

Rejuvenation of Urban Water Bodies in Indian cities - A Case study of Delhi

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Abstract

Rapid urbanization in Indian cities has led to significant environmental degradation, notably affecting urban water bodies. Delhi, the capital city, serves as a pertinent example where many water bodies have been subjected to pollution, encroachment, and neglect. This study aims to investigate the current state of urban water bodies in Delhi and evaluate the effectiveness of existing and potential rejuvenation measures. The research specifically focuses on understanding the role of policy frameworks in the sustainable management of these water resources. The research identifies a decline in the water quality and ecological diversity of Delhi's urban water bodies. While existing policies aim at rejuvenation, their implementation has been sporadic and ineffective. The study concludes that a multi-pronged approach, involving policy reform, effective governance, and active community participation, is essential for the rejuvenation of urban water bodies in Delhi. The findings have broader implications for other urban areas in India, highlighting the need for comprehensive and sustainable water resource management.

Keywords: Urban Water Bodies, Rejuvenation, Sustainable Development, Urban Ecology.

Introduction:

Urban water bodies play a pivotal role in shaping the ecological, social, and cultural landscapes of cities. From acting as sources of water supply and supporting biodiversity to serving as recreational spaces, these water bodies are integral to urban ecosystems. However, rapid urbanization and population explosion have exerted enormous pressure on these ecological assets. In India, a country experiencing unprecedented growth in its urban areas, the degradation of water bodies has become a matter of pressing concern. Delhi, the

capital city, serves as a microcosm of the challenges faced by urban water bodies in India. Various rivers, lakes, and ponds that once adorned the city are now in a state of neglect, characterized by pollution, encroachment, and ecological imbalance. The degradation of Delhi's water bodies is not merely an environmental issue; it has far-reaching implications. Water scarcity has become a significant challenge, further exacerbated by the declining state of water bodies that traditionally served as natural reservoirs. Moreover, the deterioration of water quality has had a cascading

effect on the local ecosystems, negatively affecting biodiversity and increasing health risks for communities that rely on these water sources. Given the fundamental role that water plays in human life and the broader environment, the rejuvenation of urban water bodies has emerged as an imperative for sustainable development.



Rejuvenation of Water Bodies
Source: NITI Aayog

Against this backdrop, this research paper aims to provide an in-depth examination of the challenges and opportunities in the rejuvenation of Delhi's urban water bodies. While multiple studies have investigated various aspects of water conservation and management, there remains a research gap in understanding how theoretical frameworks like Urban Ecology, Environmental Governance, and Sustainable Development can be practically applied to rejuvenate urban water bodies. This study aims to fill this gap by employing a multi-disciplinary approach to explore the intricacies of policy frameworks, community engagement, and comparative global models that have been successful in urban water body management.

The primary objectives of this study are as follows:

To assess the current state of urban water bodies in Delhi and to evaluate the efficacy of existing policies and regulations aimed at rejuvenating these water bodies.

Through these objectives, the study aims to propose actionable recommendations that can inform policymakers, urban planners, environmentalists, and the community at large.

Problem Statement

Delhi's urban water bodies are facing severe degradation due to rapid urbanization, industrialization, and population growth. Pollution, encroachment, and ecological imbalances are causing water scarcity, loss of biodiversity, increased health risks, and compromised quality of life. This study aims to investigate the root causes and assess the efficacy of rejuvenation efforts, emphasizing policy frameworks, community engagement, and global models.

Literature Review:

(Schrenk, 2013) studied "Smart Community Participation for Revitalization of Urban Green Spaces Over Time: Case Study New Delhi" and said that The Indian city of the future must integrate ecology and conservation for sustainable planning, addressing environmental pollution and biodiversity loss through smart community participation and virtual technology.

(Varghese et al., 2011) studied "Integrated source water protection plan for an urban water body – A case study of Tapi river, India" and said that the 1995 creation of a causeway-cum-weir in Surat city led to pollution sources and stakeholders being identified, requiring a study to propose a river water quality management plan.

