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WATER POLLUTION ANALYSIS – A GEOGRAPHICAL STUDY OF LUCKNOW

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1. ABSTRACT

Water pollution is one of the most critical environmental challenges faced by urban areas in India. This study focuses on Lucknow, the capital city of Uttar Pradesh, and examines the extent, causes, and spatial distribution of water pollution along the Gomti River, which flows through the city. The research integrates primary field data, government pollution reports, and GIS-based spatial analysis to assess the water quality using key indicators such as Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Nitrates, and Fecal Coliform counts. Six sampling sites were selected across urban, industrial, and residential zones to capture variability in pollution levels. The findings reveal alarmingly high levels of organic and biological pollution at multiple sites, with several zones deemed unsuitable for domestic or recreational use based on calculated Water Quality Index (WQI) scores. Further, the study demonstrates a strong correlation between poor water quality and land use intensity, population density, and the proximity of open drains and informal settlements. Despite initiatives like the Namami Gange Mission, local-level implementation remains ineffective due to inadequate infrastructure and poor governance. The paper concludes with actionable recommendations including decentralized sewage treatment, community participation, and real-time pollution monitoring systems. Overall, the research emphasizes the need for a geographically informed, multi-stakeholder strategy to restore the ecological and social integrity of urban rivers like the Gomti.

Keywords: Water Pollution; Gomti River; Lucknow; BOD; COD; Fecal Coliform; GIS; Water Quality Index (WQI); Urban Drainage; Environmental Geography; Sewage Management; Namami Gange; Spatial Analysis

2. Introduction

Water, often called the elixir of life, has been central to the development of civilizations across time. From ancient cities flourishing along riverbanks to modern urban sprawls dependent on piped supply, water continues to shape not just geography but the very sustainability of human life. However, with rapid urbanization, industrialization, and unsustainable consumption patterns, water resources in cities are increasingly under threat—none more visibly than in the form of water pollution. Among the many Indian cities grappling with this crisis, Lucknow, the capital city of Uttar Pradesh, stands as a poignant case, where the sacred Gomti River—a lifeline of the region—is now a symbol of environmental neglect.

Water pollution, in its essence, refers to the contamination of water bodies due to the direct or indirect discharge of pollutants without adequate treatment. These pollutants can range from domestic sewage and industrial effluents to agricultural runoff, plastic waste, and heavy metals. In a geographical context, the study of water pollution allows us to explore spatial variations, human-environment interactions, land use impacts, and socio-ecological outcomes. Importantly, it also provides a platform for assessing environmental justice and governance structures.

Lucknow, with its rich cultural legacy and fast-growing urban landscape, presents a unique ground for studying the interplay between urban expansion and water quality degradation. Once celebrated for its gardens, nawabi architecture, and natural charm, the city today faces severe challenges stemming from unregulated urban growth, inadequate waste management, and industrial pressure. The Gomti River, a tributary of the Ganga and one of the few rivers originating and terminating within the plains, flows through the heart of the city. Historically revered and ecologically significant, it now bears the brunt of untreated sewage, solid waste dumping, and encroachments.

The central aim of this research is to examine the causes, extent, and impact of water pollution in Lucknow from a geographical lens. By focusing on both spatial patterns and temporal trends, this study endeavors to highlight not just the environmental degradation, but also the underlying socio-economic and institutional drivers. The Gomti River serves as the primary case study, given its ecological and cultural importance to the city and its visible deterioration over the past two decades.

According to the Central Pollution Control Board (CPCB), the Gomti River has consistently shown high Biochemical Oxygen Demand (BOD) and Coliform levels—clear indicators of organic pollution and sewage contamination (CPCB, 2020). Similarly, reports from Uttar Pradesh Pollution Control Board (UPPCB) indicate that out of the 20 major drains that discharge into Gomti within Lucknow, very few are connected to functional sewage treatment plants (UPPCB, 2021). This failure in urban water management infrastructure, coupled with population pressure—currently over 3.5 million people—has severely impaired the river's self-purifying capacity.

One of the important considerations in this study is the urban-rural interface, as many of Lucknow's peri-urban zones contribute to water pollution through unregulated borewells, pesticide runoff, and lack of sanitation facilities. As Sinha and Srivastava (2018) noted, land use changes along the

Gomti's floodplain have drastically altered the natural drainage patterns and increased sediment load and pollution in the river. In particular, encroachments and construction along the riverbanks have narrowed its flow, leading to stagnant water zones—ideal breeding grounds for contaminants.

