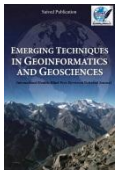

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# Water Security in Maharashtra State: A Geographical Perspective

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**Author's contribution**: The sole author designed, analysed, interpreted and prepared the manuscript

**Original Research Article**

**ABSTRACT:**

Water security, defined as the reliable availability of adequate water for health, livelihoods, ecosystems, and production, is a critical challenge in Maharashtra due to its diverse geography and uneven resource distribution. This study examines the geographical aspects of water security, including rainfall patterns, drought-prone areas, and resource management strategies. Drawing on secondary data from state policies, meteorological reports, and case studies, the analysis highlights spatial disparities across regions like Konkan, Madhya Maharashtra, Marathwada, and Vidarbha. Key findings reveal that while coastal areas benefit from abundant rainfall, interior regions face chronic scarcity exacerbated by climate variability and overexploitation. Through examples like the watershed management in Ralegan Siddhi, the paper demonstrates how community-led initiatives can enhance resilience. Recommendations emphasize integrated geographical planning to achieve sustainable water security.

**KEY WORDS**: Water, Security, Human Health, Agricultural Sustainability.

## INTRODUCTION:

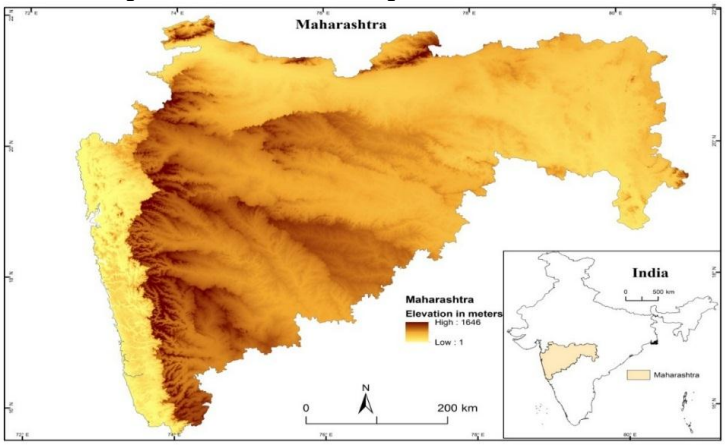
Maharashtra, located in western India, spans approximately 308 lakh hectares, making it the third-largest state by area. Its geography is marked by the Western Ghats (Sahyadri ranges), the Deccan Plateau, and a 720 km coastline along the Arabian Sea. This diverse topography influences water availability, with five major river basins—Godavari, Krishna, Tapi, Narmada, and west-flowing rivers—draining the state. However, water security remains precarious, as nearly 42.5% of the geographical area is water-stressed, and 40% is drought-prone. The state's estimated annual water resources total 198 billion cubic meters (BCM), comprising 164 BCM of surface water and 34 BCM of groundwater, but uneven distribution leads to deficits in large areas. Geographically, Maharashtra can be divided into four meteorological subdivisions: Konkan (coastal, high rainfall), Madhya Maharashtra (rain shadow zone), Marathwada (semi-arid interior), and Vidarbha (eastern plateau). Rainfall varies dramatically, from over 3,000 mm in Konkan to under 900 mm in Marathwada,

contributing to spatial vulnerabilities. Agricultural demands, which consume over 80% of water, further strain resources, particularly in drought-prone regions where groundwater depletion is rampant. This study adopts a geographical lens to analyze these patterns, incorporating data visualization and a case study to illustrate practical solutions. Existing research underscores Maharashtra's water challenges as rooted in geography and human activities. The State Water Policy (2019) highlights uneven resource distribution, with west-flowing basins holding 55% of surface water but only 10.6% of cultivable land. Studies on water poverty reveal a state-wide index of 0.47, indicating high stress, with Marathwada facing the worst due to low rainfall and sugarcane cultivation. Climate change exacerbates this, with increasing drought frequency in 148 talukas across 25 districts, covering 52% of the state. Geospatial frameworks, as applied in Pune, emphasize institutional and technical interventions for urban resilience. Case studies like those in drought-prone areas show success through rainwater harvesting and watershed management. However, gaps persist in integrating spatial data for equitable policy-making.