(Trivedi et al., 2023) studied "Groundwater pricing strategies for Indian cities - a case of Kanpur" and said that the study explores the use of groundwater pricing in Kanpur city, India, using GIS to assess the criticality of groundwater resources and propose effective pricing strategies.

(Srivastava et al., 2021) studied "Urban water resource management: experience from the revival of Rajokri lake in Delhi" and said that the paper discusses a rejuvenation project in Rajokri, Delhi, involving a SWAB system for treating domestic wastewater, improving urban management, ground water recharge, and ecosystem values.

(Siva et al., n.d.) studied "Rejuvenation of Lakes in Indian Cities: A Case Study for the Betterment of Wetlands in Bangalore" and said that Bangalore's 262 water bodies, once used until 1960, have decreased due to illegal encroachment, sewage,

toxic waste, domestic dumping, and defecation, causing fires.

(Singh & Biswas, 2022) studied “Analysis of Land Use Change Effects/Impacts on Surface Water Resources in Delhi” and said that the study examines land use changes in NCT Delhi, India, revealing decreasing surface water resources and increasing built-up land use since 1990. Factors like population growth and industrial development influence these changes. The findings are crucial for urban water rejuvenation initiatives.

(Sen et al., 2021) studied “Restoration of Urban Water Commons: Navigating Social-Ecological Fault Lines and Inequities” and said that The Bengaluru lake system, dating back to 9th century C.E., has been severely degraded due to urban expansion and social inclusions, highlighting the power dynamics within caste hierarchies.

(Rustogi & Singh., 2017) studied “Revival and Rejuvenation Strategy of Water Bodies in A Metropolitan City: A Case Study of Najafgarh Lake, Delhi, India.” And said that Urban Indian cities face water crisis due to watershed loss, pollution, encroachment, illegal constructions, and groundwater recharge. Revitalizing water bodies, like Najafgarh Lake, through rainwater harvesting and community management can mitigate drought and urbanization effects.

(Rustogi & Singh, 2017) studied “Ecological Benefits of Reviving Urban Water Bodies using Rainwater Harvesting” and said that India's rapid industrialization and urbanization are causing ecological challenges in water bodies, including loss of watersheds, pollution, and deteriorating water balance. Improving water health through rainwater harvesting and community water management schemes is crucial for public health.

(Jha et al., n.d.) studied “Restoration and Rejuvenation of Water Bodies Across Delhi-NCR - An Overview” and said that A study in India's Delhi suggests using GIS and Remote Sensing technology to restore over 1000 water bodies in the National Capital Region, emphasizing the need for policy synchronization with laws.

(Ghosh et al., 2019) studied “Urban Water Security Assessment Using an Integrated Metabolism Approach—Case Study of the National Capital Territory of Delhi in India” and said that the paper

presents an urban metabolism model for Delhi, focusing on improving stormwater infiltration, reducing runoff, and considering wastewater streams for sustainable water resource utilization. (Ghosh et al., n.d.) studied “Visitor Carrying Capacity Assessment of Urban Water-bodies and Wetlands in Indian Cities” and said that Rapid urbanization threatens natural resources like water bodies and wetlands, threatening popular nature-based tourism. This paper examines Kolkata's three popular destinations and their visitor carrying capacity for policy implications.

(Drew, 2020) studied “Political Ecologies of Water Capture in an Indian Smart City” and said that the article explores the historical water catchments of India's capital city, which were crucial for centuries of settlement growth. It highlights the need for smarter water management regimes and suggests that reviving these catchments can contribute to water stewardship but may perpetuate water access inequalities and middle-class priorities.