Furthermore, the city's geography amplifies the problem. Located on a relatively flat alluvial plain with loamy soils, Lucknow's natural drainage is slow. During monsoons, stormwater mixes freely with untreated sewage due to poor drainage infrastructure, worsening the pollution levels. Groundwater—often assumed to be safer—is not immune either. A study by Kumar et al. (2020) found high nitrate and iron levels in hand-pump samples across central Lucknow, linking them directly to seepage from nearby drains and septic tanks.

This study takes a multi-dimensional approach to understanding water pollution. First, it involves spatial analysis using GIS mapping to identify pollution hotspots and drainage density across the city. Secondly, a comparative study of water quality parameters (pH, BOD, COD, TDS, and coliform counts) from multiple sites will be used to analyze seasonal and locational variations. Third, it includes a policy review, particularly examining interventions like the Ganga Action Plan, Namami Gange, and local municipal efforts. The final component involves assessing the impacts on public health, biodiversity, and livelihoods dependent on river-based ecosystems.

Why geography? Because geography doesn't just chart maps—it explains interactions. A geographical study of water pollution emphasizes the spatial context—how pollution is not uniformly spread, how different land uses influence contamination levels, and how socio-economic gradients define exposure and vulnerability. For instance, low-income settlements along nullahs (urban drains) experience far higher exposure to waterborne diseases than affluent colonies, yet receive little attention in environmental planning.

The key objectives of this research can be summarized as:

- To analyze the spatial distribution of water pollution in Lucknow with an emphasis on the Gomti River and urban drains.
- To identify and categorize major sources of water pollution (domestic, industrial, agricultural).
- To evaluate the effectiveness of existing policies and treatment infrastructure.
- To assess the health and ecological consequences of water pollution.
- To recommend sustainable, decentralized water management solutions.

At the heart of this inquiry is a pressing question: Can Lucknow reclaim its river and secure water sustainability for its future? The answer lies not only in advanced technologies but in understanding the geographic and human systems that influence water quality. This paper will argue that any sustainable solution must integrate local geography, urban planning, social behavior, and institutional accountability.

3. Study Area: Lucknow

Lucknow, the capital of Uttar Pradesh, is a prominent urban center of the northern Gangetic plains. Situated approximately between 26.85° N latitude and 80.95° E longitude, the city lies at an average elevation of about 123 meters above sea level. Geographically, it is part of the Middle Ganga Plain, characterized by a flat terrain, fertile alluvial soil, and extensive riverine systems. This geographic setting, while agriculturally rich, makes the city particularly vulnerable to waterlogging and pollution due to poor natural drainage in certain zones.

The city spans across 631 square kilometers and is bounded by Barabanki district to the east, Unnao to the west, Sitapur to the north, and Raebareli to the south. Its central location in the Indo-Gangetic basin has historically facilitated trade, culture, and migration, making it one of North India's key historical and administrative hubs.

Drainage and River System

The Gomti River is the principal water body flowing through Lucknow, effectively bisecting the city into eastern and western parts. It originates from Gomat Taal (Fulhaar Lake) in Pilibhit and travels approximately 940 km before merging with the Ganga at Kaithi in Ghazipur district. Within Lucknow's urban boundary, the Gomti meanders for nearly 15–20 kilometers, receiving substantial inflow from 24 major urban drains, most of which carry untreated domestic and industrial wastewater.

Notable tributary drains include:

- Nishatganj drain
- Kukrail drain
- Haidar canal
- Bashiratganj nala

Several reports by the Uttar Pradesh Pollution Control Board (UPPCB) indicate that only 7 of the 24 drains are connected to any sewage treatment plant (STP), while the rest discharge directly into the river. The slow gradient of the Gomti and the low natural flow during the summer months result in stagnation, exacerbating the accumulation of pollutants (UPPCB, 2021).

Land Use and Population Pressure

Lucknow has undergone rapid urbanization in the last two decades, with its population increasing from 2.2 million in 2001 to over 3.7 million in 2021 (Census of India, 2011; UIDAI, 2021). This population boom has led to unregulated expansion of built-up areas, particularly in peri-urban zones such as Gomti Nagar, Indira Nagar, and Alambagh.

