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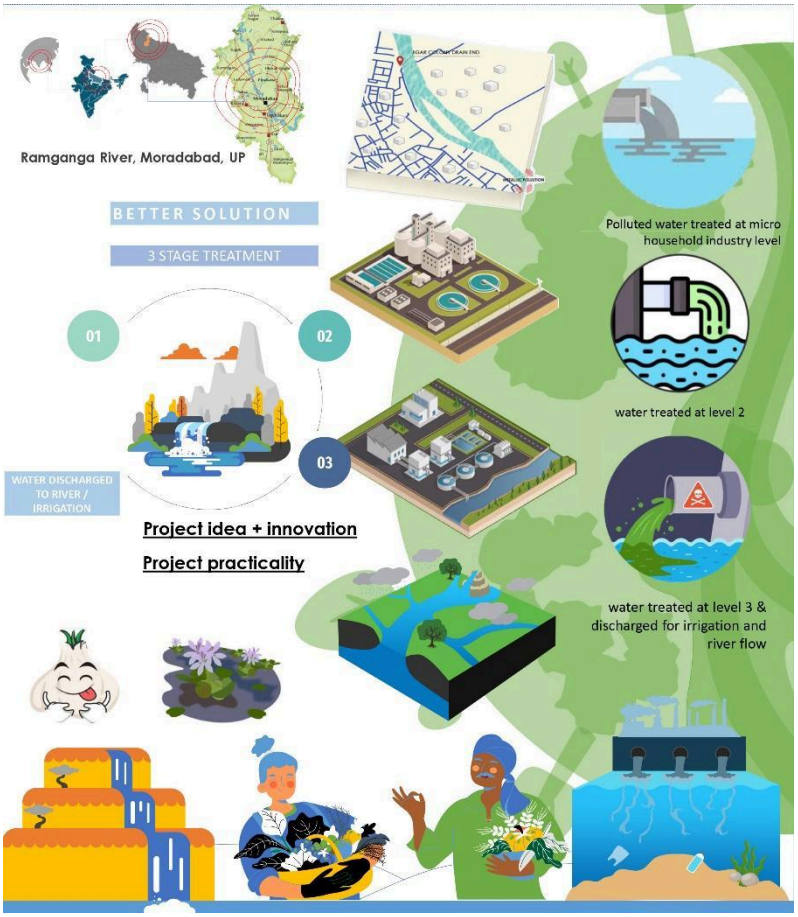
"RE-IMAGINING URBAN RIVERS"

Season- 3



Project Title : **Reinstating The Riparian Corridors For Boosting The Urban Economics: A Case Of Moradabad , U.P.**

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Preface

This executive summary presents the case for reinstating the riparian corridors in Moradabad, Uttar Pradesh, as a means to boost the urban economics of the region. Riparian corridors are strips of land along the banks of rivers or streams that play a crucial role in maintaining ecological balance, preserving biodiversity, and supporting economic activities.

This summary highlights the potential benefits of rehabilitating these corridors in Moradabad and provides recommendations for implementing such measures. Moradabad, a rapidly growing urban center, is facing various environmental challenges, including the degradation of riparian corridors. These corridors have been encroached upon and degraded due to unplanned urbanization, industrial pollution, and inadequate waste management practices.

This degradation has resulted in a loss of natural habitat, decreased water quality, and reduced opportunities for economic development. Rehabilitating riparian corridors will help restore and protect the natural ecosystem, improving water quality and supporting wildlife habitats. This conservation effort will enhance the overall environmental health of the region. Riparian corridors serve as important corridors for the movement of flora and fauna. By reinstating these corridors, the region can preserve and promote biodiversity, which can have positive ecological and economic impacts. Riparian corridors play a vital role in flood mitigation by absorbing excess water during heavy rainfall. Restoring these corridors will help regulate water flow, reducing the risk of flooding in urban areas. Rehabilitated riparian corridors can become attractive destinations for tourism and recreational activities.

They can provide opportunities for nature-based tourism, such as bird watching, hiking, and boating, thereby boosting the local economy through increased visitor spending. Restoring riparian corridors can create employment opportunities through various activities like ecological restoration, eco-tourism ventures, and the development of nature-based businesses. These economic activities can contribute to the overall growth and prosperity of the region.

Acknowledgements

I would like to express my deepest gratitude to the individuals who have contributed to the completion of my Master's thesis in Urban and Regional Planning. Their unwavering support and encouragement have played a crucial role in my academic journey. First and foremost, I am immensely grateful to my thesis guide, Dr. Mohit Kumar Agarwal. His invaluable guidance, expertise, and unwavering support throughout this research endeavor have been instrumental in shaping the direction and quality of my work. His continuous encouragement, insightful feedback, and patience have truly been a source of inspiration for me.

I would also like to express my gratitude to my friends and loved ones who have been there for me throughout this journey. Their unwavering support, understanding, and encouragement have provided me with the strength and motivation to overcome challenges and persevere. Their presence has brought joy, laughter, and solace during the demanding times of thesis work. Lastly, I would like to extend my appreciation to all the individuals who have directly or indirectly contributed to my growth as a researcher and planner. Your collective efforts have played an integral role in shaping my academic and personal development. To everyone mentioned above and to those not mentioned individually but who have been a part of my journey, please accept my heartfelt gratitude for your unwavering support, guidance, and encouragement. This thesis would not have been possible without each and every one of you. Thank you for being a part of this significant milestone in my academic life.

Shishir Verma

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List of Abbreviations

U.W.M. - Urban Water Management

R.C. - Riparian Corridors

EIA - Environmental Impact Assessment

DEWATS - Decentralized Wastewater Treatment Systems

IWRM - Integrated Water Resources Management

WTP - Water Treatment Plant

WWTP - Wastewater Treatment Plant

UWS - Urban Water Systems

SWM - Stormwater Management

I&D - Infiltration and Drainage

WUE - Water Use Efficiency

CWS - Combined Water System

WSUD - Water Sensitive Urban Design

BMPs - Best Management Practices

GIS - Geographic Information System

IoT - Internet of Things

NBS - Nature-Based Solutions

GWP - Global Water Partnership

NGO - Non-Governmental Organization

1. Introduction

1.1. Background

Riparian corridors, the strips of land along rivers and water bodies, play a crucial role in maintaining the ecological balance and providing numerous benefits to urban areas. However, rapid urbanization often leads to the degradation and encroachment of these vital natural resources, resulting in environmental, social, and economic challenges. This case study focuses on the city of Moradabad in Uttar Pradesh, India, where reinstating riparian corridors through effective urban water management is explored as a strategy to enhance the urban economy.

1.2. Need of the Study

The degradation and loss of riparian corridors in Moradabad have negatively impacted the urban environment, water resources, and overall economic development. The lack of comprehensive urban water management strategies hinders the potential for reinstating these corridors and harnessing their benefits for boosting the urban economy. Thus, there is a need to investigate and propose sustainable approaches to reinstate riparian corridors in Moradabad and leverage urban water management practices to stimulate economic growth and enhance the city's overall resilience.

This study aims to demonstrate the significance of reinstating riparian corridors in urban areas for economic growth and sustainability. By examining the specific case of Moradabad, the study provides insights into the challenges faced by the city and proposes strategies for restoring and managing riparian corridors effectively. The economic benefits resulting from such restoration efforts are explored, emphasizing the potential for improved water resources, livelihood opportunities, and increased tourism. Drawing from successful case studies and best practices, this research contributes to the knowledge base on urban water management and provides valuable recommendations for policymakers, stakeholders, and future research endeavors.

1.3. Aim & Objectives

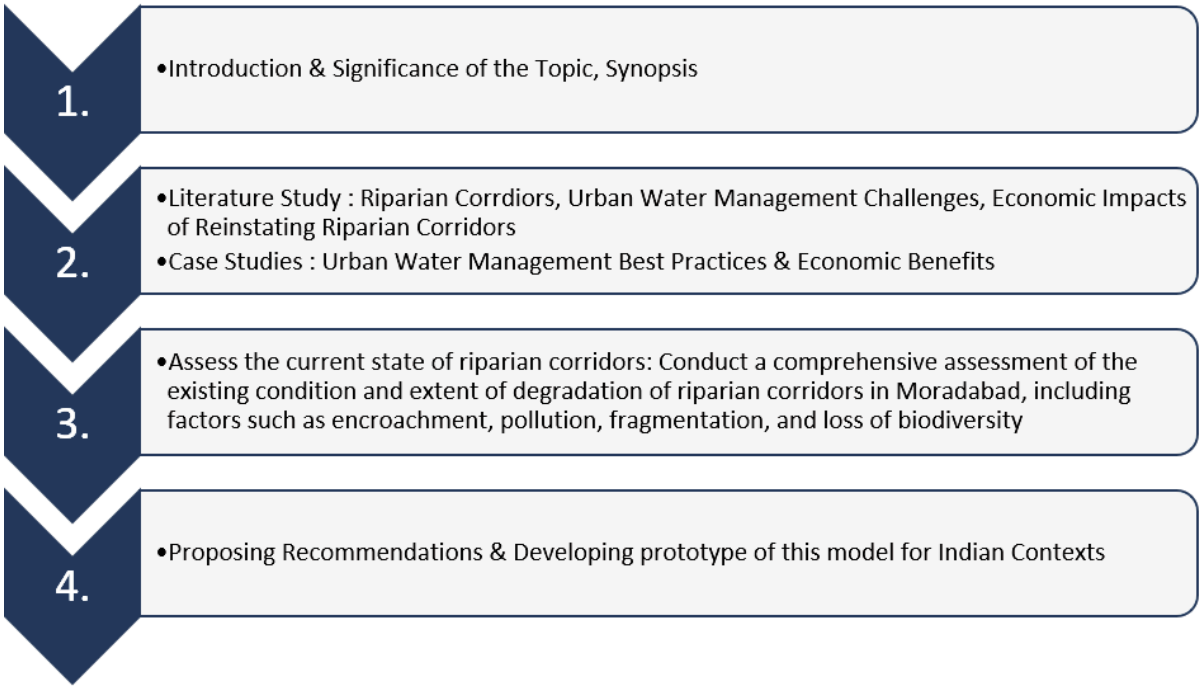
To investigate the potential of reinstating the riparian corridors for urban water management in order to boost Urban Economics and develop this framework as a Prototype to get implemented in multiple regions.