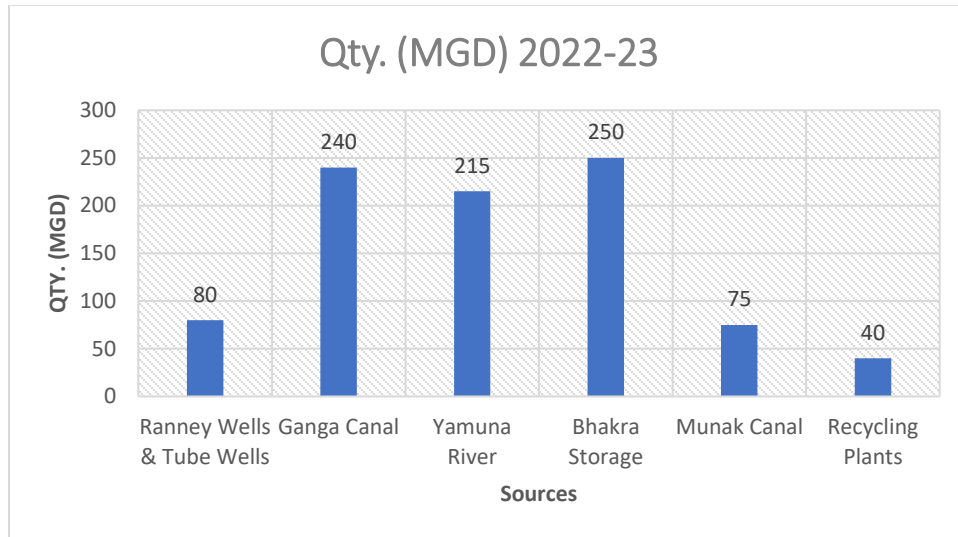
(Bhan, 2009) studied ““This is no longer the city I once knew”. Evictions, the urban poor and the right to the city in millennial Delhi” and said that Millennial Delhi's rapid urban planning and government changes, including judicial-based evictions, have led to a significant shift in slum clearance schemes, re-configuring public interest in Indian cities.

Status of Raw Water sources available in Delhi

The bar chart represents the status of raw water sources available in Delhi for the year 2022-23, measured in MGD (Million Gallons per Day). From the chart, we can observe the following quantities for each source.

Ranney Wells & Tube Wells provide Delhi with a quantity of 80 MGD of raw water. The Ganga Canal contributes a significant 240 MGD of raw water to Delhi. The Yamuna River is another major source, supplying 215 MGD. Bhakra Storage stands out as the largest contributor, providing 250 MGD of raw water. The Munak Canal contributes a moderate 75 MGD. Lastly, Recycling Plants add a further 40 MGD to Delhi's raw water availability. From this data, it's evident that the Bhakra Storage and the Ganga Canal are the most significant raw water sources for Delhi in the year 2022-23, followed closely by

the Yamuna River. In contrast, the Recycling Plants and the Munak Canal offer lesser quantities.



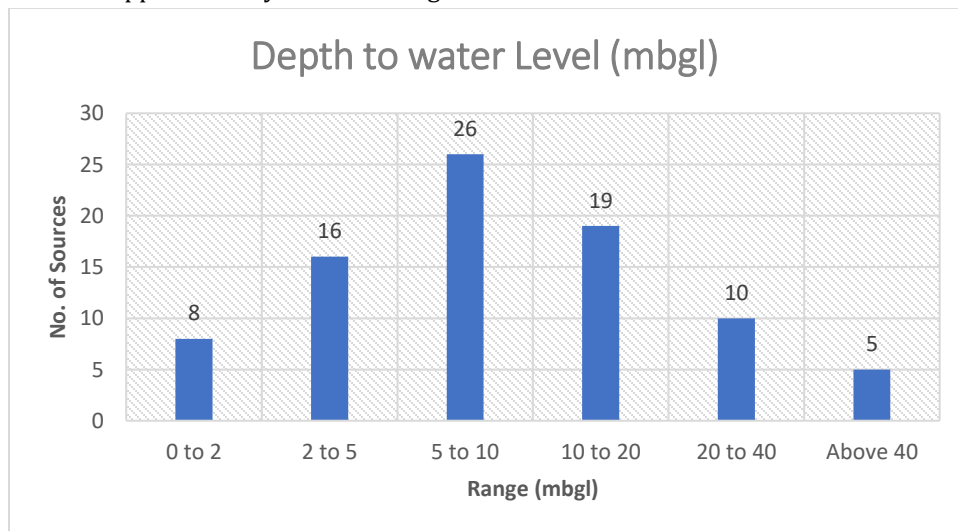
Source: Delhi Jal Board (2023)

Status of Ground Water in Delhi

The chart presents an overview of the status of ground water in Delhi by illustrating the depth to water level, measured in meters below ground level (mbgl). The x-axis denotes various depth ranges, while the y-axis represents the number of sources within each respective depth range. Here's a breakdown of the data from the chart.

