



Mission Bhagiratha: A Geographical Assessment of a State-Wide Drinking Water Infrastructure Project in Telangana, India

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DOI - 10.5281/zenodo.18479164

Abstract:

Mission Bhagiratha is one of the most ambitious state-level drinking water infrastructure projects undertaken in India, aiming to provide safe, treated surface water to every household in Telangana through an integrated pipeline network. The project represents a paradigm shift from groundwater-dependent rural water supply to a centralized, surface-water-based distribution system. This paper presents a scientific and geographical analysis of Mission Bhagiratha by examining its spatial design, hydrological sourcing, physiographic constraints, infrastructural layout, and socio-environmental impacts. Using concepts from physical geography, hydrology, and human geography, the study evaluates how terrain, river basins, settlement patterns, and climatic conditions have influenced the planning and implementation of the project. The paper also critically assesses challenges related to spatial equity, sustainability, and long-term water security in a semi-arid region experiencing increasing climate variability.

Keywords: *Mission Bhagiratha, Drinking Water Infrastructure, Telangana, Geography, Hydrology, Surface Water Supply, Spatial Planning, etc.*

Introduction:

Human settlement patterns, public health outcomes, and regional growth are all significantly influenced by water infrastructure, especially in areas with limited environmental resources. Drinking water security issues in India have gotten worse due to uncontrolled groundwater exploitation, growing population pressure, and temporal and regional variations in rainfall. These difficulties are particularly noticeable in semi-arid areas of the Deccan Plateau, where dependable access to water has historically been hampered by hydro climatic unpredictability and low surface storage capacity.

South-central India's Telangana is a prime example of these difficulties. The state has historically relied on groundwater as the main source of rural drinking water due to its

undulating plateau topography, hard rock geology, unpredictable monsoon rainfall, and high evapotranspiration rates. Declining water tables and significant issues with water quality, especially fluoride pollution in numerous regions, have resulted from an over-reliance on bore wells throughout time. In addition to compromising the supply of drinking water, these hydro geological circumstances widened the socioeconomic divide between areas that relied on strained aquifers and those that had access to dependable surface water.

The Telangana government introduced Mission Bhagiratha in 2015–16 as a comprehensive drinking water delivery scheme for the entire state in response to these ongoing limitations. From dispersed, localized groundwater-based schemes to an integrated, surface-water-based supply system, the mission

signifies a paradigm leap. Mission Bhagiratha aims to guarantee fair and sustainable access to drinkable water for both rural and urban people by obtaining treated water from significant perennial rivers like the Godavari and Krishna and delivering it via a vast pipeline network.

Geographically speaking, Mission Bhagiratha is a major spatial intervention that modifies the interaction between human settlements and natural water systems rather than just an engineering project. Climate fluctuation, settlement dispersion, river basin characteristics, and regional Physiography all have a significant impact on its planning and execution. By positioning water intake locations, treatment facilities, pumping stations, and service reservoirs in accordance with topography and population distribution, the project combines hydrological concepts with spatial planning.

This study conducts a geographical and hydrological analysis of Mission Bhagiratha to investigate how the project's design and performance have been influenced by the physical environment, the availability of water resources, and human geography. The paper seeks to advance knowledge of how large-scale drinking water initiatives can address spatial inequality while remaining hydrologically and environmentally sustainable by placing Mission Bhagiratha within the larger framework of semi-arid water management and infrastructure development.

Study Area:

Location and Physiography:

Telangana is located in south-central India between latitudes 15°46'N to 19°47'N and longitudes 77°16'E to 81°43'E. The state forms part of the **Deccan Plateau**, characterized by gently undulating terrain, residual hills, and rocky outcrops composed predominantly of granites and

basalts. Elevations range from approximately 300 m to over 600 m above mean sea level.

The plateau topography presents both opportunities and constraints for water infrastructure development. While broad plains facilitate pipeline alignment, isolated hillocks and uneven gradients require complex hydraulic designs, including pumping stations and elevated service reservoirs.