Research Objectives

- To Investigate the existing urban water management practices in Moradabad and their impact on riparian corridors. Assess the effectiveness of current water management strategies in promoting the restoration and sustainable management of riparian ecosystems.
- To Conduct a comprehensive assessment of the existing condition and extent of degradation of riparian corridors in Moradabad, including factors such as pollution, fragmentation, and loss of biodiversity
- To Identify and analyze the specific economic challenges faced by Moradabad due to the degradation of riparian corridors.

- To propose a set of recommendations and strategies for restoring and managing urban water systems in the Indian context, and to further develop this model as a prototype to be implemented in Indian contexts.

1.4. Methodology



2. Literature Review

2.1 Importance of Riparian Corridors

Riparian corridors, the strips of land along rivers, streams, and water bodies, hold significant importance due to their ecological, social, and economic benefits. The following are key reasons that highlight the importance of riparian corridors:

Biodiversity and Habitat Conservation: Riparian corridors serve as vital habitats for a diverse range of plant and animal species. The unique combination of water, vegetation, and landforms within these corridors supports a rich biodiversity, including numerous rare and endangered species. The preservation and restoration of riparian corridors are crucial for conserving ecosystem diversity and ensuring the survival of many species.

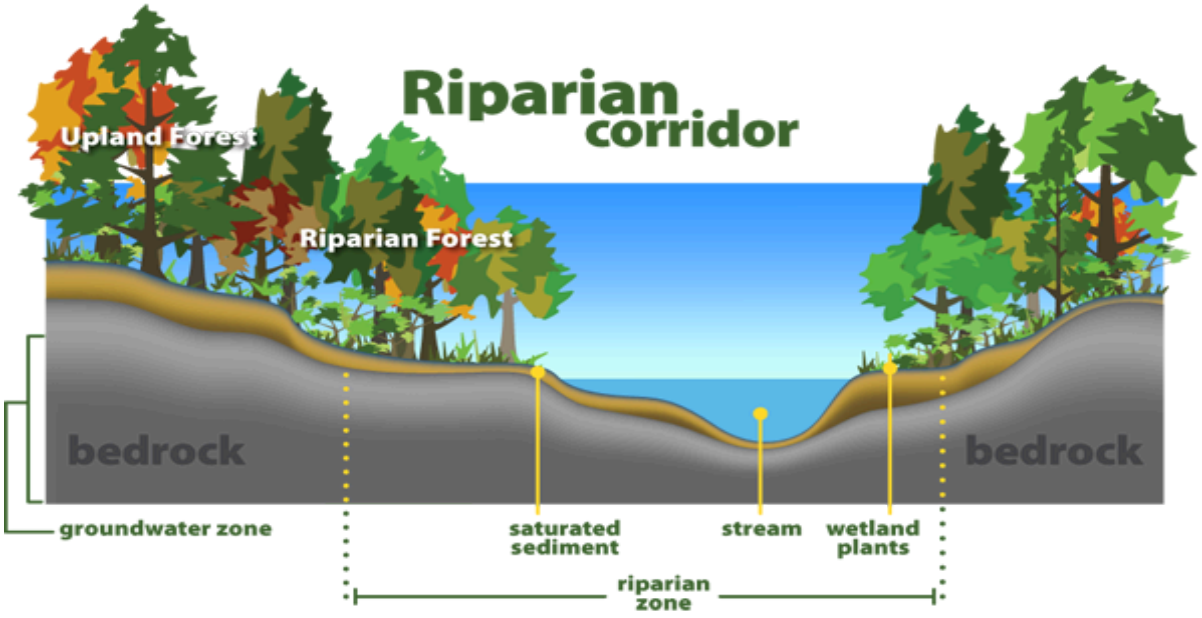


Figure 1 Riparian Corridors Section

Water Quality and Nutrient Cycling: Riparian corridors act as buffers, filtering pollutants, sediments, and nutrients from entering water bodies. The vegetation and soil within these corridors absorb and retain nutrients, thereby reducing the impact of nonpoint source pollution on water quality. Riparian vegetation also helps in stabilizing stream banks, reducing erosion, and preventing excessive sedimentation in water bodies.

Water Resource Management: Riparian corridors play a critical role in regulating water flow and maintaining hydrological cycles. They help in controlling floodwaters by absorbing excess runoff during heavy rainfall events and slowly releasing it, thereby minimizing flood risks

downstream. Riparian vegetation also contributes to groundwater recharge, ensuring the availability of water resources for both human and ecological needs.

Climate Change Adaptation: Riparian corridors provide important ecosystem services related to climate change adaptation. They help mitigate the impacts of extreme weather events by absorbing and dissipating energy from stormwater runoff, reducing the risk of flash floods and erosion. Riparian vegetation also sequesters carbon dioxide, mitigating greenhouse gas emissions and contributing to climate change mitigation efforts.

Erosion Control and Soil Stabilization: The vegetation within riparian corridors helps in stabilizing soil along riverbanks and preventing erosion. The extensive root systems of riparian plants bind the soil particles together, reducing the loss of valuable topsoil. This, in turn, helps in preserving agricultural productivity, maintaining the integrity of riverbanks, and preventing land degradation.

Recreational and Aesthetic Value: Riparian corridors provide scenic landscapes and recreational opportunities for communities. They offer spaces for activities such as fishing, boating, hiking, birdwatching, and nature exploration. Access to natural environments has positive impacts on human well-being, promoting physical and mental health, and enhancing the overall quality of life.

Economic Benefits: Riparian corridors can have direct and indirect economic benefits. They attract tourists, nature enthusiasts, and outdoor recreationists, contributing to the local economy through tourism revenue, job creation, and the development of related industries. Riparian corridors also enhance property values, especially for properties located near water bodies, thereby providing economic incentives for preserving and restoring these areas.

Overall, the preservation and restoration of riparian corridors are essential for maintaining ecological balance, ensuring water quality, managing water resources, mitigating climate change impacts, supporting biodiversity, and providing recreational and economic opportunities. Recognizing their importance is crucial for implementing effective conservation and restoration strategies, integrated land-use planning, and sustainable water management practices.

2.2 Ecological Significance

Riparian corridors hold significant ecological significance due to their unique characteristics and their interactions with surrounding ecosystems. The following points highlight the ecological importance of riparian corridors:

Biodiversity Hotspots: Riparian corridors often exhibit high levels of biodiversity, supporting a wide variety of plant and animal species. The combination of aquatic and terrestrial habitats within riparian areas provides diverse niches for various organisms, including specialized species adapted to the unique conditions of these transitional zones. Riparian corridors act as important ecological connectors, facilitating the movement of species between different habitats and contributing to overall landscape connectivity.

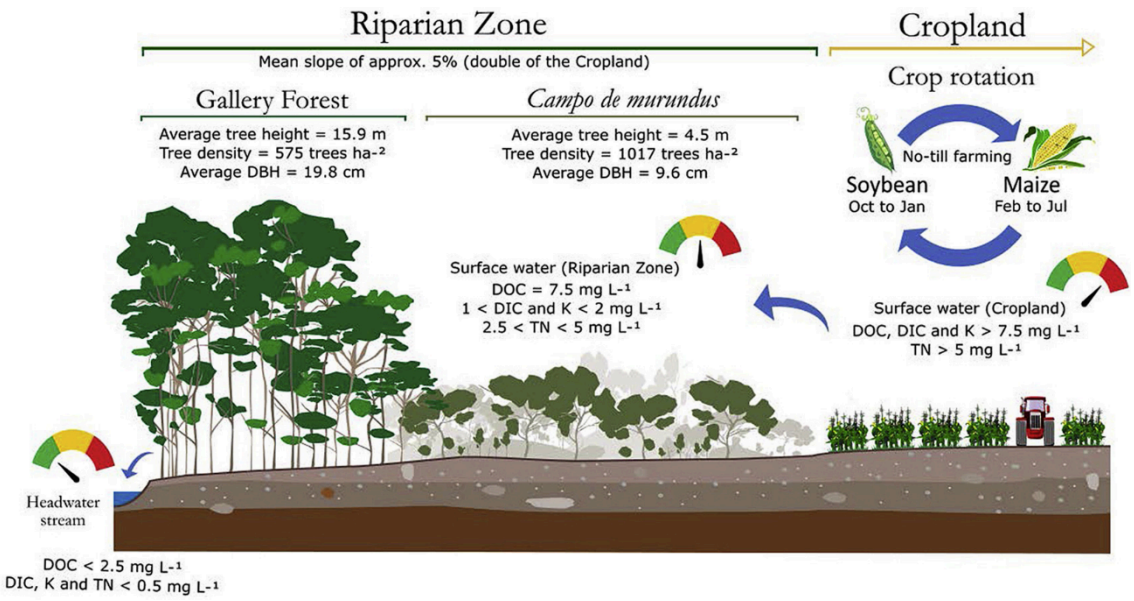


Figure 2 Ecological Significance of Riparian Corridors

Habitat Provision: Riparian corridors provide crucial habitats for a range of species, including birds, mammals, reptiles, amphibians, and aquatic organisms. The diverse vegetation found in riparian areas offers food sources, nesting sites, and shelter for a multitude of organisms. These habitats support both resident species and migratory species, contributing to the overall ecological balance and functioning of the ecosystem.

Aquatic Ecosystem Support: Riparian corridors play a vital role in maintaining healthy aquatic ecosystems. The vegetation along riverbanks provides shade, regulating water temperature and preventing excessive heating that can be detrimental to aquatic organisms. The leaf litter and woody debris from riparian vegetation act as a source of organic matter, contributing to nutrient cycling and supporting the food web in aquatic systems. Riparian areas also provide spawning grounds and nursery habitats for many fish species.