For shallow depths between 0 to 2 mbgl, there are approximately 8 sources. A depth range of 2 to 5 mbgl comprises around 16 sources. The depth range of 5 to 10 mbgl has the highest number of sources, which is approximately 26. Moving

deeper, the 10 to 20 mbgl range consists of about 19 sources. Depths between 20 to 40 mbgl show a significant decrease, with just over 10 sources. Finally, the sources that are deeper than 40 mbgl are limited to slightly under 5. From the data, it can be inferred that a considerable number of ground water sources in Delhi are located within the 5 to 10 mbgl range. As the depth increases, particularly beyond 20 meters, the number of sources diminishes, indicating that deeper ground water is less abundant or less accessed in Delhi.



Source: Ministry of Jal Shakti (November 2022)

Status of Natural Water Bodies in Delhi

District	Total	Dirty Water	Encroached	Converted to Park
East	52	16	3	8
North East	31	1	2	8
North	165	12	50	7
North West	164	14	28	21
South	142	11	29	13
South East	42	1	2	2
South West	273	30	37	13
West	64	16	18	9
New Delhi	60	3	8	5
Central	29	4	3	3
Total	1022	108	180	89

Source: Delhi Parks and Garden Society (June 2023)

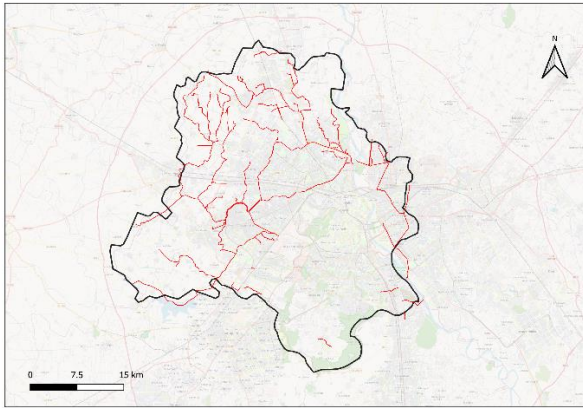
The table provides data on the status of natural water bodies in various districts of Delhi. The data is organized by district and offers insight into the total number of water bodies, the number that contain dirty water, those that have been encroached upon, and the ones that have been converted into parks.

East Delhi has 52 total water bodies, of which 16 contain dirty water, 3 have been encroached, and 8 have been converted into parks. North East Delhi has a total of 31 water bodies. Here, only 1 contains dirty water, 2 are encroached, and 8 have been turned into parks. North Delhi houses 165 water bodies, with 12 having dirty water, 50 being encroached, and 7 converted to parks. North West Delhi possesses 164 water bodies. 14 of these contain dirty water, 28 are encroached, and 21 have been transformed into parks. South Delhi has 142 water bodies, with 11 containing dirty water, 29 encroached, and 13 converted to parks. South East Delhi has 42 water bodies in total. Only 1 has