**STUDY AREA:**

Maharashtra State was formed on 1st May 1960. It extends from 15˚ 45' to 20˚ 6' north range and 70˚ 36' to 80˚ 54' east longitude (Map no 1). The entire geographical place is 3, 07,713 sq. Km. Maharashtra ranks third with recognize to region. The western Ghat is the bodily backbone of the Maharashtra kingdom. Deccan Plateau is geographical identity of state. Maharashtra occupies the western and central part of the country and has a long shoreline stretching nearly 720 Km along the Arabian Sea. The relative location of Maharashtra state is Chhattisgarh in the East, Andhra Pradesh in the Southwest, Karnataka in the South and Goa in the Southwest, Madhya Pradesh in the North. Maharashtra state has 36 districts and 355 Tehsils and 63663 villages under 6 subdivisions. According to 2011 census state has 35 districts and newly adds Palghar (total Districts are 36). According to 2011 census the sex ratio is 925 and population density is 365 per sq.km. Human Development Index (HDI) of Maharashtra state is 0.695which ranks 15th rank in country according to 2017, current population is 124,862,220.

Map no 1: Location Map Maharashtra State




**OBJECTIVE:**

Its main objective is to conduct a theoretical study Water Security in Maharashtra. The following objectives have been taken for this research.

1. To study Importance of Water Security in Maharashtra.
2. To study Role of Water Security in Maharashtra

**DATABASE AND METHODOLOGY:**

Secondary data has been used for this research to study the Water Security in Maharashtra a geographical perspective. The information has been collected from various sources such as journals, reference books, internet literature/ Key tools include web searches.

**IMPORTANCE:**

Water security, defined as the sustainable access to adequate quantities of acceptable quality water for human needs, ecosystems, and economic activities, is a cornerstone of Maharashtra's development due to its diverse geography and socio-economic challenges. This section elaborates on its significance, building on the geographical study of water security in Maharashtra.

**1.** Sustaining Human Health and Livelihoods

Water security ensures safe drinking water and sanitation, critical for Maharashtra’s population of over 112 million (2011 Census). In regions like Marathwada, where water scarcity is acute due to low rainfall (882 mm annually), inadequate access leads to health issues like waterborne diseases. Rural areas, housing 54.8% of the population, depend on agriculture, which consumes 80% of water resources. Reliable water supply supports irrigation, ensuring food security and stable livelihoods, particularly in drought-prone districts like Beed and Solapur.

**2.** Economic Stability and Agricultural Productivity

Maharashtra contributes 14% to India's GDP, with agriculture forming a significant economic base. Water security directly impacts crop yields, especially for water-intensive crops like sugarcane in Marathwada, where overexploitation has depleted groundwater. The Ralegan Siddhi case demonstrates how watershed management increased irrigation coverage from 70 ha to over 1,000 ha, boosting incomes and reducing migration. Conversely, water insecurity in 40% of drought-prone areas threatens economic losses, with historical droughts like 2013 affecting millions.

**3.** Environmental Sustainability

Water security preserves ecosystems in Maharashtra's diverse landscapes, from the Western Ghats' biodiversity hotspots to river basins like Godavari and Krishna. Overexploitation of groundwater in 76 watersheds and low reservoir levels in Marathwada (below 10% in dry seasons) degrade soil and aquatic ecosystems. Sustainable water management, as seen in Ralegan Siddhi's percolation tanks, recharges groundwater and maintains ecological balance, ensuring long-term environmental health.

**4.** Mitigating Climate Change Impacts

Climate variability exacerbates water insecurity, with increasing drought frequency in 148 talukas across 25 districts. Maharashtra's rain shadow zones, like Madhya Maharashtra, face erratic monsoons, reducing agricultural reliability. Water security measures, such as rainwater harvesting and watershed programs, build resilience against these impacts, as evidenced by Ralegan Siddhi's 5-6 meter rise in groundwater levels.