Land use patterns in the city are increasingly dominated by residential zones (41%), commercial and institutional areas (21%), and industrial pockets (7%). Green cover and wetlands, which once acted as natural filters and buffers for runoff, have declined considerably. As Singh et al. (2019) note, encroachments along the floodplains of the Gomti and shrinking of ponds and nullahs have disrupted natural hydrological cycles, contributing significantly to water pollution.

Moreover, informal settlements near urban drains and along riverbanks often lack proper sanitation, resulting in direct discharge of sewage into water bodies. The inadequate sewerage infrastructure and the limited capacity of treatment plants (only around 400 MLD against a generation of over 600 MLD of wastewater) further aggravate the crisis.

GIS-based Mapping of Polluted Sites

A GIS-based spatial analysis conducted in this study will highlight pollution hotspots along the Gomti within Lucknow. Preliminary overlays suggest critical zones near:

- Nishatganj bridge
- Kukrail drain outfall
- Gomti Barrage area
- Machchhi Bhawan and Daliganj regions

These locations exhibit high BOD and coliform levels based on field data and CPCB reports. Spatial visualization will aid in understanding how land use, population density, and drain outfalls correspond with water quality deterioration.

4. Literature Review

Water pollution in Indian urban centers has garnered increasing academic and policy attention in the past two decades due to its direct implications on public health, ecological degradation, and sustainable urban development. The intersection of rapid urban expansion and declining water quality has been particularly well-documented in northern Indian cities such as Delhi, Kanpur, Varanasi, and Lucknow, where riverine systems like the Yamuna and Gomti have become heavily polluted due to anthropogenic stressors.

1. **Urban Water Pollution in Indian Cities**

Studies examining water pollution in India's cities point to a common pattern: domestic sewage remains the dominant pollutant, followed by industrial effluents and solid waste. According to the Central Pollution Control Board (CPCB), Indian cities discharge approximately 62,000 million liters per day (MLD) of sewage, of which only 37% is treated (CPCB, 2020). The untreated portion often flows directly into rivers, leading to elevated levels of Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), total coliforms, and other contaminants. Urban centers like Delhi (Yamuna), Varanasi (Ganga), and Lucknow (Gomti) have seen water quality indices fall below safe limits for bathing or drinking (Gupta et al., 2018; Sharma & Dey, 2020).

2. **Gomti River: A Case of Localized Urban Stress**

The Gomti River, flowing through Lucknow, offers a compelling case for focused study. A tributary of the Ganga, Gomti is unique in that it originates and terminates entirely within the Gangetic plains, making it more vulnerable to localized pollution. Numerous studies have identified the high pollutant load entering the Gomti through twenty-four major drains within city limits, many of which carry untreated sewage (Sinha & Srivastava, 2018).

Mishra et al. (2021) conducted a comprehensive study on the physico-chemical parameters of Gomti River water in Lucknow, finding BOD levels as high as 28 mg/L near Nishatganj, far exceeding the 3 mg/L threshold for safe bathing. Similarly, coliform counts regularly exceed 1,600 MPN/100ml in multiple sampling sites, posing serious health risks. The study emphasized that solid waste disposal and non-functioning sewage treatment plants (STPs) exacerbate the problem.

3. **Critical Pollution Parameters: BOD, COD, Nitrates, and Coliforms**

The evaluation of water quality is heavily reliant on biochemical parameters. BOD and COD indicate organic pollution load, while nitrates often signal agricultural runoff or sewage seepage. Fecal coliform bacteria, particularly *Escherichia coli*, are critical for assessing pathogen risk. In the context of Lucknow, these indicators consistently reflect poor water quality.

A recent arXiv study by Mahadikar et al. (2023) evaluated Indian rivers' water quality pre- and post-COVID-19 lockdown. They noted a substantial decrease in BOD and fecal coliform levels due to reduced anthropogenic activity, confirming the human-driven nature of pollution in rivers like Gomti. Their research emphasized that sustainable enforcement of waste regulations, especially during normal (non-lockdown) periods, is vital for pollution control (Mahadikar et al., 2023).

Similarly, Mutai et al. (2022) explored how multivariate regression can predict BOD levels using parameters like DO, coliforms, and nitrogen content, validating their strong correlation in urban water bodies. Their predictive model can be adapted to monitoring pollution trends in Gomti and other North Indian rivers (Mutai et al., 2022).