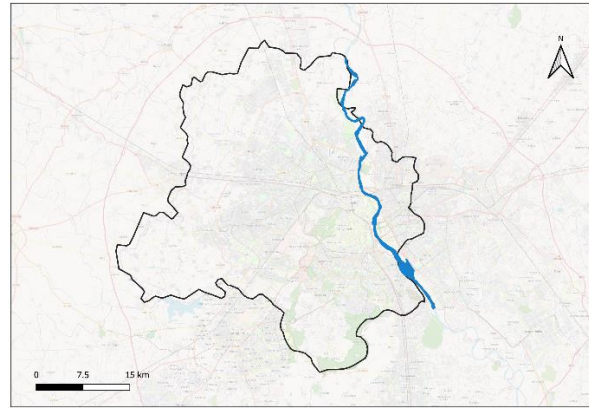
dirty water, 2 are encroached, and 2 have become parks. South West Delhi has the highest number of water bodies at 273. Out of these, 30 contain dirty water, 37 are encroached, and 13 have been turned into parks. West Delhi has 64 water bodies. 16 of them have dirty water, 18 are encroached, and 9 are now parks. New Delhi district has 60 water bodies, with 3 containing dirty water, 8 encroached, and 5 transformed into parks. Central Delhi has 29 water bodies, where 4 have dirty water, 3 are encroached, and 3 have been turned into parks. In total, Delhi has 1,022 natural water bodies. Out of these, 108 contain dirty water, 180 have been encroached upon, and 89 have been converted into parks.

The data provides an overview of the state of natural water bodies in Delhi, highlighting the challenges they face, including pollution (dirty water), encroachments, and urban development (converted into parks).

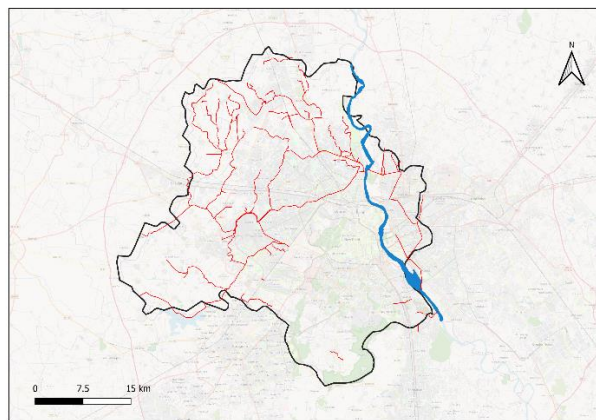
Yamuna and Storm Water Drains in Delhi



Storm Water Drains of Delhi



Flow of Yamuna through Delhi



Flow of Yamuna along with Natural Drains in Delhi

Source: Author Generated using Geographical Information system tool

The image 1 depicts a map showcasing the storm water drains of Delhi. The map provides an overview of Delhi's storm water drainage system, an essential infrastructure that helps manage water runoff during rains and prevent flooding. Such a layout is crucial for urban planning and can provide insights into areas that might be at risk during heavy rainfall or need further infrastructure development. The map provides an aerial view of the region, with the layout of Delhi highlighted, and the storm water drains are marked in red lines. From the image, it is evident that these storm water drains spread throughout the city, intersecting at multiple points.

The image 2 illustrates the flow of the Yamuna River as it courses through the city of Delhi. The river's trajectory is delineated by a prominent blue line, vividly contrasting against the muted background map of the city. From the visual representation, one can discern that the Yamuna River meanders through Delhi in a generally north to south direction. The river appears to be the most prominent water body within the city's boundaries, indicative of its significance in Delhi's geography and history. In essence, this map provides a clear portrayal of the Yamuna River's route within Delhi, emphasizing its pivotal role in the city's ecology, culture, and urban planning. The

Yamuna is not only a vital source of water but also plays an integral part in the city's religious, social, and economic fabric.

The image 3 presents a comprehensive depiction of Delhi, focusing on the flow of the Yamuna River, delineated by a pronounced blue line, alongside the city's network of natural stormwater drains, highlighted in vivid red lines. From the image, it's evident that the Yamuna River traverses Delhi in a primarily north to south orientation, playing a central role in the city's hydrological system. Its trajectory is complemented by a dense lattice of natural stormwater drains that weave throughout the city. These drains, showcased in red, span across various neighborhoods, intersecting at certain junctures and eventually converging into the Yamuna. The drains' vast spread suggests their essential function in managing water runoff, especially during monsoon seasons, thereby averting potential flooding scenarios.

Theoretical Concepts

Urban Ecology: Urban Ecology examines the relationship between urban development and natural ecosystems, particularly in Delhi, focusing on the degradation of urban water bodies due to human activities like construction and waste disposal.