Climate and Rainfall:

Telangana experiences a **semi-arid tropical climate**, with hot summers, moderate winters, and a monsoon-dependent rainfall regime. Average annual rainfall ranges from 700 mm to 900 mm, with high spatial and temporal variability. Frequent droughts and prolonged dry spells have historically reduced the reliability of surface water bodies and accelerated groundwater extraction.

High evapotranspiration rates further exacerbate water stress, making sustainable water supply planning a major challenge in the region.

Water Resource Base and Hydrological Context:

1 River Basins:

Telangana is drained mainly by two major river systems:

1. Godavari Basin (northern and eastern Telangana)
2. Krishna Basin (southern Telangana)

These rivers are perennial compared to local streams and form the backbone of Mission Bhagiratha's surface water sourcing strategy. Major reservoirs such as Sripada Yellampally, Kaleshwaram link reservoirs, Nagarjuna Sagar, Palair, and Wyra act as intake points for drinking water abstraction.

Groundwater Conditions:

Prior to Mission Bhagiratha, rural drinking water supply depended heavily on

groundwater extracted through bore wells. Over-extraction led to falling water tables, seasonal drying of wells, and water quality issues, particularly fluoride contamination in districts like Nalgonda, Medak, and Mahabubnagar. These hydro geological challenges provided the scientific rationale for shifting towards a surface-water-based supply system.

Conceptual Framework and Project Design:

Mission Bhagiratha is conceptualized as a state-wide drinking water grid, integrating rivers, reservoirs, treatment plants, transmission pipelines, and local distribution networks.

1 Spatial Segmentation:

The state has been divided into multiple segments and zones based on river basin boundaries, topography, and population distribution. Each segment includes:

1. Raw water intake structures
2. Water Treatment Plants (WTPs)
3. Clear water pumping mains
4. Service reservoirs (ground-level and overhead)
5. Village and urban distribution networks

This segmentation reflects a regional planning approach, ensuring that physiographic and hydrological conditions are accounted for in infrastructure layout.

Scale of Infrastructure:

Mission Bhagiratha involves:

1. Over 1.5 lakh km of pipeline network
2. Hundreds of pumping stations and reservoirs
3. Treatment capacity designed for present and projected population demand

The sheer scale of the network makes it one of the largest drinking water supply projects in India, with significant spatial footprint across rural and urban landscapes.

Topography and Hydraulic Design:

Topography plays a crucial role in determining pumping requirements, reservoir locations, and energy consumption. In plateau regions, water is often pumped to elevated points. Topography plays a crucial role in determining pumping requirements, reservoir locations, and energy consumption. In plateau regions, water is often pumped to elevated points and then distributed by gravity. However, in rugged or undulating terrain, maintaining adequate pressure across long distances poses technical challenges.

GIS-based mapping and elevation modeling have been used to optimize pipeline routes and reservoir siting, highlighting the integration of **geospatial technologies** in project planning.

Settlement Geography:

Telangana has a dispersed rural settlement pattern, with thousands of small habitations spread across the plateau. Ensuring equitable access to each habitation requires extensive branch pipelines and local storage structures. From a human geography perspective, Mission Bhagiratha aims to reduce spatial inequalities in water access, especially between urban centers and remote villages.

Socio-Economic and Public Health Impacts:

1 Drinking Water Security: The provision of treated surface water has reduced dependence on unsafe groundwater sources. In fluoride-affected regions, this transition has the potential to significantly improve public health outcomes, reducing water-borne and chronic diseases.

2 Gender and Livelihood Dimensions: Improved household water supply reduces the burden on women, who traditionally spend considerable time collecting water. This has indirect socio-economic benefits, including

improved participation in education and livelihoods.

Environmental and Sustainability

Considerations:

1 Energy–Water Nexus: Mission Bhagiratha is energy-intensive due to long-distance pumping. Rising electricity demand raises concerns about carbon emissions and operational sustainability. Integrating renewable energy sources and improving hydraulic efficiency are critical for long-term viability.

2 Source Sustainability: Dependence on major rivers raises concerns under climate change scenarios, including altered monsoon patterns and inter-state water sharing conflicts. Ensuring environmental flows and balancing irrigation and drinking water demands remain key challenges.