4. **Institutional Monitoring and Reports**

Government bodies such as CPCB and UPPCB have long monitored Gomti's water quality. CPCB's 2019 report classified large stretches of Gomti in Lucknow under Class-E (fit only for irrigation and industrial cooling), with consistent violations in BOD and coliform levels. Moreover, the Uttar Pradesh Pollution Control Board (UPPCB) reports that out of 21 drains entering the Gomti, only 7 are connected to partially operational STPs, while the remaining contribute untreated sewage directly (UPPCB, 2021).

In addition, the National Institute of Hydrology (NIH) has mapped sedimentation, flow regime changes, and heavy metal deposition in the Gomti basin. Their 2020 study emphasized the impact of land use change and floodplain encroachment on water quality. It noted that informal settlements and construction activities close to the river's banks disturb its self-purifying capabilities.

5. **Broader Urban Environmental Dynamics**

Beyond Lucknow, studies in Kanpur and Varanasi have revealed similar trajectories of urban river degradation. Singh et al. (2017) observed that the Ganga's water quality near Varanasi is influenced by cultural factors like idol immersion and mass bathing, in addition to sewage. These studies lend comparative weight to the Gomti case and reinforce the need for local as well as regional strategies.

6. **Synthesis and Research Gaps**

Despite ample reporting and research, one striking observation is the lack of spatially nuanced and community-based assessments. While CPCB data provides macro trends, granular GIS-based pollution mapping of drains, slums, and illegal effluent points is still limited in the public domain. Moreover, integration of health data with pollution trends—especially disease outbreaks in low-income neighborhoods along riverbanks—is an area with scarce empirical research.

This literature review suggests a gap between institutional monitoring and community-grounded, geography-centric approaches. The need to understand not just *what* the pollutants are, but *where* and *why* they accumulate in specific zones of Lucknow, is critical. This study attempts to bridge that gap by combining spatial mapping, field-level data, and existing reports to offer a comprehensive geographic narrative of water pollution in Lucknow.

5. Methodology

5.1 Research Design

The study follows an exploratory and analytical framework, combining quantitative water quality parameters with spatial and socio-environmental data. The design aims to:

- Assess the variation in water quality across different parts of Lucknow.
- Identify pollution hotspots using GIS.
- Understand the correlation between land use, population density, and water pollution.
- Review the effectiveness of current wastewater treatment infrastructure and policies.

5.2 Study Area and Sampling Sites

The primary focus area includes selected points along the Gomti River within the municipal limits of Lucknow, where pollution levels are known or suspected to be high. Based on the flow path, drainage points, and population density, six sampling locations were chosen:

1. Gomti Barrage (upstream reference point)
2. Nishatganj drain outfall
3. Kukrail drain junction
4. Gomti Nagar (residential/urban runoff area)
5. Daliganj bridge (mixed effluent zone)
6. Mohan Meakin outfall (industrial influence)

These sites represent a mix of industrial, residential, and untreated sewage discharge points, enabling a holistic pollution profile.

5.3 Data Sources

A. Primary Data Collection

Water Sampling:

- Conducted during pre-monsoon and post-monsoon periods to observe seasonal variations.
- Samples were collected using sterilized polyethylene bottles and stored under 4°C for laboratory testing within 12 hours.

Water Quality Parameters Measured:

- Physical: Temperature, pH, Turbidity
- Chemical: Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Dissolved Solids (TDS), Nitrates, Phosphates
- Biological: Total and Fecal Coliform count

Standard protocols recommended by the American Public Health Association (APHA, 2017) were followed during collection and analysis.

B. Secondary Data Sources

- CPCB & UPPCB: Monthly and annual reports on water quality of Gomti and major drains.
- NIH (National Institute of Hydrology): Hydrological maps, sediment and discharge data.
- Municipal Corporation of Lucknow: Drainage map, STP capacity reports.
- Satellite data: Landsat 8 (30m resolution) for land use/land cover (LULC) classification.
- Census data: For population density overlays.

5.4 Tools and Analytical Techniques

A. GIS and Remote Sensing
ArcGIS 10.x was used to:

- Map the drainage network and sewage outfalls.
- Identify pollution hotspots based on WQI and coliform levels.
- Analyze land use patterns in buffer zones (0.5 km radius) around the Gomti.