Nutrient Cycling and Water Quality: Riparian vegetation plays a critical role in nutrient cycling and water quality regulation. The roots of riparian plants stabilize the soil, preventing erosion and reducing sedimentation in water bodies. They also absorb excess nutrients, such as nitrogen and phosphorus, from surrounding runoff, reducing the input of these pollutants into waterways and preventing eutrophication. Riparian vegetation filters and traps sediments and pollutants, improving water quality downstream.

Flood Mitigation and Erosion Control: Riparian corridors act as natural buffers against flooding. They can absorb and store excess water during periods of high rainfall, reducing flood peak flows and providing floodplain storage capacity. The dense root systems of riparian plants bind the soil, stabilizing riverbanks and reducing erosion. This helps prevent the loss of valuable topsoil, maintain the integrity of river channels, and minimize sedimentation in downstream areas.

Climate Change Resilience: Riparian corridors contribute to climate change resilience by providing ecosystem services that help mitigate and adapt to climate impacts. They sequester

carbon dioxide through photosynthesis, helping to mitigate greenhouse gas emissions. Riparian vegetation also helps regulate microclimates, reducing heat island effects in urban areas and providing shade and cooling effects along water bodies. These functions contribute to climate change adaptation and the overall resilience of ecosystems.

Preserving and restoring riparian corridors is crucial for maintaining biodiversity, supporting aquatic ecosystems, regulating water quality, mitigating flooding and erosion, and enhancing climate change resilience. Recognizing their ecological significance and implementing conservation measures is essential for the long-term health and sustainability of riparian ecosystems and the broader landscapes they are a part of.

2.3 Socio-economic Benefits

Reinstating riparian corridors can bring about a range of socio-economic benefits for communities and urban areas. The following are key socio-economic benefits associated with the restoration and conservation of riparian corridors:

Tourism and Recreation: Riparian corridors provide attractive natural landscapes that can serve as tourist destinations and recreational areas. Activities such as fishing, boating, hiking, birdwatching, and nature photography can draw visitors, generating tourism revenue and supporting local businesses. The presence of well-preserved riparian areas enhances the quality of life for residents and provides opportunities for leisure and outdoor activities.

Property Values and Real Estate Development: Properties located near riparian corridors, especially those with water views or direct access, often experience increased value. The aesthetic appeal, ecological amenities, and recreational opportunities associated with riparian areas make them desirable locations for residential and commercial development. The presence of well-maintained riparian corridors can attract investments and stimulate real estate development, thereby contributing to economic growth.

Job Creation and Local Economy: The restoration and management of riparian corridors can create employment opportunities in various sectors. These include ecological restoration, habitat monitoring, nature-based tourism services, park maintenance, and environmental education. The development of riparian areas as tourist destinations or recreational spaces can generate jobs in hospitality, food services, retail, and other related industries, providing income and livelihood opportunities for local communities.

Ecosystem Services: Riparian corridors provide valuable ecosystem services that directly benefit human communities. They help regulate water flow, reduce flood risks, and control erosion, thereby protecting infrastructure, agricultural lands, and human settlements from the impacts of extreme weather events. Riparian vegetation also improves water quality by filtering pollutants and nutrients, supporting a clean and reliable water supply for urban areas.

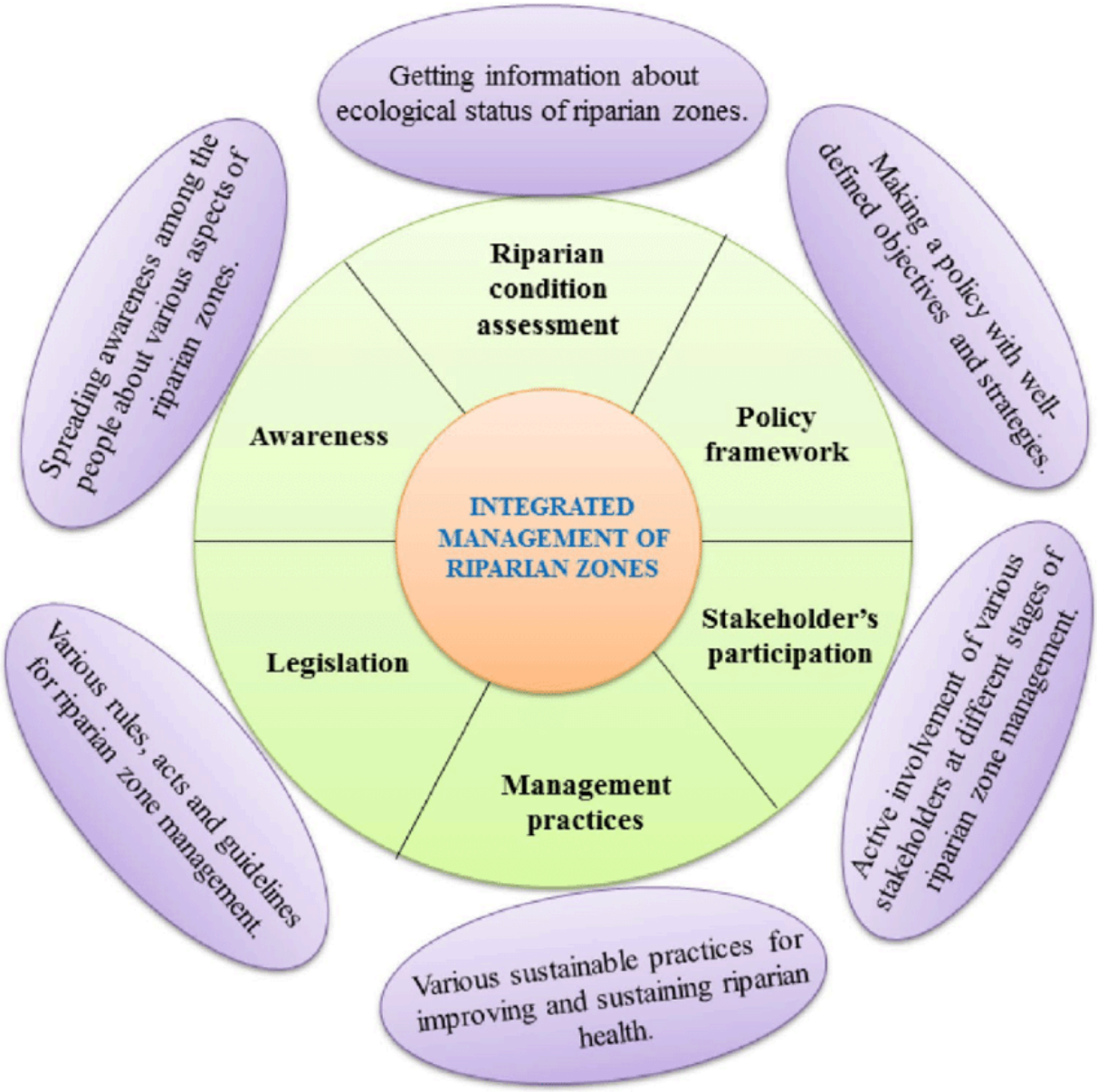


Figure 3 Socio economic benefits of riparian corrdiors

Climate Change Adaptation: Riparian corridors contribute to climate change adaptation by providing green infrastructure that helps mitigate and adapt to climate impacts. The vegetation in riparian areas absorbs carbon dioxide, reducing greenhouse gas emissions and mitigating climate change. Riparian vegetation also helps regulate local microclimates, reducing urban heat island effects and providing cooling effects in cities.

Cultural and Heritage Value: Riparian corridors often have cultural and historical significance for local communities. They may hold traditional or spiritual value, representing important cultural landscapes and heritage sites. The restoration and preservation of riparian areas can help maintain cultural connections, promote cultural tourism, and preserve traditional knowledge associated with these ecosystems.

Health and Well-being: Access to riparian corridors and green spaces has been linked to improved physical and mental well-being. The presence of natural environments, such as riparian areas, supports physical exercise, stress reduction, and improved mental health for residents. Well-designed and accessible riparian corridors can contribute to healthier and more livable urban environments.

By recognizing and harnessing the socio-economic benefits of riparian corridors, communities and urban areas can promote sustainable development, enhance quality of life, and create opportunities for economic growth and resilience. Integrating riparian corridor restoration and conservation into urban planning and decision-making processes can unlock these benefits and ensure the long-term socio-economic well-being of communities.

2.4 Urban Water Management

Urban water management refers to the planning, development, and implementation of strategies and practices aimed at efficiently managing water resources within urban areas. It involves various aspects, including water supply, wastewater management, stormwater management, and water conservation. Effective urban water management is crucial for ensuring sustainable and resilient water systems in cities. The following are key components and approaches involved in urban water management:

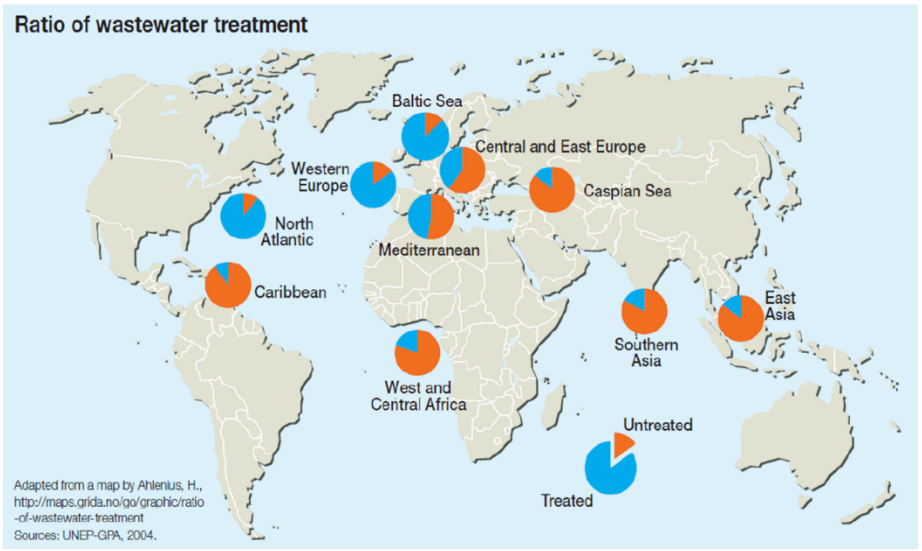


Figure 4 Wastewater Treatments Worldwide

Water Supply and Distribution: Urban water management focuses on ensuring reliable and sustainable water supply for urban areas. This includes strategies such as water source diversification, infrastructure development (e.g., water treatment plants, distribution networks), and demand management techniques to optimize water use.