Challenges and Critical Issues:

Despite its achievements, Mission Bhagiratha faces several constraints:

1. Irregular water supply in remote and elevated habitations
2. Maintenance challenges across a vast spatial network
3. Quality perception issues among beneficiaries
4. Institutional coordination between state agencies and local bodies

From a geographical perspective, these challenges highlight the difficulty of translating large-scale infrastructure into consistent micro-level service delivery.

Mission Bhagiratha exemplifies a geography-driven infrastructure model, where physical environment, hydrology, and settlement patterns shape project outcomes. The shift from groundwater to surface water represents a strategic adaptation to regional hydro-climatic realities. However, the project also underscores

the importance of integrating local geographic variability into centralized planning frameworks.

Conclusion:

Mission Bhagiratha represents a transformative intervention in Telangana's drinking water sector, reflecting a deliberate shift from localized, groundwater-dependent supply systems to an integrated, surface-water-based infrastructure model. From a geographical perspective, the project demonstrates how large-scale water infrastructure can be designed in response to region-specific physical constraints, including semi-arid climate, hard rock geology, uneven topography, and spatially dispersed settlement patterns.

The analysis highlights that Mission Bhagiratha has substantially improved drinking water accessibility by leveraging perennial river systems and large reservoirs, thereby reducing dependence on overexploited and contaminated groundwater sources. The spatial redistribution of water through an extensive pipeline network has contributed to greater equity in water access, particularly in fluoride-affected and drought-prone regions. By aligning intake structures, treatment plants, and service reservoirs with physiographic and hydrological conditions, the project illustrates the practical application of geographical principles in infrastructure planning. However, the study also reveals that the effectiveness of such a centralized system is uneven across space. Variations in terrain, elevation, and settlement remoteness continue to influence supply reliability and service levels. Energy-intensive pumping, maintenance challenges across a vast network, and concerns regarding long-term source sustainability underscore the need for continuous adaptive management. Moreover, emerging climate uncertainties, inter-basin water sharing issues, and

increasing demand place additional stress on surface-water-dependent systems.

From a sustainability standpoint, Mission Bhagiratha must be complemented by decentralized water management strategies, including rainwater harvesting, groundwater recharge, demand-side management, and energy-efficient operations. Strengthening institutional coordination at local levels and integrating geospatial monitoring tools can further enhance system performance and resilience.

In conclusion, Mission Bhagiratha offers important lessons for water-scarce regions across India and other semi-arid environments. It demonstrates that while large-scale, surface-water-based drinking water projects can address structural inequities and improve public health outcomes, their long-term success depends on geographic sensitivity, environmental sustainability, and adaptive governance. Future water infrastructure planning must therefore adopt a balanced approach that integrates regional physical geography with technological innovation and community-based management to ensure resilient and equitable water security.

References:

1. Government of Telangana. (2020). *Mission Bhagiratha – Status and coverage report*. Hyderabad: Mission Bhagiratha Department.
2. Ministry of Jal Shakti. (2019). *National water policy and drinking water security in India*. Government of India.
3. Central Ground Water Board. (2018). *Groundwater year book – Telangana State*. Ministry of Water Resources, Government of India.
4. Shah, T. (2009). Climate change and groundwater: India's opportunities for mitigation and adaptation. *Environmental Research Letters*, 4(3), 1–13. <https://doi.org/10.1088/1748-9326/4/3/035005>
5. Falkenmark, M., & Rockström, J. (2006). The new blue and green water paradigm: Breaking new ground for water resources planning. *Journal of Water Resources Planning and Management*, 132(3), 129–132.
6. Kumar, M. D., & Singh, O. P. (2005). Virtual water in global food and water policy making: Is there a need for rethinking? *Water Resources Management*, 19(6), 759–789.
7. Vaidyanathan, A. (2010). *India's water resources: Contemporary issues on irrigation*. Oxford University Press.
8. Narain, S., & Pandey, P. (2012). India's water future: Water harvesting and conservation. *Down To Earth*, Centre for Science and Environment.