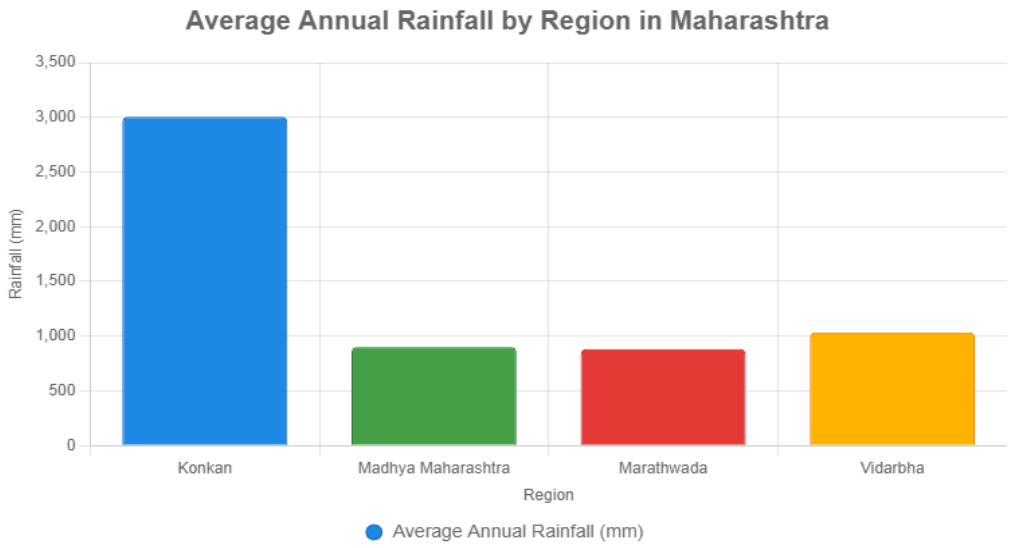
**5.** Reducing Regional Disparities

Maharashtra's geography creates stark water availability contrasts, with Konkan receiving 3,005 mm rainfall compared to Marathwada's 882 mm. This disparity fuels socio-economic inequalities, as coastal regions benefit from abundant water while interior regions face scarcity. Water security initiatives, like equitable dam allocations and community-led projects, can bridge these gaps, ensuring fair resource distribution. To highlight the regional disparities, the following bar chart visualizes average annual rainfall across Maharashtra's meteorological subdivisions, emphasizing the need for targeted water security measures.

Table 1: Water Stress Indicators by Geographical Regions in Maharashtra

| Region | Average Rainfall (mm) | Drought-Prone Area (%) | Key Challenges |
|---|---|---|---|
| Konkan | 3,000+ | Low | Flooding, but abundant resources |
| Madhya Maharashtra | 900-1,000 | Moderate | Rain-shadow effects, soil erosion |
| Marathwada | <900 | High (up to 52%) | Groundwater depletion, crop demands |
| Vidarbha | 1,000-1,200 | Moderate to High | Variable monsoons, tribal scarcities |

**Graph no 01: Average Annual Rainfall in Maharashtra**




**Role of Water Security in Maharashtra:**

Water security plays a pivotal function in Maharashtra's socio-economic and environmental framework, influenced heavily by the state's varied topography, which includes coastal plains, plateaus, and rain-shadow zones. It encompasses not only the provision of sufficient water for various uses but also the management of resources to mitigate risks from scarcity, pollution, and climate variability. In a state where 42.5% of the geographical area is water-stressed and 40% is drought-prone, water security acts as a linchpin for sustainable development, bridging spatial disparities across regions like the high-rainfall Konkan and the semi-arid Marathwada. This section explores its multifaceted roles, drawing on geographical factors such as topography, soil types, and rainfall patterns that shape water availability and utilization.

**1.** Facilitating Agricultural Sustainability and Economic Growth:

In Maharashtra, where agriculture accounts for a significant portion of the economy and employs over half the workforce, water security ensures reliable irrigation, which is vital in drought-prone interiors. Geographical features like the Deccan Plateau's black cotton soils and erratic monsoons in Marathwada exacerbate water demands for crops such as sugarcane and cotton. By promoting efficient allocation and conjunctive use of surface and groundwater, water security reduces crop failures, stabilizes yields, and supports rural economies. For instance, in regions with overexploited aquifers, secure water management prevents economic losses from droughts, fostering diversification into less water-intensive farming and enhancing overall GDP contributions.

**2.** Ensuring Access to Safe Drinking Water and Public Health:

Water security is essential for providing potable water in both rural and urban settings, addressing conflicts between agricultural and domestic needs. In Maharashtra's tribal and remote areas, such as Palghar district, geographical isolation and low groundwater recharge rates lead to chronic shortages, impacting health through increased disease risks. Initiatives focusing on rainwater harvesting and watershed conservation play a key role in sustaining drinking water sources, as seen in policies that integrate surface, groundwater, and rooftop collection to achieve long-term availability. This role extends to urban centers like Mumbai, where secure supplies mitigate contamination and support sanitation, ultimately improving quality of life and reducing healthcare burdens.

**3.** Promoting Environmental Conservation and Ecosystem Balance:

Geographically diverse ecosystems in Maharashtra, from the Western Ghats' forests to river basins, rely on water security for maintenance. It prevents degradation caused by over extraction, such as declining groundwater levels in semi-arid zones, which affect biodiversity and soil health. Through sustainable practices like watershed management, water security restores natural recharge processes, preserving habitats and combating erosion in hilly terrains. In tribal habitations, conservation measures have addressed long-standing scarcities by enhancing local water bodies, demonstrating how geographical interventions can safeguard environmental integrity.