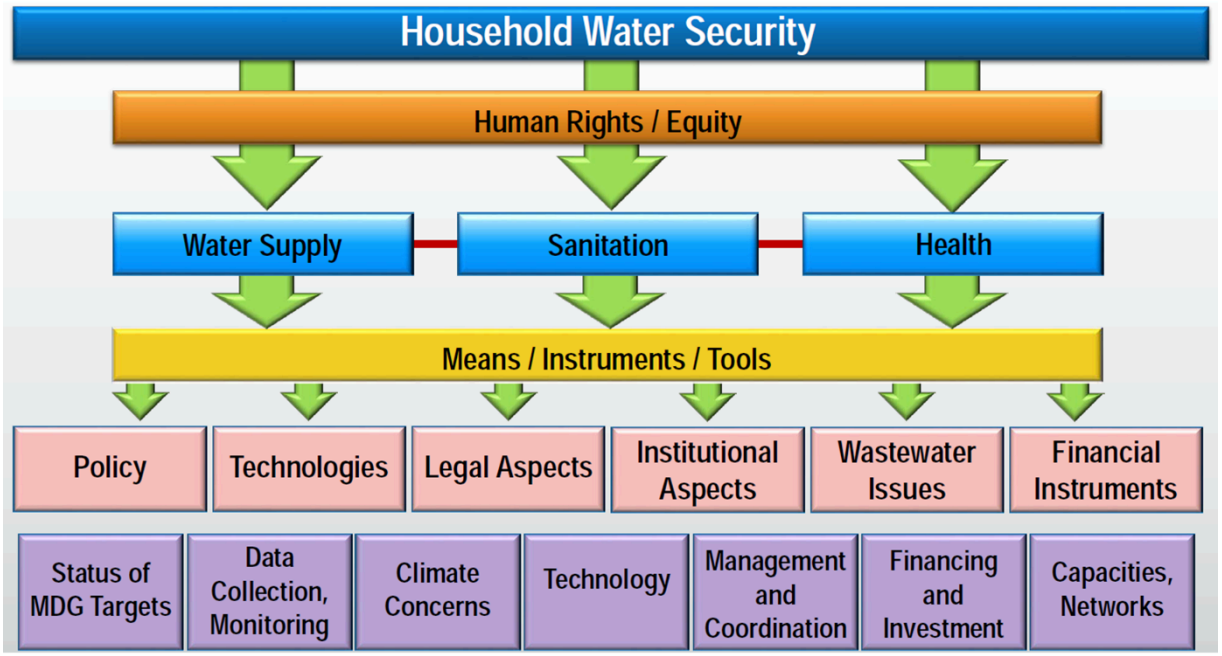


Figure 5 Household Water Security

Wastewater Management: Proper treatment and management of wastewater are essential for protecting public health and the environment. Urban water management involves the collection, treatment, and safe disposal or reuse of wastewater. This can include the construction and operation of wastewater treatment plants, sewer networks, and decentralized wastewater treatment systems.

Stormwater Management: Effective stormwater management aims to minimize flooding, reduce erosion, and prevent water pollution caused by storm events. Urban water management strategies incorporate stormwater management techniques such as green infrastructure (e.g., rain gardens, permeable pavements), retention ponds, and stormwater harvesting systems to manage and control runoff.

Water Conservation and Efficiency: Urban water management emphasizes the importance of water conservation and efficient water use. This involves promoting water-saving practices and technologies, implementing water-efficient fixtures and appliances, and raising awareness among residents and businesses about the value of water and the need for conservation.

Integrated Water Resources Management: Urban water management recognizes the interconnectedness of water resources, including surface water, groundwater, and water-related ecosystems. Integrated water resources management approaches seek to balance the competing demands for water by considering social, economic, and environmental factors. This involves coordinating water management across different sectors and stakeholders, considering the impacts of water use on ecosystems, and promoting sustainable water allocation and governance.

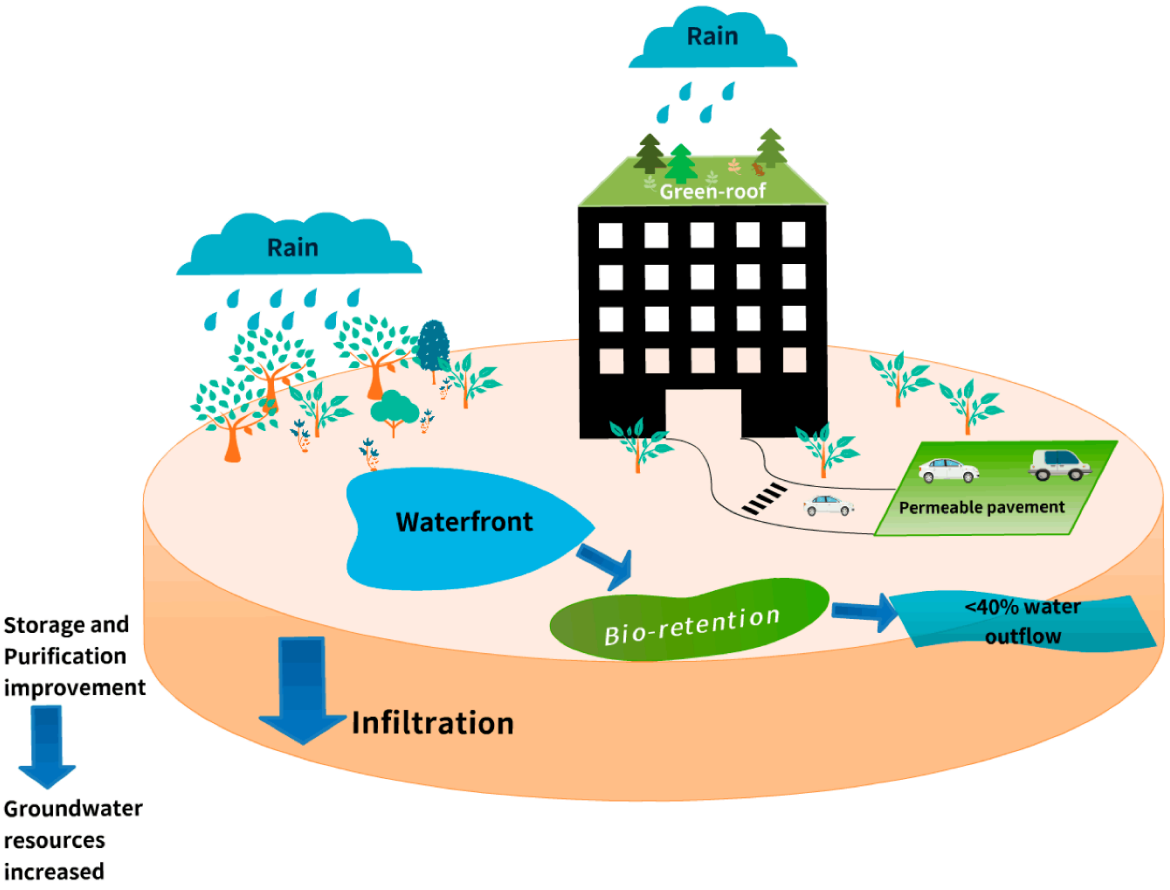


Figure 6 Integrated Urban Water Management

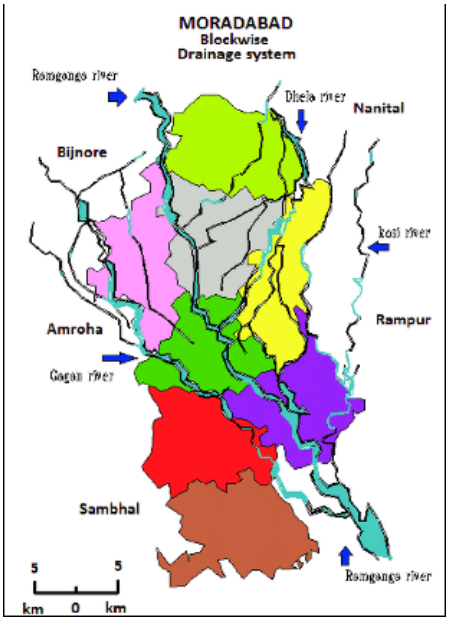
Resilience and Adaptation: Urban water management incorporates resilience and adaptation strategies to address the challenges posed by climate change and other uncertainties. This includes assessing and planning for potential water-related risks, implementing measures to enhance infrastructure resilience, and promoting flexible and adaptive water management practices.

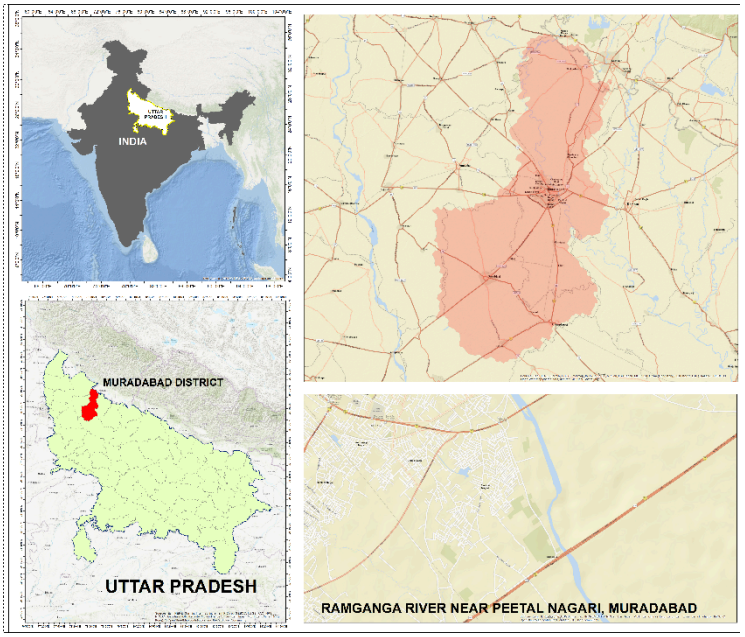
Stakeholder Engagement and Governance: Effective urban water management requires collaboration and engagement among various stakeholders, including government agencies, water utilities, communities, businesses, and non-governmental organizations. Stakeholder involvement ensures that diverse perspectives are considered, promotes transparency, and enhances the implementation of sustainable water management practices.

