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RESEARCH ARTICLE

Understanding India's Water Paradox: Abundance of Rainfall but Growing Water Scarcity

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ABSTRACT

India experiences a unique water paradox where the country receives substantial annual rainfall but continues to face increasing water scarcity in many regions. According to estimates by the Central Water Commission, India receives about 4000 billion cubic meters (BCM) of annual precipitation, mainly concentrated during the monsoon season. However, the total utilizable water resources are only around 1999 BCM, which includes approximately 690 BCM of surface water and about 447 BCM of groundwater. This significant gap between total water availability and utilizable water resources highlights the challenges in effective water management.

In many regions of the nation, water stress has been exacerbated by the rising demand for water brought on by fast population increase, urbanization, industrial expansion, and intensive agricultural practices. The increasing shortage of water is also caused by the unequal seasonal and spatial distribution of rainfall, excessive groundwater extraction, pollution of water bodies, and inadequate infrastructure for conservation and storage. As a result, even though there is a lot of rainfall, many areas have water shortages.

The purpose of this study is to investigate the fundamental causes of India's water paradox and to emphasize the significance of effective water resource management. In order to guarantee long-term water security and sustainable development in India, the article highlights the necessity of sustainable water management techniques, enhanced storage infrastructure, groundwater regulation, and efficient conservation tactics.

Keywords: *Water Scarcity, Water Resource Management, Groundwater Depletion, Rainfall Distribution, Sustainable Water Conservation*

INTRODUCTION

Water is an essential natural resource that sustains ecological equilibrium, human life, and economic growth. In India, water is essential for domestic consumption, industry, agriculture, and energy production. Even though the nation receives a substantial quantity of rainfall each year, many areas nonetheless struggle with growing water scarcity. This leads to what is known as India's "water paradox," a situation where a nation with copious amounts of rainfall nonetheless faces severe water shortages. The Central Water Commission, which is part of the Ministry of Jal Shakti, estimates that India receives an average of 4000 billion cubic meters (BCM) of precipitation every year, including both rainfall and snowfall. The southwest monsoon season, which typically lasts from June to September, accounts for around 3000 BCM of this. However, only a portion of this water can be used efficiently because of things like evaporation, runoff, and storage infrastructure constraints. India's total yearly water resources are estimated by the Central Water Commission to be over 4000 BCM, however only about 1999 BCM are really usable.

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This comprises roughly 447 BCM of replenishable groundwater and 690 BCM of useable surface water. These numbers show that even though India receives a lot of rainfall, a significant amount of it cannot be collected or stored for useful purposes. The ongoing decrease in the amount of water available per person is another significant issue. According to estimates, India's per capita water availability has drastically declined as a result of the country's fast population increase, urbanisation, and rising water demand from industry and agriculture. The nation is steadily approaching a state of water stress, in which there is not enough water available to fulfil rising demand. In addition, India has a very uneven distribution of rainfall, both seasonally and geographically. While some areas suffer from droughts and acute water shortages, others enjoy a lot of rainfall and floods. The issue of water scarcity has also been made worse by excessive groundwater extraction, ineffective irrigation techniques, pollution of water bodies, and insufficient water management systems. Thus, a significant obstacle to India's water resource management is the coexistence of heavy rainfall and growing water scarcity. In order to create effective regulations, enhance water conservation techniques, and guarantee sustainable water security for future generations, it is imperative to comprehend the reasons of this water paradox.

Review of Literature

Mukherji, A. (2006). Political ecology of groundwater: The contrasting case of water-abundant West Bengal and water-scarce Gujarat, India. Hydrogeology Journal, 14(3), 392–406. examines groundwater governance in India by contrasting Gujarat and West Bengal. It makes the case that institutional and political considerations frequently influence groundwater management and policies more than the actual availability of water supplies. Without much opposition from farmers, the government of West Bengal, whose groundwater supplies are comparatively plentiful, was able to enact stringent groundwater laws and raise energy prices for irrigation. Gujarat, on the other hand, has a severe groundwater shortage but has had difficulty enacting stringent laws because of competing interests and considerable political influence from agricultural groups. The study comes to the conclusion that political dynamics, institutional structures, and power relations have a significant impact on groundwater management results and water scarcity rather than just physical water availability.

Bharucha, Z. P., Smith, D., & Pretty, J. (2014). All Paths Lead to Rain: Explaining why Watershed Development in India Does Not Alleviate the Experience of Water Scarcity. The Journal of Development Studies, Taylor & Francis. discusses the widespread promotion of watershed development (WSD) programs in India to alleviate water scarcity in dryland areas and enhance rain-fed agriculture. Nevertheless, the results of these initiatives are sometimes incomplete and transient. The paper contends that local attitudes and policy narratives frequently see watershed development primarily as a way to increase irrigation water supply, which oversimplifies the intricate nature of agricultural water management. WSD initiatives frequently fall short in addressing more general problems like water demand, agricultural patterns, and long-term resource management because of this supply-oriented approach. As a result, many communities still face water scarcity even after watershed improvements are put into place, demonstrating that efficient water management calls for a more comprehensive and long-term strategy than just boosting water supply.