**4.** Building Resilience against Climate Variability:

With climate change intensifying monsoon irregularities and drought frequency, water security serves as a buffer in Maharashtra's vulnerable regions. Topographical factors, including rain-shadow effects in Madhya Maharashtra, amplify these risks, making adaptive strategies crucial. Its role involves implementing policies for equitable allocation during crises, as highlighted in state frameworks that counter neoliberal approaches by prioritizing water as a public good. Community-driven efforts, informed by local mental models of groundwater sustainability, enhance resilience by promoting conservation in farmer practices across semi-arid districts.

**5.** Addressing Spatial Inequities and Social Justice:

Water security mitigates geographical disparities, ensuring fair distribution between water-abundant coastal areas and scarcity-hit interiors. Districts in Marathwada exhibit higher water poverty due to spatial variations in rainfall and soil, leading to social tensions over resources. By supporting inclusive policies and programs, it reduces inequalities, particularly in rural and tribal zones, where government roles in watershed management have proven effective in fostering equity. This contributes to national stability, linking local water management to broader security concerns.

**Characteristics of Water Security in Maharashtra:**

**Uneven Distribution:**

Rainfall is highly variable across the state, with some regions experiencing severe droughts while others face flood risks.

**High Demand:**

Increasing urbanization, industrialization, and agricultural needs put immense pressure on available water resources.

**Groundwater Over-extraction:**

Over-reliance on groundwater for irrigation and other purposes has led to depletion and declining water tables.

**Inadequate Infrastructure:**

Lack of sufficient storage facilities, inefficient irrigation systems, and poor water distribution networks contribute to water scarcity.

**Water Quality Issues:**

Industrial and domestic wastewater discharge contaminates surface and groundwater sources, affecting water quality.

**Climate Change Impacts:**

Climate change is expected to intensify rainfall variability, potentially leading to more frequent and severe droughts and floods.

**Inter-Sectoral Conflicts:**

Competition for water resources between agriculture, domestic use, and industries leads to disputes and conflicts.

**Rural-Urban Divide:**

Access to safe and reliable water supply is a major challenge in rural areas, while urban areas face issues related to supply and infrastructure.

**Policy and Management Challenges:**

Implementation of water policies, integrated water resource management, and community participation in water management are crucial for addressing water security issues.

**Water Security Challenges**:

**Water Scarcity:**

Many regions face water scarcity, especially during the dry season, due to uneven rainfall and limited groundwater recharge.

**Inter-State Water Disputes:**

Sharing river basins with other states leads to disputes and limits water availability for Maharashtra's needs.

**Increasing Demand:**

Rapid population growth, urbanization, and industrialization are increasing water demand, exacerbating existing water stress.

**Climate Change:**

Increased drought frequency and intensity, along with changes in rainfall patterns, further complicate water management.

**Water Quality:**

Pollution from industrial and agricultural activities degrades water quality, impacting both drinking water and irrigation.

**Flood Management:**

Flooding in coastal areas and along riverbanks causes significant damage to property and infrastructure.

Strategies for Water Security:

**Integrated Water Resources Management:**

A holistic approach is needed, considering both surface and groundwater resources, and addressing the needs of different regions.

**Water Use Efficiency:**

Improving water use efficiency in agriculture, industries, and households is crucial.

**Rainwater Harvesting:**

Promoting rainwater harvesting in both urban and rural areas can help augment water supplies.

**Groundwater Recharge:**

Implementing measures to enhance groundwater recharge, such as artificial recharge techniques, is essential.

**Water Recycling and Reuse:**

Reusing treated wastewater, especially in urban areas, can help reduce the demand for fresh water.

**Inter-Basin Water Transfer:**

Exploring options for inter-basin water transfer, while carefully considering environmental impacts, may be necessary.

**Flood Management:**

Improving flood forecasting and warning systems, along with enhancing drainage infrastructure, is vital.

**Community Participation:**

Engaging local communities in water management and conservation efforts is crucial for long-term sustainability.

Addressing Maharashtra's water security challenges requires a multi-faceted approach that integrates geographical considerations, technological advancements, and community participation. Effective water management is not only vital for the state's economic development but also for the well-being of its population.

**CONCLUSION:**

In Maharashtra, water security functions as a foundational element for agricultural viability, health safeguards, environmental protection, climate adaptation, and equitable resource sharing. Geographically tailored approaches, such as those in watershed programs, amplify its impact, transforming challenges into opportunities for sustainable progress. Strengthening these roles through integrated policies will be key to the state's future resilience. Water security in Maharashtra is vital for health, economic stability, environmental sustainability, climate resilience, and reducing regional disparities. Geographically tailored solutions, inspired by successes like Ralegan Siddhi, can ensure sustainable water management, leveraging Maharashtra's diverse topography to meet the needs of its people and ecosystems.

**DISCLAIMER (ARTIFICIAL INTELLIGENCE)**

Author hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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