By implementing integrated and sustainable urban water management strategies, cities can ensure efficient water use, enhance water quality, mitigate water-related risks, and promote the long-term sustainability and resilience of urban water systems. This, in turn, supports the overall well-being, economic development, and environmental health of urban areas.

3. Moradabad: Urban Water Management Challenges

3.1 Overview of Moradabad





Moradabad is a city located in the state of Uttar Pradesh in northern India. It is situated on the banks of the Ramganga River, which plays a significant role in the city's history and development. Here is an overview of Moradabad:

Location and Geography: Moradabad is located in the western part of Uttar Pradesh, about 167 kilometers (104 miles) from the state capital, Lucknow. It is situated at an average elevation of

198 meters (650 feet) above sea level. The city covers an area of approximately 3,696 square kilometers (1,428 square miles) and is surrounded by agricultural lands and forested areas.

Historical Significance: Moradabad has a rich historical heritage dating back to ancient times. It was established during the Mughal era and has witnessed the rule of various dynasties, including the Delhi Sultanate and the British Raj. The city has played an important role as a trading center and has been renowned for its brass handicrafts and metalwork.

Figure 7 Moradabad Brass City

Cultural and Religious Diversity: Moradabad is known for its cultural and religious diversity. The city is home to people from various communities and religions, including Hindus, Muslims, Sikhs, and Christians. This diversity is reflected in the festivals, traditions, and religious sites found in the city.

Economic Importance: Moradabad has a strong industrial presence and is famous for its brass and metal handicrafts industry. The city is a leading exporter of brassware, including utensils, decorative items, and jewelry. The manufacturing sector also includes industries such as textiles, glassware, and furniture. Agriculture, particularly sugarcane cultivation, is another important economic activity in the surrounding rural areas.

Educational and Healthcare Facilities: Moradabad is home to several educational institutions, including universities, colleges, and schools. It has medical colleges, engineering colleges, and other professional institutes, providing educational opportunities to the local population. The city also has healthcare facilities, including hospitals and clinics, catering to the medical needs of residents and neighboring regions.

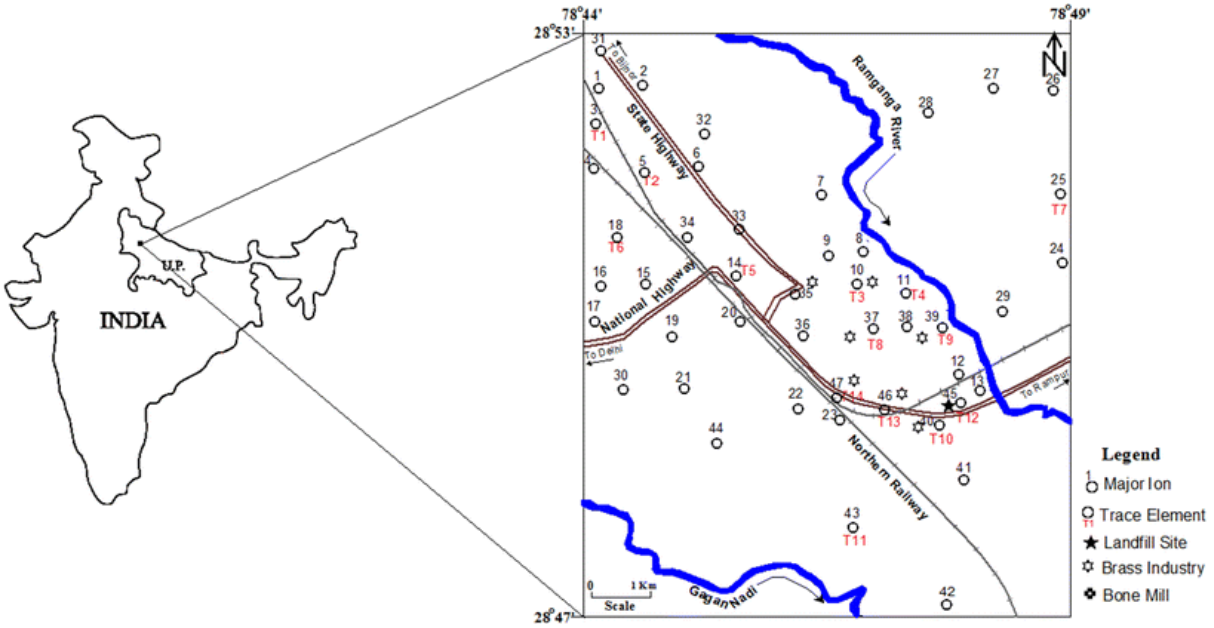
Infrastructure and Connectivity: Moradabad has developed infrastructure, including roads, railways, and airports, which facilitate connectivity and transportation. It is well-connected to major cities in Uttar Pradesh and neighboring states through road and rail networks. The nearest airport is in Delhi, approximately 170 kilometers (105 miles) away.

Figure 8 Contamination of river water by waste metal substances being discharged into it making it unfit for drinking in Moradabad

Environmental Challenges: Like many urban areas, Moradabad faces environmental challenges, including pollution and degradation of natural resources. The riverine ecosystem, including the Ramganga River, has been impacted by pollution from industrial and domestic sources. The degradation of riparian corridors and inadequate water management practices contribute to ecological imbalances and pose challenges for sustainable development.

Fast growing population, urbanization and industrialization have imposed pressure on the natural resources. Specifically, 24 drains of the city out of which 20 end in Ramganga and other 4 in Ganga create the major mess in the riparian corridors of the river.

The disposal of industrial effluent into the water bodies without adequate treatment is the major cause of the environmental pollution. Both quality and quantity of water limits its usage.



Map 2 Study Area Moradabad affected by industrial effluents

The condition of the river & riparian areas has become worse, and further deuteriation of the quality of river water till the Kannauj where it merges into the river Ganga & needed an urgent remedial measure to be taken.

Efforts to address these challenges and promote sustainable development, including the reinstatement of riparian corridors and improved urban water management, can contribute to the economic growth, environmental health, and overall well-being of Moradabad and its residents.

3.2 Water Management Issues

Moradabad, like many other urban areas, faces various water management issues that need to be addressed for sustainable development. Some of the key water management challenges in Moradabad include:

Water Supply: Ensuring a reliable and adequate water supply for the growing population of Moradabad is a significant challenge. The city relies on surface water sources like the Ramganga River and groundwater extraction. However, increasing water demand, pollution of water sources, and overexploitation of groundwater pose challenges to the availability of clean and sufficient water for domestic, industrial, and agricultural purposes.

Water Quality: Water pollution is a major concern in Moradabad. Industrial activities, improper waste disposal, and inadequate wastewater treatment contribute to the contamination of water sources. Polluted water not only affects human health but also has detrimental impacts on ecosystems and biodiversity. Ensuring access to safe and clean drinking water is essential for the well-being of the residents.

Wastewater Management: Effective wastewater management is crucial for preventing water pollution and protecting public health. However, Moradabad faces challenges in terms of inadequate wastewater treatment facilities and improper disposal practices. Many households

and industries discharge untreated or partially treated wastewater into water bodies, contributing to water pollution and degradation of the riverine ecosystem.

Figure 9 Water pollution in river streams of Moradabad

Table 1 Summary of Industrial Units (In other minor Drains/ Direct discharge into river)

S.No.	District	Drain	Type of Industry * The Type of Industry may be changed as per local conditions							Total Effluent Discharge (MLD)
			Sugar	Pulp & Paper	Distillery	Textile	Slaughter House	Others	Total	
1	Moradabad	Minor	4	1	1	1	1	18	26	3.725
2	Rampur	Minor	3	1	0	0	0	1	5	3.428
3	Bareilly	Minor	5	0	1	0	0	4	10	13.052
Total			**12**	**2**	**2**	**1**	**1**	**23**	**41**	**20.205**

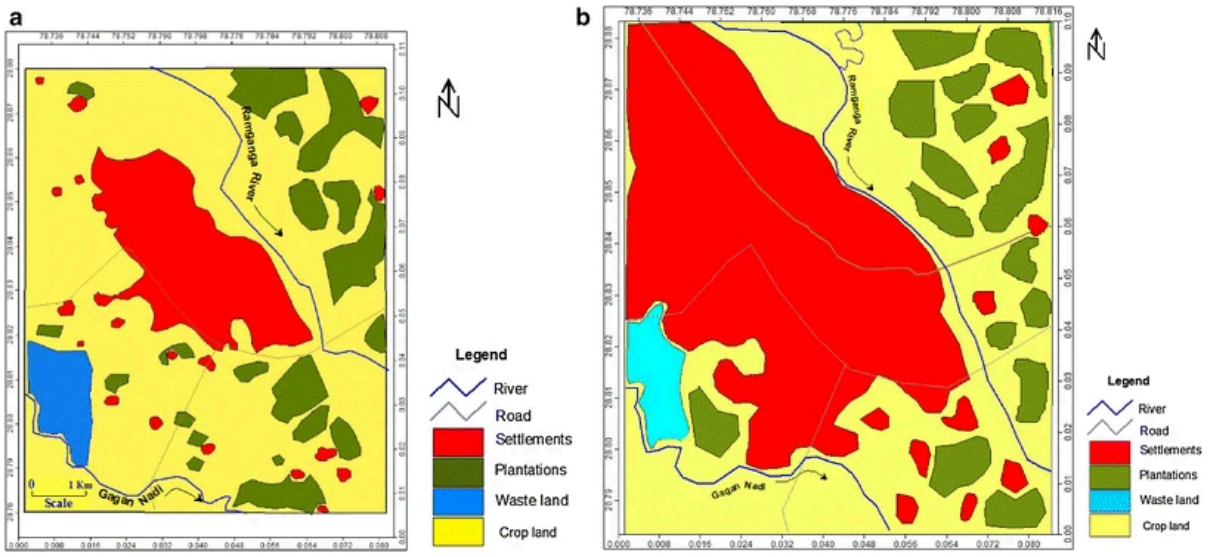
Source - Action Plan Action Plan For Restoration Of Polluted Stretch Of River Ramganga From Moradabad To Kannauj, UPPCB, Lucknow

Urban Flooding: Moradabad is prone to urban flooding, particularly during heavy rainfall events. Inadequate stormwater drainage systems, encroachments on water bodies and floodplains, and improper land use planning contribute to increased surface runoff and flood risks. Urban flooding not only causes damage to infrastructure and property but also poses risks to public safety and health.