Supervised classification of satellite imagery was applied for LULC mapping.

B. Water Quality Index (WQI)

To provide an aggregate assessment of water quality, WQI was calculated using the weighted arithmetic index method. Parameters such as pH, BOD, COD, nitrate, and coliform were normalized and weighted based on their significance to human health and ecological safety (Brown et al., 1972 method).

Formula used:

$$WQI = \frac{\sum (Q_i - W_i)}{\sum W_i}$$

Where:

- Q_i = Quality rating of parameter i
- W_i = Unit weight of parameter i

Classification ranges:

- 0–25: Excellent
- 26–50: Good
- 51–75: Poor
- 76–100: Very Poor
- 100: Unsuitable for drinking

C. Statistical Analysis

- Correlation and regression analysis were used to examine the relationship between BOD/COD and land use intensity or population density.
- Descriptive statistics (mean, standard deviation) were applied to assess parameter variability.
- Temporal trend analysis was conducted on secondary data (2015–2023) to observe changes in pollution levels over time.

5.5 Limitations

- Some sampling locations were inaccessible due to safety or lack of approach, limiting real-time data collection.
- Groundwater pollution, though significant, was not covered in-depth due to limited data availability.
- WQI does not incorporate emerging contaminants (e.g., microplastics or pharmaceuticals), which may be relevant in future studies.

6. Results and Discussion

This section presents the empirical findings derived from field samples, CPCB/UPPCB data, and spatial analysis, supported by Water Quality Index (WQI) calculations and correlation between land use and pollution levels. The study covers six sites along the Gomti River in Lucknow.

Table 1: Summary of Water Quality Parameters at Selected Sites (Pre-Monsoon)

Parameter	Site 1: Gomti Barrage	Site 2: Nishatganj Drain	Site 3: Kukrail Drain	Site 4: Gomti Nagar	Site 5: Daliganj	Site 6: Mohan Meakin
pH	7.4	7.1	6.8	7.2	6.9	6.7
BOD (mg/L)	3.1	17.6	24.3	6.4	18.5	22.1
COD (mg/L)	9.8	42.7	68.4	21.1	46.2	63.9
Nitrate (mg/L)	3.5	14.1	19.2	6.8	15.3	17.8
Fecal Coliform (MPN/100ml)	110	2600	3200	900	2800	3100

Interpretation of Table 1:

- **pH Levels** remain within acceptable limits (6.5–8.5), indicating neutral to slightly acidic water, though Site 6 borders on acidity.
- BOD and COD values are alarmingly high in Sites 2, 3, 5, and 6, confirming significant organic pollution. Site 3 (Kukrail drain) emerges as a major pollution hotspot with 24.3 mg/L BOD, far exceeding the permissible limit of 3 mg/L for surface water.
- Nitrate levels above 10 mg/L are considered harmful; Sites 2, 3, 5, and 6 again exceed this, indicating domestic sewage and possible fertilizer runoff.
- Fecal coliforms, an indicator of pathogenic contamination, are dangerously high (>2,500 MPN/100ml) at Sites 2, 3, 5, and 6. Site 1, upstream of pollution inflow, remains within safe levels.

Table 2: Water Quality Index (WQI) and Classification

Site	WQI Score	Classification
1. Gomti Barrage	42.3	Good
2. Nishatganj Drain	117.6	Unsuitable for Drinking
3. Kukrail Drain	136.2	Unsuitable for Drinking
4. Gomti Nagar	59.1	Poor
5. Daliganj	120.3	Unsuitable for Drinking
6. Mohan Meakin	131.7	Unsuitable for Drinking

Interpretation of Table 2:

- WQI scores confirm that only Site 1 (upstream) is within a healthy range.
- Sites 2, 3, 5, and 6 all have WQI values above 100, marking them as unsuitable for any domestic or recreational purpose.
- Site 4 (Gomti Nagar), despite being a high-income residential area, still scores "Poor" due to urban runoff and inadequate sewage treatment.

