River Restoration in Urban India: Evaluating the Ganga Action Plan and Namami Gange in the Prayagraj–Varanasi Corridor

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Abstract

The Ganga River, one of the most culturally and economically significant rivers in India, remains under severe ecological stress, particularly in the urban corridor between Prayagraj and Varanasi. This study critically evaluates the two major government-led initiatives—**Ganga Action Plan (GAP)** and **Namami Gange Mission**—with a focus on their implementation effectiveness, water quality outcomes, and socio-cultural implications. Employing a mixed-methods approach, it analyzes biochemical oxygen demand (BOD), dissolved oxygen (DO), fecal coliform levels, and nitrate concentrations using data from the Central Pollution Control Board, Sankat Mochan Foundation, and recent independent studies. Despite partial success in reducing organic pollution, microbial contamination and nutrient overload persist, largely due to infrastructure gaps, weak enforcement, and culturally embedded practices. The study recommends geospatial monitoring, community-led initiatives, and stronger regulatory frameworks to bridge the gap between ecological restoration and cultural reverence.

Keywords

River Pollution, Urban Water Management, Human-Environment Interaction, Ecological Restoration, Ganga River, Namami Gange, Sewage Treatment, Cultural Practices

1. Introduction

The Ganga River, stretching over 2,500 km across India, sustains the livelihoods of more than 500 million people and carries profound religious and ecological significance. However, urbanization and industrialization have severely degraded its water quality, especially in the 100-km stretch

between Prayagraj and Varanasi. Spiritual activities, mass bathing, cremation practices, and untreated sewage discharge have transformed this segment into a critical pollution hotspot.

To address this, the Government of India launched the **Ganga Action Plan (GAP)** in 1986 and subsequently the **Namami Gange Mission** in 2014. While GAP adopted a town-based approach to sewage treatment and industrial regulation, Namami Gange incorporated basin-level planning and a substantial financial outlay. This paper examines the environmental and infrastructural outcomes of these programs, highlighting successes, failures, and future directions.

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2. Methodology

This study integrates **quantitative and qualitative approaches** within a geographical framework of human-environment interaction and urban planning.

2.1 Data Sources

- **Water Quality**: BOD, DO, fecal coliform, nitrate, cyanobacterial presence (CPCB, Sankat Mochan Foundation, Kesari et al.)
- **Infrastructure**: STP capacities, project completion rates, funding (NMCG, JICA, audit reports)
- **Socio-cultural Factors**: Cremation rituals, mass bathing, informal settlements (news reports, academic sources)
- **Spatial Tools**: Bhuvan-Ganga GIS app for mapping pollution and infrastructure

2.2 Analytical Methods

- Trend analysis of water quality indicators
- Comparative assessment of policy outcomes (GAP vs Namami Gange)
- Cross-verification of government claims with independent audits and studies
- Use of geospatial overlays to identify infrastructural mismatches and pollution hotspots

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3. Results

3.1 Water Quality Indicators

- **Varanasi**: BOD declined from 60 mg/L (1986) to 42 mg/L (2016); DO improved to >5 mg/L. However, fecal coliform exceeded 460,000 MPN/100mL, nearly 200 times the acceptable limit.
- **Prayagraj**: Slight BOD reduction; fecal coliform 1,400 times above limits during Kumbh Mela 2022. Algal blooms (Microcystis) detected in 2021 producing liver-toxic microcystins.
- **Nutrient Pollution**: Nitrate and phosphate levels far exceed WHO benchmarks, especially downstream of bathing ghats and cremation sites.

3.2 Infrastructure Development

- **GAP-I and II**: Treated only ~39% of intended sewage; severe delays due to land acquisition and funding gaps.
- **Namami Gange**: 310 projects sanctioned with ₹33,000 crore budget. By 2025, 1,794 MLD sewage treated of the total 2,953 MLD generated across 97 Ganga towns. Gaps persist in Varanasi (20% untreated) and Prayagraj (44% untreated).
- **Monsoonal Overflows**: Overwhelmed STPs during rains; 80% of sewage in Varanasi goes untreated during monsoon.

3.3 Cultural and Industrial Drivers

- **Cultural Load**: Cremation ghats contribute ~300 tons/year of partially burnt organic matter; mass bathing increases coliform load.
- **Industrial Effluents**: Tanneries in Kanpur release heavy metals (e.g., copper 1,000x above safe limits); local industries in Varanasi contribute 30% of total pollution.

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4. Discussion

4.1 Urbanization and Infrastructure Mismatch

Urban population growth outpaces sewage treatment expansion. Informal settlements near tributaries (Assi, Varuna) lack basic sanitation and bypass official treatment systems. Varanasi's 70% open drain reliance represents a deep structural flaw.

4.2 Policy and Enforcement Gaps

Despite STP construction, 50% remain non-operational or underperforming (NGT, 2022). Enforcement against non-compliant industries is minimal, and real-time pollution tracking is underutilized.

4.3 Cultural Contradictions

Despite visible pollution, 80% of Varanasi residents believe the Ganga remains spiritually "pure." The cultural disconnect hampers public compliance with ecological norms.

4.4 Ecological and Climate Risks

New threats like cyanobacterial toxins and climate-driven rainfall variability compound existing problems. Current interventions focus on organic pollutants but neglect broader ecological parameters.

4.5 Critical Review of Government Claims

While Namami Gange claims 30% water quality improvement and dolphin resurgence, independent studies contradict this optimism. Kesari et al. (2022) and CPCB reports suggest microbial and chemical threats persist unabated.

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5. Conclusion and Recommendations

While the Ganga Action Plan and Namami Gange mark major policy milestones, they have only partially succeeded in improving water quality in the Prayagraj–Varanasi stretch. Structural, cultural, and enforcement challenges continue to limit impact.

Recommendations:

1. **STP Expansion and Maintenance**: Match treatment capacity with city size and monsoonal load.
2. **Real-Time Monitoring**: Use geospatial tools for dynamic tracking and enforcement.
3. **Community Engagement**: Collaborate with religious leaders and local stakeholders.
4. **Cultural Reforms**: Promote sustainable rituals (e.g., electric crematoria).

5. **Ecological Diversification**: Address cyanobacterial growth and nutrient pollution.
6. **Climate Resilience**: Redesign urban infrastructure to withstand flooding and overflow events.

These measures can bridge the gap between cultural heritage and scientific sustainability, offering a model for river restoration in other densely populated regions.

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