Sustainable Development: The United Nations' Sustainable Development Goals (SDGs) guide the assessment of urban water body rejuvenation measures, with a focus on clean water, sanitation, life below water, and sustainable cities and communities, ensuring short-term effectiveness and long-term sustainability.

Environmental Governance: Environmental Governance examines policy-making, regulations, and governance structures in managing and preserving urban water bodies, analyzing effectiveness and potential improvements for better conservation efforts.

Community Engagement: This study explores community engagement in urban water body conservation, focusing on best practices for sustainable outcomes. It emphasizes the importance of local stewardship and ownership in achieving sustainable outcomes.

Water Quality Management: Theories on water quality management focus on pH levels, dissolved oxygen, and pollutant concentrations, providing a scientific basis for assessing water bodies and evaluating rejuvenation efforts.

Variables in the Study

Dependent Variable:

This study examines the state of urban water bodies in Delhi using indicators like water quality, biodiversity, ecological balance, and public usage. These measures provide a comprehensive understanding of the city's water body's health and sustainability.

Independent Variables:

Policy Implementation: The study evaluates the effectiveness of urban water body rejuvenation policies, focusing on structural and operational aspects like frameworks, guidelines, enforcement, and monitoring.

Community Engagement: The variable assesses the efficacy of community involvement in urban water body management and rejuvenation, utilizing metrics such as community-led initiatives, public awareness campaigns, and local stewardship.

Pollution Levels: The variable evaluates pollution levels in urban water bodies, focusing on industrial discharge, sewage, and littering, with potential measurements including pollutant concentrations and their impact on water quality.

Urban Planning: The variable examines the impact of urban development and planning decisions on urban water bodies, considering their integration into green or recreational spaces.

State of Urban Water Bodies: Refers to the overall condition of water bodies like rivers, lakes, and ponds in urban Delhi, encompassing factors such as water quality, biodiversity, and ecological balance.

Relationships:

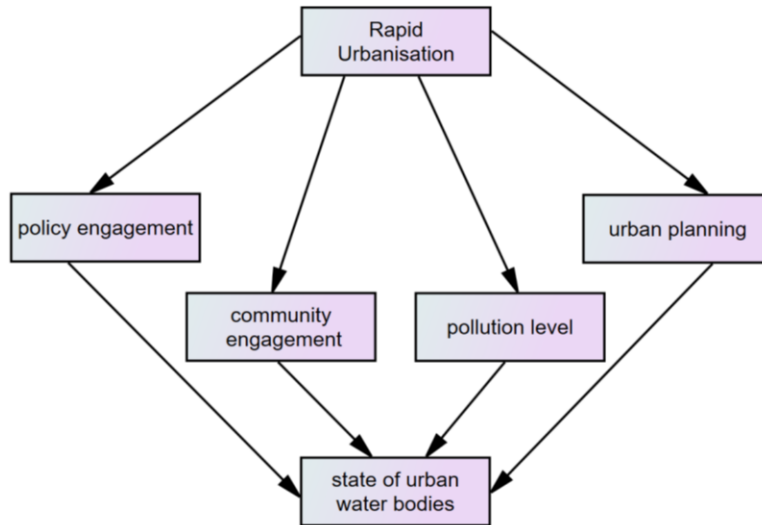
Policy Implementation and State of Urban Water Bodies: Effective policy implementation positively impacts urban water bodies' state, enhancing water quality and ecological balance.

Community Engagement and State of Urban Water Bodies: Community engagement, education, and active participation are hypothesized to

enhance urban water bodies' cleanliness, public usage, biodiversity, and water quality through community-led initiatives.

Pollution Levels and State of Urban Water Bodies: The expected inverse relationship is that increased pollution levels will negatively impact urban water bodies, leading to deteriorated water quality and a decrease in biodiversity.

Urban Planning and State of Urban Water Bodies: Urban planning decisions can positively or negatively affect water bodies' state, with proper zoning promoting their natural or recreational value, while neglect and encroachment can negatively affect their health.