Mohapatra, S., Mitra, A., & Pohit, S. (2025). The water paradox in India: Managing abundance amid growing scarcity. National Council of Applied Economic Research (NCAER) shows that even though India receives a significant amount of rainfall each year—roughly 3,800 billion cubic meters—it nevertheless has a severe water shortage. Due to weak water governance, insufficient storage facilities, and unequal rainfall distribution, only a small percentage of this water is used efficiently. Climate change, urbanization, rapid population expansion, and excessive groundwater extraction have put more strain on water resources, resulting in a dramatic drop in per capita water availability while demand is predicted to treble by 2030. Even while home and industrial demand is rising quickly, agriculture continues to be the biggest user of water. In order to guarantee sustainable water security and promote long-term economic development in India, the report emphasizes the necessity of integrated water resource management, enhanced wastewater recycling, demand-side conservation measures, and climate-resilient infrastructure.

Research Gap

Few studies explicitly address the paradox of abundant rainfall and increasing water scarcity, despite the fact that many explore groundwater depletion, water scarcity, and water management in India. Additionally, rather than using current national-level data, the majority of research depends on regional case studies.

In order to comprehend the discrepancy between rainfall availability and usable water supplies, this study analyzes India's water enigma using secondary data from the Central Water Commission.

Objectives

1. To study the distribution of India’s annual water resources based on average precipitation and identify the share of utilizable and non-utilizable water resources.
2. To understand the trend between average rainfall and per capita water availability in India.

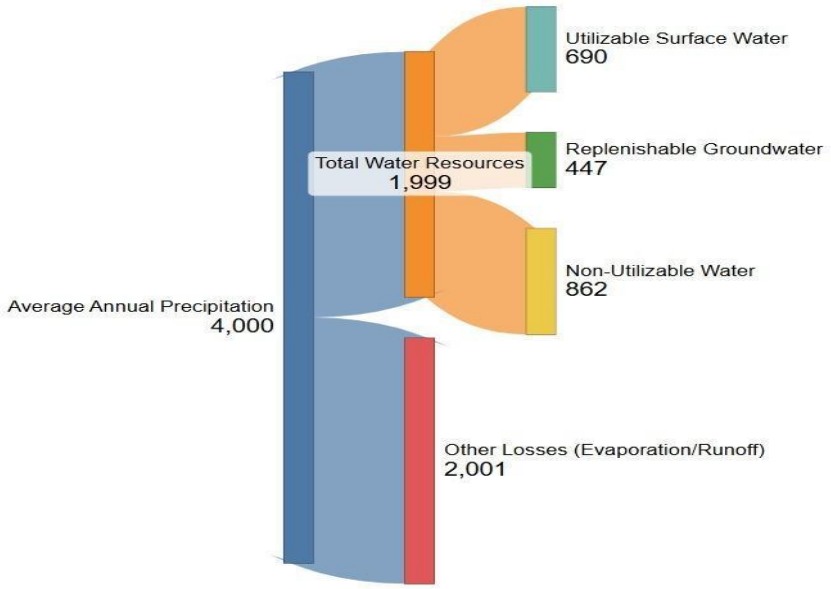
Methodology

The secondary data used in this study was gathered from the Central Water Commission's official website, which is part of the Ministry of Jal Shakti. The data were taken from the Water Resource Estimation reports available on the website. The Commission uses hydrological data, including rainfall, river discharge, and basin features over extended periods of time, to assess water resources. In order to comprehend the distribution and availability

of water resources in India, the gathered data were combined and subjected to descriptive analysis.

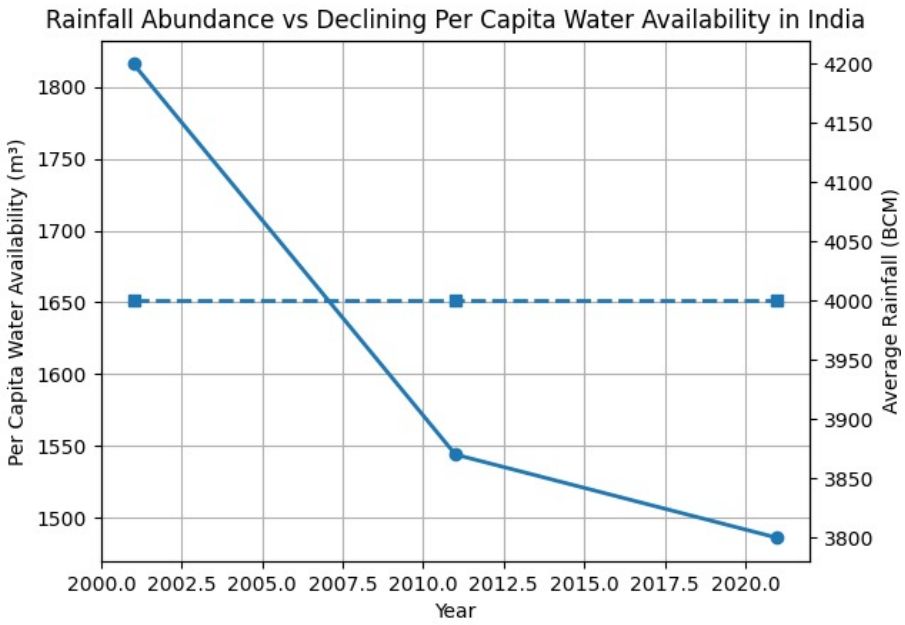
Data analysis

Figure 1:Flow of Water Resources in India (BCM)