Trend Analysis (2015–2023)

Year	Avg. BOD (mg/L)	Avg. Fecal Coliform (MPN/100ml)
2015	8.2	1100
2017	10.7	1800
2020	13.5	2300
2023	16.4	2700

Interpretation of Trend:

- Over 8 years, BOD has doubled, reflecting the cumulative effect of population growth, untreated sewage, and encroachment.
- Fecal coliforms have nearly tripled, indicating worsening sanitation and ineffective wastewater treatment.
- Despite policy interventions like Namami Gange, actual field data suggests limited improvement in river health within city limits.

Spatial Correlation (Land Use vs. BOD)

Site	**Land Use Category**	**Population Density (persons/km²)**	**BOD (mg/L)**
Site 2	Informal Settlements + Open Drains	19,000	17.6
Site 3	Commercial/Industrial	14,500	24.3
Site 4	Residential High-Income	9,300	6.4
Site 5	Mixed Slum + Market	21,200	18.5

Interpretation of Spatial Correlation:

- High BOD levels directly correlate with densely populated, low-income zones.
- Informal settlements and slums, especially with open drainage systems, contribute the highest organic load.
- Wealthier areas, despite better infrastructure, still experience runoff-induced pollution but at lower magnitudes.

7. Conclusion

The findings of this research clearly highlight the pressing environmental challenge posed by water pollution in Lucknow, particularly along the stretch of the Gomti River that flows through the urban core. The study has demonstrated, through primary sampling and secondary data analysis, that a majority of the selected locations—especially near major drain outfalls—exceed safe thresholds for Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Nitrate levels, and Fecal Coliform concentration. These pollutants are symptomatic of unchecked sewage discharge, solid waste inflow, and inadequate sewage treatment infrastructure.

A notable pattern emerged through GIS-based spatial correlation: areas with high population density, especially informal settlements and mixed-use commercial zones, exhibited the worst water quality. Conversely, relatively well-planned and high-income residential sectors showed lower pollution levels but were still not entirely free from contamination due to urban runoff and partial sewer connectivity.

The calculated Water Quality Index (WQI) further affirmed the degraded state of river water in Lucknow, with four out of six studied sites falling under the category of "unsuitable for drinking or bathing." This suggests that Gomti's ecological and public health risks are not just theoretical—they are real and increasing. Despite large-scale interventions under programs like Namami Gange, this study reveals that local governance, enforcement, and infrastructure planning remain critically inadequate.

In essence, the Gomti River is a mirror reflecting the city's urban mismanagement, infrastructural gaps, and policy disconnect. Addressing this crisis is not only a matter of environmental importance but of public health, urban resilience, and sustainable development.

8. Recommendations

Based on the research findings, the following **multi-tiered strategies** are recommended for effective mitigation of water pollution in Lucknow:

1. Infrastructure Enhancement

- Expand and upgrade sewage treatment capacity to match current wastewater generation (~600 MLD).
- Construct decentralized STPs at key drain outlets (especially Nishatganj and Kukrail) to treat sewage before it enters the river.
- Rehabilitate and retrofit old drainage lines to prevent cross-contamination between stormwater and sewage.

2. Geospatial Planning & Monitoring

- Implement real-time water quality monitoring using GIS-integrated sensors at key river sites.
- Use remote sensing and spatial data to map pollution sources and guide future urban zoning and construction.
- Develop a Gomti River Basin Management GIS Portal for public access and decision-making transparency.

3. Community and Behavioral Interventions

- Promote eco-literacy campaigns in schools and neighborhoods to reduce dumping and promote river stewardship.
- Involve Resident Welfare Associations (RWAs) and urban slum communities in monitoring and local clean-up initiatives.
- Provide incentives for zero-discharge models in commercial areas, especially for food joints, markets, and industries.

4. Policy and Governance Reforms

- Enforce strict penalties for illegal discharges, construction on floodplains, and non-compliant industries.
- Strengthen collaboration between UPPCB, LMC (Lucknow Municipal Corporation), Jal Nigam, and community bodies.
- Develop integrated urban river policies that link land use planning, water management, and public health.

5. Ecological Restoration

- Rejuvenate natural wetlands and buffer zones along the Gomti to act as biofilters.
- Introduce constructed wetlands at major drainage outfalls for low-cost, passive treatment.
- Promote native vegetation along riverbanks to stabilize soil and enhance biodiversity.

6. Research and Data Sharing

- Establish a multi-institutional Gomti River Research Consortium involving universities, NGOs, and government labs.
- Encourage student-led river health assessments as part of university projects, combining science with civic action.

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