Effect of Rapid Urbanization on State of Urban Water Bodies

The provided diagram illustrates the interconnectedness of various factors relating to urbanization and its impact on the environment and community. Rapid urbanization sits at the apex of the diagram, highlighting it as a primary force or driver. Urbanization often comes with a slew of challenges and issues, particularly when it's rapid and not well-planned. Urban Planning represents the strategies, policies, and processes by which urban areas are designed and organized. Rapid urbanization necessitates efficient urban planning to ensure sustainable growth, proper infrastructure, and efficient use of resources. One of the major fallouts of urbanization is the increase in pollution. This can range from air pollution due

to increased vehicular traffic and industries to water pollution from untreated waste. Urban water bodies like lakes, ponds, and rivers can be adversely affected by rapid urbanization. This includes problems like encroachment, pollution, and reduced groundwater recharge. As cities grow, community involvement becomes vital to address urban issues. A community that's engaged can actively participate in decision-making processes and contribute to sustainable urban development. Policymaking becomes crucial in rapidly urbanizing areas. This refers to the creation and implementation of policies that guide urban growth, ensuring it's sustainable, inclusive, and beneficial.

Government's Initiative:



Delhi Parks and Garden Society (Government of NCT of Delhi), 2023,

The Delhi government has been actively involved in the rejuvenation and conservation of water bodies across the city. Their initiatives encompass a range of activities, from cleaning up existing ponds and lakes to setting up decentralized sewage treatment plants, and reviving natural drainage systems. Public awareness campaigns have also been a significant part of these efforts, with community participation encouraged in the form of cleanliness drives, water harvesting projects, and educational programs. Special projects, often in collaboration with environmental organizations and experts, aim to restore aquatic ecosystems, improve groundwater levels, and create recreational spaces for residents. This multi-pronged approach aims not only to address the immediate concerns of water scarcity and pollution but also to build a sustainable, long-term solution for the city's water needs. It's a significant step forward in urban environmental management, and the efforts are closely watched as a possible model for other cities facing similar challenges.

Suggestions:

- **Strengthening Policy Frameworks:** Promote tougher pollution control and waste disposal rules near urban waterways. Policymakers should address industrial and residential polluter accountability loopholes.
- **Effective Governance and Monitoring:** Call for a specialized governing body or task group to monitor water bodies routinely. This organization might also penalize policy infractions and alert affected agencies.
- **Community Involvement:** Encourage local communities to clean and revitalize waterways. Community clean-ups, awareness initiatives, and education may foster civic pride.
- **Technology Integration:** Recommend the adoption of advanced water treatment and surveillance technologies. IoT sensors and drones can be used for real-time monitoring of water quality, while eco-friendly methods can be employed for water treatment.

- Public-Private Partnerships: Suggest forming collaborations between government agencies and private entities who have a stake in the betterment of the environment. This can bring in additional resources and expertise.
- Educational Programs: Call for environmental education in schools to teach future generations about sustainable water management.
- Regular Audits and Assessments: Advocate for periodic evaluations to assess the effectiveness of rejuvenation measures, with results to be made public for transparency.

Conclusion:

The rejuvenation of urban water bodies is not just an environmental imperative but also a social and economic necessity. Therefore, it is crucial for all stakeholders—from policymakers and urban planners to environmentalists and community members—to engage actively and collaboratively in the restoration efforts. This study serves as a foundational resource for such endeavors, urging immediate and cohesive action for the sustainable management of Delhi's precious water resources. This study has underscored the alarming degradation of urban water bodies in Delhi, a problem exacerbated by rapid urbanization and ineffective policy measures. The complexities associated with managing urban water bodies in Delhi necessitate a multi-pronged approach that combines policy reform, effective governance, and community participation. Our actionable recommendations outline a comprehensive strategy that involves not only rigorous policy reform but also calls for the integration of advanced technology and emphasizes the crucial role of community involvement. While this study focused on Delhi, the findings and recommendations have broader implications, serving as a pertinent guide for other urban areas grappling with similar challenges in India.

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