WATER SCARCITY ISSUE IN MAHARASHTRA STATE WITH HIGHLIGHT ON PARBHANI DISTRICT

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Abstract
Water scarcity constitutes a persistent environmental and socio-economic challenge in Maharashtra, with acute manifestations in the semi-arid Marathwada region. Within this context, Parbhani district has emerged as a critical locus of concern, attributed to erratic precipitation patterns, declining groundwater reserves, and insufficient water management infrastructure. In 2024, the district recorded a mere 523 mm of rainfall substantially below its long-term average resulting in the depletion of eight minor irrigation schemes and rendering several reservoirs nearly desiccated. The district's dependence on basaltic aquifers, which are inherently susceptible to over-extraction and seasonal fluctuations, further intensifies the water scarcity. This study examines the multidimensional nature of water scarcity in Parbhani, encompassing climatic variability, hydrogeological limitations, and socio-political dynamics. It underscores the medium-level drought hazard classification assigned to the region and anticipates an escalation in severity under projected climate change scenarios. The cascading effects on agricultural productivity, public health outcomes, and rural livelihoods highlight the imperative for integrated water resource governance, adoption of sustainable irrigation technologies, and participatory conservation models. By situating Parbhani within the broader hydrological challenges of Maharashtra, the analysis seeks to inform evidence-based policy formulation and foster resilience through scientific planning and inclusive stakeholder engagement.
Keywords: *Maharashtra, Parbhani district, Water Scarcity, Climate, Rainfall*

Introduction:

India continues to grapple with a persistent water scarcity shortage, affecting hundreds of millions annually and exerting considerable pressure on ecological systems and agricultural productivity. Despite accommodating over 1.4 billion inhabitants, the nation possesses merely 4% of the global freshwater reserves (Dhawan, 2019). The seasonal desiccation of rivers and reservoirs particularly in states such as Maharashtra, Andhra Pradesh, and Rajasthan exacerbates the water scarcity. Maharashtra, characterized by climatic heterogeneity and a high dependency on agriculture, experiences acute water stress across six distinct regions. Key indicators include sustained reliance on water tankers, perennial shortages, and significant depletion of groundwater resources (Shinde & Kondhekar, 2025). In contrast, states like Uttar Pradesh and Himachal Pradesh report relative water abundance (Ghori, 2022).

Parbhani district, situated in the Marathwada region, serves as a microcosm of Maharashtra's broader hydrological challenges. Its basaltic geology, marked by poor water retention capacity, coupled with erratic rainfall only 523 mm recorded in 2024 has led to the failure of eight minor irrigation schemes and critically low levels in reservoirs such as Masoli and Zari. Hazard assessments forecast a 20% probability of drought occurrence over the next decade, posing significant risks to agricultural sustainability, food security, and public health. The intensifying drought conditions in regions like Maharashtra and Saurashtra (Gujarat), where crop failures and farmer suicides are increasingly prevalent, underscore the severity of the water scarcity (Times of India, 2024). This analysis establishes a foundation for examining the water shortage in Parbhani, elucidating its underlying causes, socio-environmental impacts, and potential mitigation strategies. It further situates the district within the broader discourse on climate vulnerability and systemic water mismanagement across Maharashtra, thereby informing policy frameworks aimed at resilience and sustainable resource governance.

Methodology & data source

This study is based exclusively on secondary data derived from a range of authoritative sources, including government publications, Yojana Magazine (Government of India), peer-reviewed academic literature, Aquifer Maps and the Ground Water Management Plan, as well as verified online platforms. Particular emphasis is placed on the Parbhani District of Maharashtra, serving as the focal geographical unit for analysis.

Background

Parbhani District, located within the Marathwada region of Maharashtra, experiences recurrent episodes of water scarcity primarily attributable to irregular precipitation patterns, inadequate water governance mechanisms, and progressive depletion of groundwater resources.

Fig.1.1 Map of Maharashtra State and Parbhani district

Climatic Context

Parbhani District, situated at 505.1 meters above sea level, experiences a tropical wet and dry climate (Aw), with an average annual temperature of 30.04°C approximately 4% above the national mean and predominantly arid conditions, receiving most of its rainfall during the southwest monsoon (June–September) and following a four-season cycle: cold (December–February), hot (March–May), monsoon (June–September), and post-monsoon (October–November).

