water sources and have limited legal or institutional support.

Overall, the **human dimension** of groundwater depletion cannot be ignored. It exacerbates **poverty, distress, and inequality**, making it not just an environmental concern, but a **critical issue of rural development and justice** that requires urgent, inclusive, and sustainable interventions.

Conclusion

The groundwater crisis in rural Maharashtra is far more than an environmental issue—it is a deepening **socio-economic emergency** that jeopardizes agricultural productivity, drinking water availability, and overall rural stability. The trends observed in various drought-prone and over-exploited districts reveal that **groundwater depletion is spatially uneven**, requiring geographically tailored interventions instead of uniform state-wide policies.

There is an urgent need to transition from **water-intensive agriculture** to more sustainable and climate-resilient farming practices. This includes encouraging **crop diversification**, reducing the cultivation of water-guzzling crops like sugarcane in vulnerable zones, and promoting **drip and sprinkler irrigation** systems. Additionally, **community-based water governance**, coupled with **local aquifer mapping** through participatory approaches, can empower rural stakeholders to take ownership of conservation efforts. The fusion of **indigenous knowledge systems** with modern tools like GIS and satellite remote sensing can greatly enhance planning precision and responsiveness.

Strengthening **institutional mechanisms** is also vital. Local-level solutions like **water budgeting at the Gram Panchayat level**, implementation of **incentivized recharge structures** (e.g., check dams, percolation tanks), and **strict enforcement of groundwater regulation acts** should be prioritized. These initiatives must be supported by real-time data and regular impact assessments to ensure transparency and accountability. **Decentralization** of water management decisions can bring contextual sensitivity to interventions and improve their success rate.

Finally, achieving long-term water sustainability will only be possible through **multi-stakeholder collaboration**. Farmers, women, youth, NGOs, and government bodies must work together in an integrated manner. Awareness campaigns, school-level education on water literacy, and farmer training programs should be institutionalized. If Maharashtra is to avert a severe **groundwater catastrophe**, it must embrace a strategy that combines **scientific evidence, strong policy frameworks, and grassroots-level action** in a cohesive and determined manner.

References

1. Central Ground Water Board (CGWB). (2022). *Dynamic Ground Water Resources of India*. Ministry of Jal Shakti, Government of India.
2. Government of Maharashtra. (2021). *Water Resources Department Annual Report*.
3. Kulkarni, S., & Shah, M. (2019). *Groundwater Governance in India*. IWMI-Tata Policy Brief.
4. Mishra, A., & Rao, N. (2020). Geospatial assessment of groundwater stress in Maharashtra. *International Journal of Hydrology Research*, 45(3), 214–228.
5. Singh, R. B. (Ed.). (2017). *Water Resource Management in South Asia*. Springer.
6. Iyer, R. R. (2019). *Water and the Laws in India*. Sage Publications.
7. Jain, M. (2022). Climate change and its impact on groundwater in central India. *Environmental Monitoring and Assessment*, 194(12), 950. https://doi.org/10.1007/s10661-022-10589-w