The allocation of India's yearly water resources according to average annual precipitation is depicted in the diagram. About 2,001 of the 4,000 billion cubic meters (BCM) of rainfall that India receives are lost to evaporation and runoff and cannot be used. Following these losses, there are roughly 1,999 BCM of water resources left. Only 690 BCM of this is surface water from rivers and reservoirs that may be used, and 447 BCM is groundwater that can be replenished. However, due to technical and geographic constraints, 862 BCM is still unusable. This shows that even while India receives a lot of rainfall, only a small percentage of its water resources are truly usable for home and commercial purposes, underscoring the significance of effective water management and conservation.

Figure 2: Rainfall Abundance vs Declining Per Capita Water Availability in India



The graph shows the relationship between India's per capita water availability and average rainfall for the years 2001, 2011, and 2021. Water availability was comparatively better in 2001, with per capita water availability of about 1820 m³ and average rainfall of about 4200 BCM. Both indicators showed a decline by 2011, with per capita water availability falling to about 1545 m³ and rainfall falling to about 3880 BCM. In

2021, rainfall slightly decreased to about 3800 BCM, while per capita water availability further declined to nearly 1485 m³. While rainfall has only slightly decreased over time, the graph generally indicates a continuous decline in per capita water availability. This shows that, despite comparatively stable rainfall levels, factors like population growth, increasing water demand, and pressure on water resources have contributed to the decline in water availability per person in India.

Findings

Important information about the availability, distribution, and use of water resources in India as well as the trend in per capita water availability over time can be gleaned from the graph analysis. The following are the main conclusions:

- About 2,001 BCM of the 4,000 BCM of precipitation that India receives each year is lost to runoff and evaporation. Consequently, only 1,999 BCM remain as total water resources, indicating that a significant portion of rainfall cannot be used efficiently.
- Only 690 BCM of the water resources are surface water from rivers and reservoirs that can be used. This suggests that the ability to store and disperse surface water is still constrained despite significant water inflows.
- India has roughly 447 BCM of replenishable groundwater, which is essential for supplying water for domestic, industrial, and agricultural purposes. Thus, a significant portion of the nation's usable water supply comes from groundwater.
- Due to geographical, technological, and infrastructure constraints, about 862 BCM of water resources are still unusable. This emphasizes the necessity of improved conservation methods, storage facilities, and water management.
- Even though rainfall has only slightly decreased, India's per capita water availability fell from roughly 1820 m³ in 2001 to 1485 m³ in 2021. This suggests that the nation's water resources are under more stress due to population growth and rising water demand.

Suggestions

- In order to collect some of the rainfall that is currently lost through runoff and evaporation, the government and local communities should encourage rainwater harvesting systems in both urban and rural areas.
- To make better use of the surface water and groundwater resources that are available, better water management techniques should be put into place.
- To cut down on water waste in agriculture, farmers should be encouraged to use contemporary irrigation methods like sprinkler and drip irrigation.
- To prevent excessive groundwater extraction and to guarantee the sustainable use of subterranean water resources, strict regulations and oversight are required.
- People should be educated about water conservation and responsible water use through awareness campaigns.
- Extra monsoon water can be stored for use during dry spells by constructing more reservoirs, check dams, and storage facilities.
- Policymakers will be able to make better decisions about water management with the support of ongoing data collection and research on rainfall patterns, water availability, and the effects of climate change.
- Policies should prioritize sustainable urban planning and effective water distribution since population growth and increased demand are the primary causes of the decline in per capita water availability.

Conclusion

India's water paradox draws attention to the difference between the country's plentiful annual rainfall and its growing water scarcity issue. Even though the nation receives around 4,000 billion cubic meters (BCM) of precipitation annually, much of it is lost to evaporation and runoff, leaving just a little amount of surface and groundwater resources that may be used. Simultaneously, the steadily declining per capita water availability between 2001 and 2021 indicates increasing strain on water resources as a result of population expansion, increased consumption, and ineffective management. The analysis demonstrates that inadequate rainfall is only one factor contributing to India's water scarcity; other factors include inadequate storage capacity, unequal water distribution throughout the country, and overuse of groundwater. In order to solve this problem, efficient water management, better storage facilities, rainwater collection, and sustainable water resource usage are crucial. In conclusion, the government, communities, and legislators must work together to solve India's water paradox in order to guarantee effective water conservation and fair distribution. Securing the nation's future water demands and lowering the likelihood of water stress would require bolstering water governance and encouraging sustainable practices.

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