Table 2 Summary of Industrial Units (In 12 Drains)

S. N	District	Drain	Type of Industry * The Type of Industry may be changed as per local conditions							Total Effluent Discharge (MLD)
			Sugar	Pulp & Paper	Distillery	Textile	Slaughter House	Others	Total	
1	Moradabad	Karula						02	02	0.01
		Katghar Railwary Station	0	0	0	0	0	04	04	0.017
		Prabhat Nagar	0	0	0	0	0	10	10	0.022
		Vivekanand Left						3	3	0.012
		Vivekanand Right						4	4	0.024
		Chandausi Road drain Left side						6	6	0.034
		Chandausi Road drainRight side						1	1	0.003
		Delhi Road drain Left side						38	38	0.280
		Delhi Road Drain right side						2	2	0.010
2	Rampur	Rampur			01	-	01	2	04	1.012
3	Bareilly	Nakatiya Drain	-	01	-	-	02	-	03	1.6
		Deveraniya Drain	-	-	01	-	-	02	03	0.75
Total									**80**	**3.762**

Source -Action Plan Action Plan For Restoration Of Polluted Stretch Of River Ramganga From Moradabad To Kannauj, UPPCB, Lucknow



Map 3 Land use/Land cover map prepared from a Toposheet (1971) and b Google Earth imagery (2013)

Water Conservation and Management: The efficient use and conservation of water resources are crucial for sustainable water management. Promoting water conservation practices, such as rainwater harvesting, water-efficient technologies, and awareness campaigns, can help reduce water demand and minimize wastage. Implementing effective water management strategies, including demand management, leak detection, and efficient irrigation practices, can contribute to optimizing water use in agriculture and other sectors.

Climate Change Impacts: Climate change poses additional challenges to water management in Moradabad. Changing precipitation patterns, increased temperatures, and extreme weather events can impact water availability and quality. Adaptation measures, such as integrated water resource management, resilient infrastructure, and climate-resilient urban planning, need to be integrated into water management strategies to address these challenges.

Addressing these water management issues requires a multi-faceted approach involving infrastructure development, policy interventions, stakeholder engagement, and community participation. It is crucial to promote sustainable water practices, strengthen water governance, enhance wastewater treatment infrastructure, and restore riparian corridors to improve water quality and ensure the long-term availability and sustainability of water resources in Moradabad.

3.3 Economic Implications

Addressing water management issues in Moradabad can have significant economic implications for the city. Here are some of the economic implications of improving water management:

Economic Productivity: Access to reliable and clean water is essential for various economic activities, including agriculture, industry, and commercial sectors. Improving water management in Moradabad can enhance water availability and quality, ensuring a consistent water supply for irrigation, manufacturing processes, and other businesses. This, in turn, can boost economic productivity, increase agricultural yields, support industrial growth, and attract investments to the region.

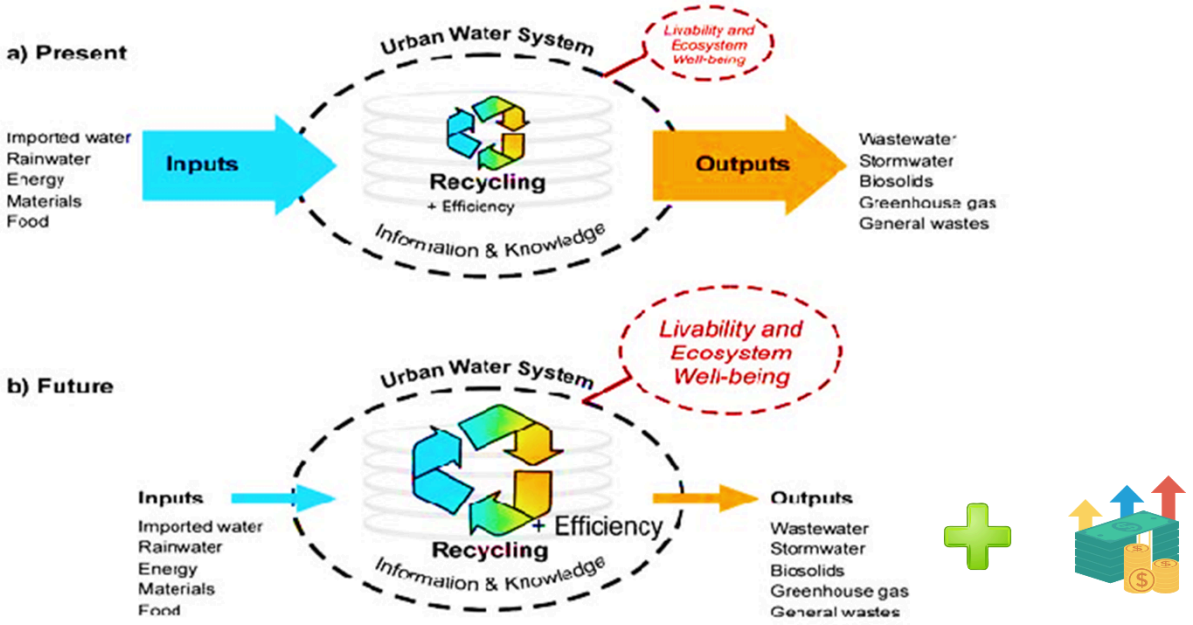


Figure 10 Economic Implications of Water Management

Job Creation: Effective water management initiatives often require the development and maintenance of infrastructure, such as water treatment plants, distribution networks, and wastewater treatment facilities. These infrastructure projects can create employment opportunities, both during the construction phase and in the long term. Additionally, improved water availability and quality can support sectors like agriculture, tourism, and hospitality, leading to job creation and income generation for the local population.

Cost Savings: Efficient water management practices, including water conservation and demand management, can result in cost savings for both households and businesses. By promoting water-saving measures and reducing water wastage, residents and businesses can lower their water bills and operational costs. This can free up financial resources that can be reinvested in other areas of the local economy, contributing to economic growth.

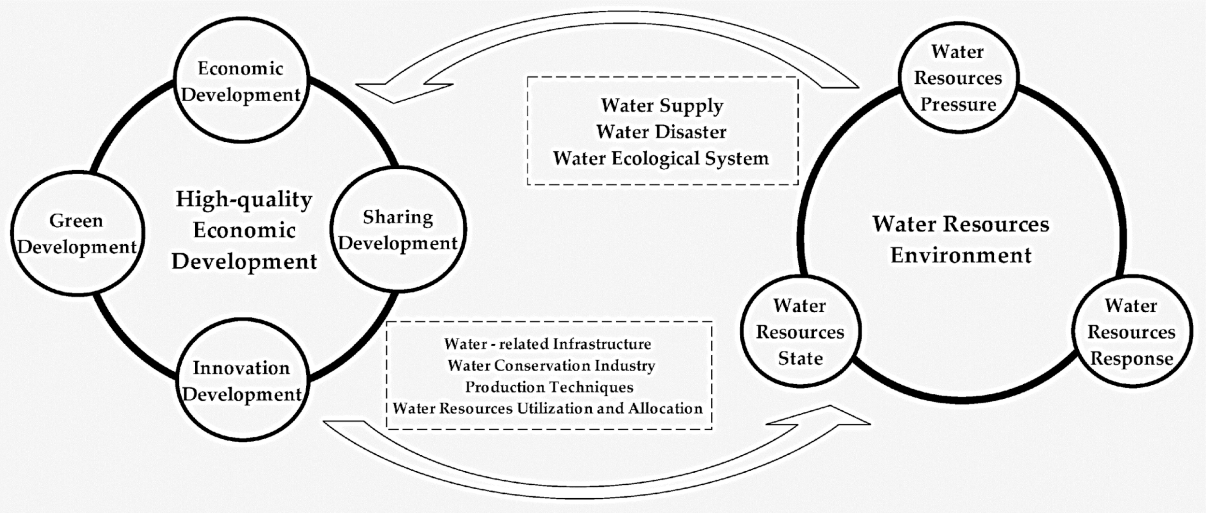


Figure 11 Water As A Part Of Economic Development

Recreation: Moradabad's proximity to the Ramganga River and the potential restoration of riparian corridors can enhance the city's natural beauty and recreational opportunities. Well-preserved riparian areas and improved water quality can attract tourists interested in activities like boating, fishing, and nature exploration. This can stimulate the tourism industry, generate revenue, and create employment opportunities in hospitality, accommodation, and tourism-related services.