Rainfall Deficit

In 2024, Parbhani District received only 523 mm of rainfall, well below its annual average, indicating severe water stress. As of 18 May 2025, cumulative rainfall was 20.0 mm. Between June 2018 and May 2025, daily rainfall averaged 62.1 mm, with extremes from 761.3 mm (30 Sep 2021) to 0.0 mm (1 Jan 2022). Data from the India Meteorological Department via CEIC reveal high interannual variability, with monsoon rains crucial for agricultural output. Figure 1.2 illustrates the long-term rainfall trends from 1999 to 2019, indicating a consistent decline in annual precipitation, often falling below 1000 mm. This reduction has significantly impacted groundwater recharge, resulting in deeper borewell levels across the district.

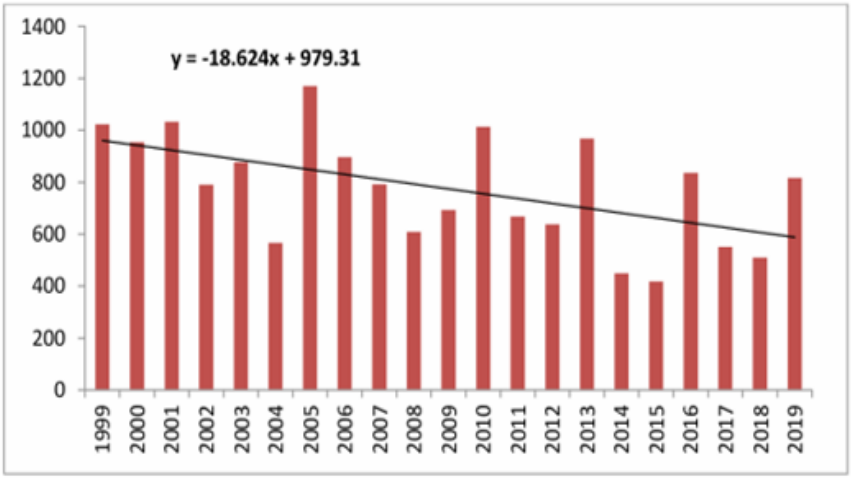

Fig. 1.2 Graph showing long term amount of rainfall during (1999-2019)

Dry Conditions in Reservoirs

Parbhani District contains several critical reservoirs that serve as primary sources for irrigation, potable water supply, and ecological regulation. Currently, the region is undergoing acute hydrological stress, marked by severe reservoir desiccation resulting from deficient rainfall and elevated ambient temperatures reaching up to 42.6°C. As of the latest observations, nine minor reservoirs have reached 0% storage capacity, while *Karpara* and *Masoli* reservoirs retain only 21% and 16.7% of their respective capacities. Tanks located in *Pedgaon, Adgaon, Chincholi,* and *Devgan* are nearly depleted, leading to adverse consequences for agricultural productivity and livestock sustenance,

including fodder scarcity and widespread crop damage.

Groundwater Depletion

Parbhani District hosts a network of strategically significant reservoirs that function as primary sources for irrigation, domestic water supply, and ecological stability. The region is presently experiencing acute hydrological stress, characterized by pronounced reservoir desiccation due to subnormal precipitation and elevated ambient temperatures, peaking at 42.6°C. Recent assessments indicate that nine minor reservoirs have reached complete depletion (0% storage capacity), while the Karpara and Masoli reservoirs retain only 21% and 16.7% of their respective capacities. Tanks in Pedgaon, Adgaon, Chincholi, and Devgaon are nearing exhaustion, resulting in substantial disruptions to agricultural output and livestock maintenance, including acute fodder shortages and extensive crop damage.

Affected Villages

Over the past five years, around 470 villages in Parbhani District have faced chronic water scarcity due to repeated monsoonal rainfall deficits. Talukas like Palam, Gangakhed, and Jintur consistently recorded below-average precipitation. From 2013 to 2023, seven out of twelve years saw subnormal rainfall, highlighting the district's climatic vulnerability and water sustainability challenges.

Seasonal Impact

The severity of the water shortage escalates during the summer months, compelling residents to undertake prolonged journeys to access potable water due to the depletion of local sources.

Discussions

Maharashtra, a prominent state in western India, encompasses a substantial portion of the Deccan Plateau and is bounded by the Arabian Sea to the west. As the second-most populous state in the country, it ranks among the most densely inhabited regions globally. With a civilizational history extending over millennia, Maharashtra shares its borders with Karnataka, Goa, Telangana, Chhattisgarh, Gujarat, Madhya Pradesh, and the union territory of Dadra and Nagar Haveli and Daman and Diu.