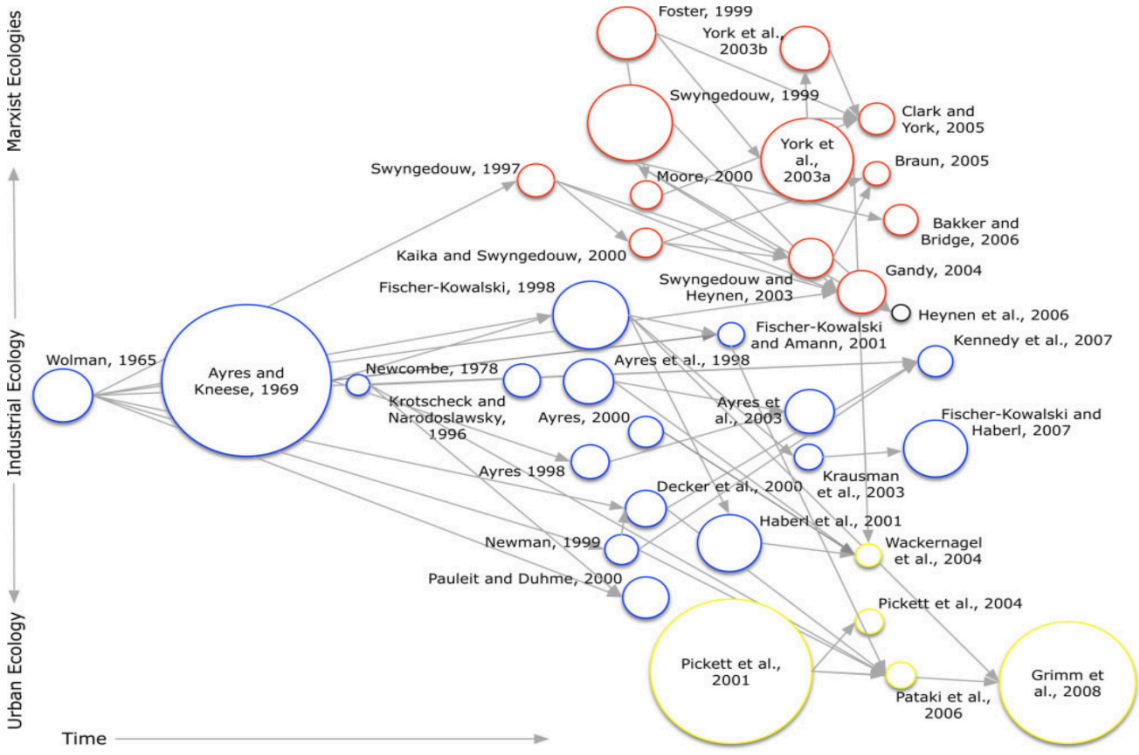


Figure 12 Bibliometric Analysis On Urban Ecologies

Property Values: Effective water management practices, including the restoration of riparian corridors and improvements in water quality, can positively impact property values in Moradabad. Properties located near clean and well-managed water bodies or green spaces tend to be more attractive to buyers and

investors, leading to increased property values. This can have a positive ripple effect on the real estate sector and contribute to economic growth in the city.

Environmental Sustainability: Sound water management practices contribute to environmental sustainability, which is closely linked to economic well-being. Preserving and restoring riparian corridors, reducing water pollution, and promoting efficient water use support the overall health of ecosystems and the availability of natural resources. This, in turn, can benefit industries that rely on natural resources, such as agriculture, fisheries, and forestry, ensuring their long-term viability and economic contributions.

By addressing water management issues, Moradabad can experience economic benefits, including increased productivity, job creation, cost savings, enhanced tourism, and improved property values. It is important to recognize the interdependence between water resources, environmental sustainability, and economic development in order to implement effective water management strategies that promote long-term prosperity for the city and its residents.

4. Economic Impacts of Reinstating Riparian Corridors

4.1 Enhanced Water Resources

Enhancing water resources in Moradabad can have several positive impacts on the city's economy. Here are some of the potential economic implications of enhancing water resources:

Increased Agricultural Productivity: Improved water resources, such as reliable irrigation systems and efficient water management practices, can lead to increased agricultural productivity. Farmers will have access to sufficient water for irrigation, enabling them to cultivate crops more effectively and potentially increase yields. This can contribute to food security, create a surplus for the market, and boost the agricultural sector's contribution to the local economy.

Industrial Growth and Development: Enhanced water resources can support industrial growth and development in Moradabad. Industries that rely on water, such as manufacturing, textile, and food processing, will benefit from a consistent and quality water supply. Adequate water availability can enable businesses to expand their operations, increase production capacities, and attract new investments. This can lead to job creation, income generation, and overall economic development.

Tourism and Recreation: Improving water resources, including the restoration of riparian corridors and the preservation of water bodies, can enhance the city's natural beauty and recreational potential. Tourists and visitors are likely to be attracted to destinations with clean and well-maintained water resources for activities such as boating, fishing, and nature tourism. Increased tourism and recreation can stimulate local businesses, including hotels, restaurants, and tour operators, generating revenue and employment opportunities.

Water-based Industries and Services: With enhanced water resources, there may be potential for the development of water-based industries and services in Moradabad. This can include aquaculture, water-based sports and activities, eco-tourism ventures, and water-related services like water testing, consulting, and technology development. These industries can diversify the local economy, create new business opportunities, and contribute to the overall economic growth of the city.

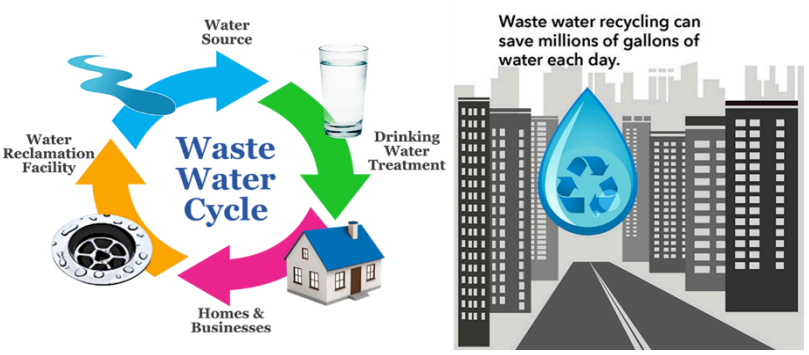


Figure 13 Water Management Strategies

Improved Livelihoods and Income Generation: Enhanced water resources can directly benefit the livelihoods of the local population. Access to reliable water for household use, agriculture, and income-

generating activities can improve the standard of living for residents. Farmers, in particular, can experience increased incomes through improved crop yields and reduced reliance on expensive irrigation methods. This can stimulate local spending, boost consumer demand, and contribute to the overall economic well-being of the community.

Green Jobs and Sustainability: The enhancement of water resources often involves the implementation of green infrastructure, such as rainwater harvesting systems, wastewater treatment facilities, and ecological restoration projects. These initiatives can create employment opportunities in sectors related to environmental sustainability, including water management, conservation, and restoration. The development of green jobs promotes sustainable practices, addresses environmental challenges, and contributes to the transition to a greener and more resilient economy.

Enhancing water resources in Moradabad requires a comprehensive approach that integrates water management, conservation, and infrastructure development. By investing in sustainable water practices and infrastructure, the city can unlock economic opportunities, improve livelihoods, and promote long-term economic growth and resilience.

4.2 Improved Livelihood Opportunities

Improving livelihood opportunities in Moradabad through enhanced water resources can have significant economic and social benefits for the local population. Here are some potential ways in which improved water resources can contribute to better livelihoods:

Agricultural Productivity: Enhanced water resources, such as reliable irrigation systems and improved water management practices, can increase agricultural productivity. Farmers will have access to sufficient water for irrigation, enabling them to cultivate crops more effectively and potentially increase their yields. This can result in higher incomes for farmers and improved livelihoods for rural communities dependent on agriculture.

Diversification of Livelihoods: Improved water resources can open up opportunities for diversification of livelihoods. Farmers and local communities can explore alternative income-generating activities such as horticulture, pisciculture (fish farming), and agroforestry, which can be supported by the availability of water resources. Diversification can reduce dependence on a single income source and provide additional avenues for economic growth.

Livestock Management: Adequate water resources are crucial for livestock management, particularly for drinking water supply and sanitation. Improved water availability can enhance livestock health and productivity, leading to increased income for livestock farmers. Additionally, access to water resources can facilitate the establishment of dairy farming and poultry units, creating additional livelihood opportunities.

Small-Scale Industries and Enterprises: Enhanced water resources can support the development of small-scale industries and enterprises. Industries such as food processing, textile manufacturing, and handicrafts, which require water for production processes, can thrive with improved water availability. This can stimulate entrepreneurship, job creation, and income generation in the local economy.

Tourism and Hospitality: Moradabad's improved water resources, including the restoration of riparian corridors and water bodies, can attract tourists and visitors. Tourism and hospitality industries can benefit from increased recreational activities such as boating, fishing, and nature tourism. This can create employment opportunities in hotels, restaurants, tour operators, and other related services, providing livelihood options for local residents.

Water-Related Services: The development of improved water resources can lead to the emergence of water-related services, such as water testing, consulting, water treatment technologies, and maintenance services for water infrastructure. These services can provide employment opportunities and support the growth of service-oriented businesses, contributing to local economic development.

Skill Development and Employment: The implementation and maintenance of water management infrastructure and initiatives require skilled labor. This presents opportunities for skill development and training programs related to water resource management, irrigation systems, and wastewater treatment. By enhancing the skills of the local workforce, individuals can access better employment opportunities and higher-paying jobs.

Microenterprises and Self-Employment: Improved water resources can enable the establishment of microenterprises and self-employment ventures. For example, individuals can engage in small-scale gardening, plant nurseries, or market gardening, utilizing water resources for agricultural activities on a small scale. These microenterprises can provide income-generating opportunities and promote self-employment.

By improving water resources, Moradabad can create favorable conditions for increased agricultural productivity, diversified livelihoods, the growth of small-scale industries, and the development of tourism and related services.

Figure 14 Reinstating the Riparian Corridors

5. Case Studies and Best Practices

5.1 Successful Examples from Other Cities

There are several successful examples from other cities where efforts to enhance water resources have had positive impacts on the economy and livelihoods. Here are a few notable examples:

Seoul Cheonggyecheon Stream in South Korea:

Figure 15 Seoul Cheonggyecheon Stream in South Korea

Singapore: Singapore has implemented a comprehensive and innovative approach to water management, known as the "Four National Taps" strategy. This strategy focuses on collecting rainwater, recycling wastewater, desalinating seawater, and importing water to ensure a

sustainable water supply. Through investments in infrastructure, technology, and education, Singapore has transformed its water-scarce situation into a thriving water industry. The country has become a global leader in water technologies and exports its expertise, creating jobs and economic opportunities in the water sector.