Among its five administrative regions, Marathwada is particularly vulnerable to hydrological stress, primarily due to deficient monsoonal precipitation ranging between 600–800 mm annually significantly lower than the 2000 to 4000 mm received by the Western Ghats. This disparity, compounded by physiographic constraints, intensive agricultural practices, and state-supported sugarcane cultivation, has exacerbated systemic water mismanagement and intensified the region's water scarcity.

Reason Back to the scarcity situation

Water scarcity in Maharashtra is driven by regional rainfall disparities, weak water governance, and climate variability. Key factors include promotion of water-intensive crops like sugarcane in drought-prone areas, poor adoption of sustainable irrigation, declining groundwater, and limited institutional coordination. These structural and environmental challenges demand integrated, region-specific solutions. Contributing factors underlying this persistent scarcity include:

a) Shadow zone effect

This region receives limited precipitation due to its location within the rain-shadow zone of the Western Ghats, where prevailing winds lose their moisture content upon ascending and crossing the orographic barrier. In seismology, the term "shadow zone" refers to areas on the Earth's surface where seismic waves are not detected, with their extent and characteristics varying according to wave type and the location of the earthquake epicenter.

b) Climate Change effect

Recent investigations reveal a discernible increase in the frequency and intensity of arid conditions across central Maharashtra, exacerbating the region's ongoing water scarcity (Kamble *et al.,* 2024). The agricultural sector, a cornerstone of the state's economy, is increasingly vulnerable to the adverse impacts of climate change. In the Indian context, climate change has far-reaching consequences for agriculture, water resources, forest ecosystems, biodiversity, public health, and coastal stability, with declining farm productivity emerging as one of its most critical outcomes (Sirsat, 2024).

Disruptions in monsoonal patterns manifested through reduced and erratic rainfall have significantly impaired crop growth, leading to diminished agricultural output and jeopardizing the livelihoods of millions. Western Maharashtra, in particular, is experiencing heightened climatic volatility, including rising temperatures and recurrent droughts, which have destabilized farming systems and reduced crop yields. Water-intensive crops such as sugarcane and rice are especially susceptible, underscoring the urgent need for climate-resilient agricultural practices and adaptive water management strategies. Figure 1.3 depicts a rising trend in annual atmospheric temperatures in Parbhani district, with summer temperatures frequently ranging between 40°C and 46°C, indicating intensifying heat conditions over time.

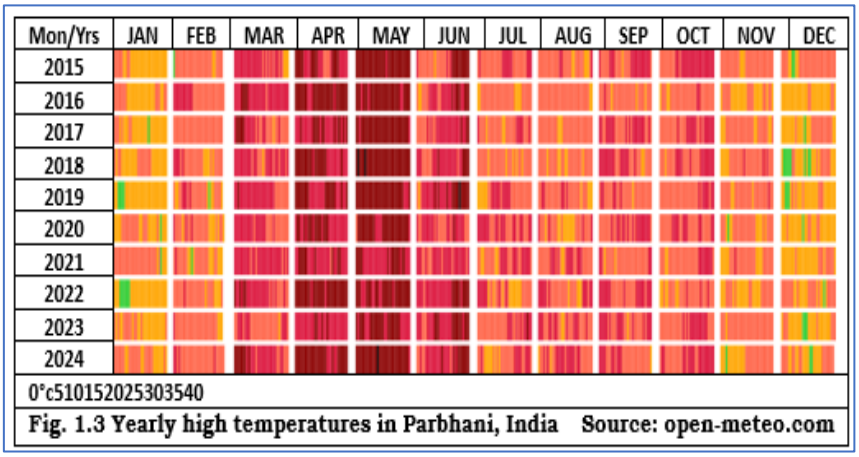

Fig. 1.3 Yearly high temperatures in Parbhani, India Source: open-meteo.com

c) Water intensified agriculture

Water-intensive agriculture refers to cultivation practices that rely heavily on substantial water inputs, particularly through irrigation, to enhance crop productivity and sustain intensive farming systems. Crops such as sugarcane, which require between 1500–2500 mm of water annually, are emblematic of this approach and contribute significantly to regional water stress. This method is prevalent in areas prioritizing high-output food production, where precise water management is essential to optimize yield and quality through efficient irrigation systems (Roy *et al.,* 2024). The Food and Agriculture Organization (FAO) has issued a Water Report outlining actionable strategies to achieve tangible water savings in agriculture by improving crop water productivity. Enhanced irrigation efficiency and equitable water allocation are central to these recommendations. Given the escalating global demand for food, irrigation not only remains indispensable for current agricultural output but must also be expanded and refined to ensure long-term sustainability.

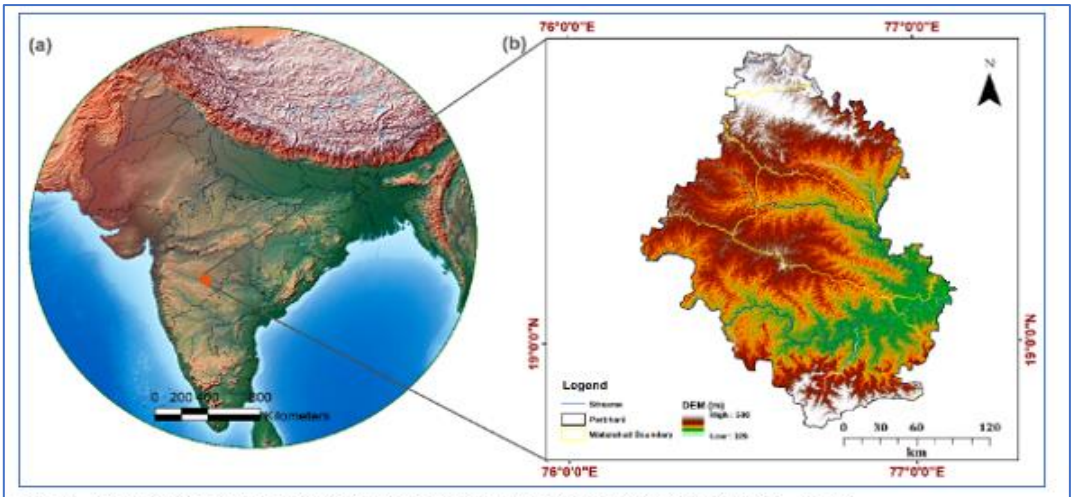

Fig. 1.4 Groundwater Potential Mapping in Parbhani District of M.S., India

d) Declining Dam Storage

Maharashtra, with over 2300 dams, is one of India's most dam-rich states. These structures are vital for irrigation, drinking water, power, and flood control especially in drought-prone regions like Marathwada and Vidarbha. Eleven major dams in Marathwada play a crucial role in sustaining agriculture and regional water security. Fig. 1.4. here is limited groundwater potential mapping data available on the quantitative mapping of surface water resources, necessitating comprehensive efforts to document their distribution and volume. Additionally, an extensive assessment of water quality must be undertaken to support effective resource management. Figure 1.5 presents the spatial distribution of groundwater locations across the district, offering a visual representation of key recharge zones, extraction points, and areas with varying groundwater availability.

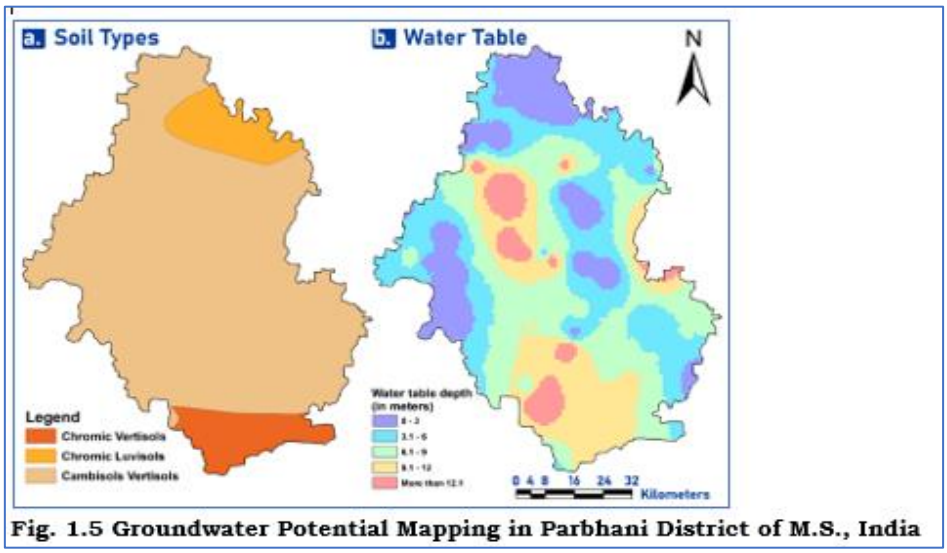

Fig. 1.5 Groundwater Potential Mapping in Parbhani District of M.S., India

Causes of water scarcity recorded

The key causes of water scarcity in Parbhani district were studied and include irregular and declining rainfall, overdependence on rain-fed agriculture, and excessive groundwater extraction. Limited irrigation infrastructure and topographical constraints further exacerbate the issue, especially in upland areas. Additionally, population pressure, low adoption of water-efficient practices, and gaps in policy and governance contribute to the district's persistent water stress.

Impact of the Water Scarcity

i) Drinking Water Shortage

Marathwada is currently experiencing an acute drinking water shortage affecting both rural and urban populations, necessitating emergency interventions such as the deployment of water tankers to meet basic consumption needs. In several areas, groundwater sources have been exhausted, with wells running dry and local reservoirs nearing depletion. Projections indicate that continued scarcity may compel authorities to transport water via rail from hydrologically stable regions (Kale & Gond, 2016). Parbhani District exemplifies this scarcity, having received only 523 mm of rainfall in 2024 substantially below the climatological norm. As a result, eight minor reservoirs have completely dried up, while nine others are functionally inoperative, further intensifying the region's dependence on external water provisioning mechanisms. Figures 1.6 and 1.7 depict the acute shortage of potable water during the summer months of April, May, and June, highlighting scenes of residents queuing for water tankers—a reflection of the district's strained water supply and growing dependence on emergency distribution systems.

Fig. 1.6 Water supply through tankers

Fig. 1.7 A line of peoples waiting for water

ii) Agricultural Losses

Crop failure induced by water scarcity has profound implications for agrarian livelihoods, contributing to widespread economic instability. In Marathwada, over 80% of agricultural land is rain-fed, rendering the region's farming systems highly susceptible to monsoonal variability. Historical data indicate that inadequate rainfall has precipitated significant yield reductions, such as the 40% decline recorded in 2015, resulting in substantial economic losses (Kharkre, 2021). Furthermore, shifts in cropping patterns driven by water availability constraints have exacerbated inter-regional water tensions between Marathwada and Western Maharashtra, highlighting the complex socio-hydrological dynamics of agricultural water use.

iii) Regional Disparities

Water scarcity in Marathwada exhibits significant spatial variability, with upland regions experiencing acute shortages due to limited groundwater retention, while valley areas maintain relatively higher subsurface water availability. Approximately one-third of Maharashtra falls within a rain-shadow zone, contributing to its designation as containing nearly 25% of India's drought-prone territory (IRAP India). Marathwada is particularly susceptible to recurrent droughts, with several districts receiving less than 50% of their average annual rainfall. This climatic unpredictability severely disrupts both agricultural productivity and the reliability of drinking water supplies.

Required Measures

Water scarcity in Maharashtra, especially in drought-prone areas like Parbhani, requires a multidisciplinary approach combining hydrology, climate science, agriculture, socio-economics, and policy reform for sustainable, region-specific solutions.

1) *Supply-side Solutions:* Adopting watershed practices like contour trenches, earthen bunds, and desilting water bodies improves resource management and boosts water availability.
2) *Demand-side Solutions:* Encouraging efficient irrigation, drought-tolerant crops, and varied livelihoods helps lower water demand.
3) *Policy Shifts:* Promoting low-water, high-value crops and shifting sugarcane to water-abundant regions can ease the scarcity.
4) *Government Intervention:* Stronger policies and focused aid for vulnerable areas boost water resilience.
5) *Integrated Water Resource Management (IWRM):* Holistic planning across the Parbhani's water scarcity stems from erratic rains, overuse, and poor recharge. IWRM offers coordinated planning across sectors for sustainable management.
6) *Community led Initiatives:* Empowering people through education/local groups for water conservation techniques.
7) *Technology Use:* Focus on using advanced technologies such as – GIS mapping, remote sensing, and smart irrigation systems.

Conclusion

Water scarcity in Maharashtra remains a pressing challenge, and its impact is deeply felt in districts like Parbhani. Irregular rainfall, over-dependence on monsoon, excessive groundwater extraction, and limited irrigation facilities have worsened the situation. Although government schemes and water conservation drives are being introduced, their success depends on active community participation, efficient water management, and sustainable agricultural practices. For Parbhani, strengthening watershed development, promoting crop diversification, and improving storage capacity in dams can provide long-term relief. Ultimately, solving water scarcity requires collective responsibility. Citizens, farmers, and authorities must work hand in hand to secure every drop of water for the future. Securing every drop of water

for the future demands collaborative action among citizens, farmers, and authorities. Future research on water scarcity in Maharashtra, particularly in Parbhani, should prioritize hydro-climatic analysis, agricultural adaptation, drinking water accessibility, governance frameworks, and technological innovations in water resource management.

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