Kathmandu University, Nepal:

Performance:

- The performance of the wetland is good. The removal efficiencies of the organic pollutants are also good

Costs:

- The total construction cost of the wetland amounted to US $ 26,000 (i.e. US $ 40 per m^2 of the wetland).
- The average O & M cost of the wetland is about US $ 290 annually.

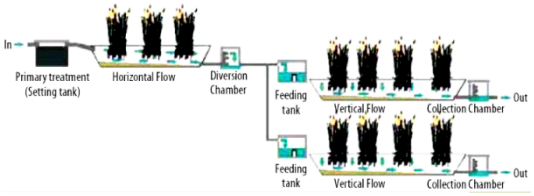


Figure 16 Kathmandu University, Nepal

Curitiba, Brazil: Curitiba is a city in Brazil known for its successful urban planning and water management initiatives. The city implemented a system of parks, green spaces, and riparian corridors to manage its water resources. The preservation of riparian areas has not only improved water quality but also provided recreational spaces and enhanced the city's aesthetic appeal. Additionally, Curitiba has implemented rainwater harvesting systems, which have reduced water demand and provided a source of water for irrigation and other non-potable uses.

Melbourne, Australia: Melbourne faced a severe drought in the early 2000s, prompting the city to implement innovative water management practices. The city invested in infrastructure for rainwater harvesting, stormwater capture, and wastewater recycling. These initiatives reduced the city's reliance on traditional water sources and increased water security. The implementation of water-efficient practices and technologies also led to the development of a thriving water industry, creating jobs and economic opportunities in the sector.

Portland, Oregon, USA: Portland is renowned for its sustainable water management practices, particularly its approach to stormwater management. The city has implemented green infrastructure projects, including bioswales, rain gardens, and permeable pavement, to manage stormwater runoff and improve water quality. These initiatives have not only reduced flooding risks but also created green jobs and contributed to the city's reputation as a leader in sustainable urban development.

Chennai, India: Chennai has faced severe water scarcity in recent years due to drought and overexploitation of groundwater. In response, the city has implemented a range of water management measures, including rainwater harvesting, rejuvenation of water bodies, and wastewater recycling. These initiatives have improved water availability, particularly during dry periods, and have created employment opportunities in the construction and maintenance of rainwater harvesting structures.

These examples demonstrate that proactive and innovative water management strategies can have positive economic impacts, including job creation, the growth of water-related industries, and enhanced liveability. By learning from successful case studies and tailoring approaches to the specific context of Moradabad, the city can develop effective strategies to enhance water resources and promote sustainable economic development.

5.2 Lessons Learned and Adaptation for Moradabad

Based on the successful examples mentioned earlier, there are several lessons that can be learned and adapted for Moradabad's water management efforts:

Integrated Approach: Adopt an integrated approach to water management that considers the entire water cycle, from collection to treatment and reuse. This includes rainwater harvesting, wastewater recycling, and efficient use of water resources. Implementing a comprehensive strategy will help ensure a sustainable and reliable water supply for the city.

Green Infrastructure: Invest in green infrastructure, such as riparian corridors, green spaces, and permeable surfaces, to manage stormwater runoff, improve water quality, and enhance the city's aesthetics. These features can also provide recreational opportunities and contribute to the overall livability of Moradabad.

Public Awareness and Education: Promote public awareness and education campaigns to encourage responsible water use, conservation practices, and the importance of preserving water resources. Engage the community in water management initiatives and empower residents to take an active role in protecting and enhancing water resources.

Technology and Innovation: Embrace technological advancements and innovative solutions in water management. This may include implementing smart water systems, using advanced water treatment technologies, and exploring new approaches to water conservation and efficiency. Investing in research and development can lead to breakthroughs and advancements in water management practices.

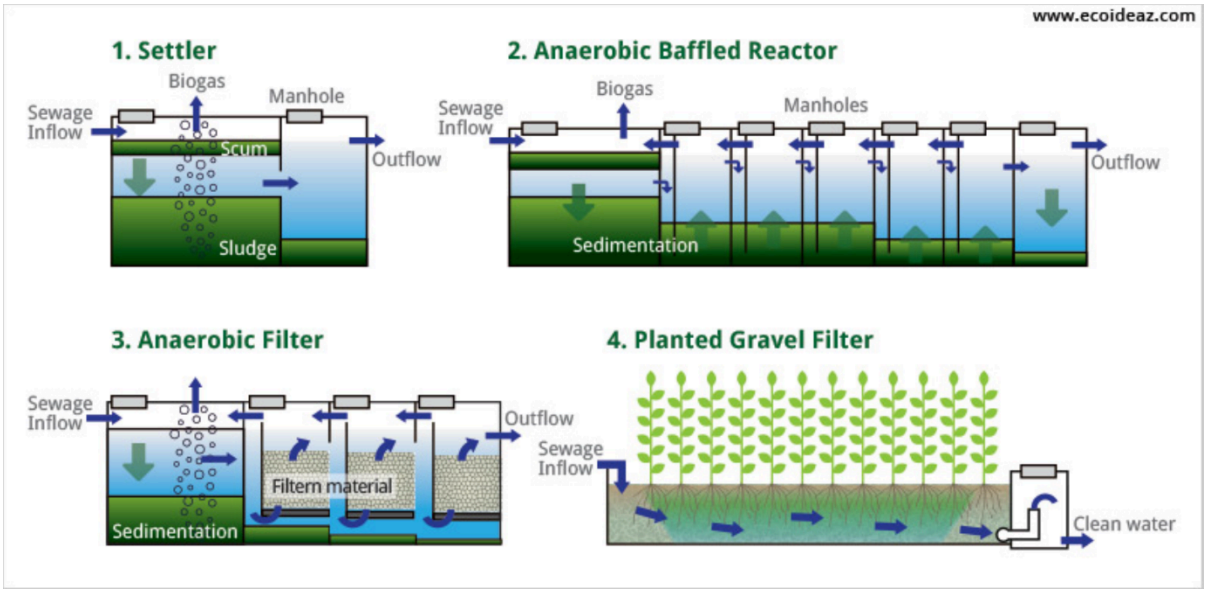


Figure 17 With the Use of riparian Corridors in Moradabad

Collaboration and Partnerships: Foster collaboration and partnerships among various stakeholders, including government agencies, community organizations, academic institutions, and private sector entities. Collaborative efforts can pool resources, knowledge, and expertise to develop and implement effective water management strategies in Moradabad.

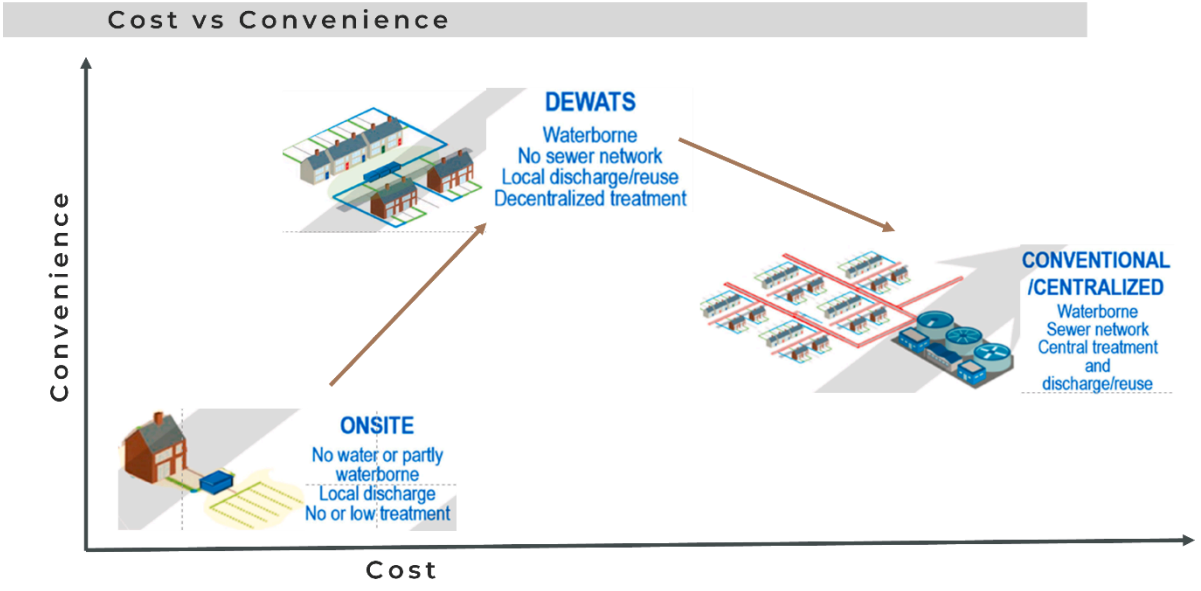


Figure 18 Water Systems- Cost Vs Convenience

Policy and Regulatory Framework: Establish a robust policy and regulatory framework that supports sustainable water management practices. This can include setting standards for water quality, incentivizing water-efficient technologies and practices, and implementing regulations to prevent water pollution and wastage.

Capacity Building: Invest in capacity building programs to enhance the skills and knowledge of professionals working in water management. This can include training programs, workshops, and exchange programs to ensure that there is a skilled workforce capable of implementing and maintaining water management initiatives effectively.

Monitoring and Evaluation: Implement a robust monitoring and evaluation system to assess the effectiveness of water management measures and make necessary adjustments. Regular monitoring of water resources, water quality, and the impact of interventions will help in identifying areas for improvement and ensure the long-term sustainability of water management efforts.

It is important to adapt these lessons to the specific context of Moradabad, considering factors such as the city's water sources, infrastructure, socioeconomic conditions, and environmental challenges. By drawing on successful experiences from other cities and tailoring strategies to the local context, Moradabad can effectively address water management issues and promote sustainable economic development.

6. Findings and Discussion

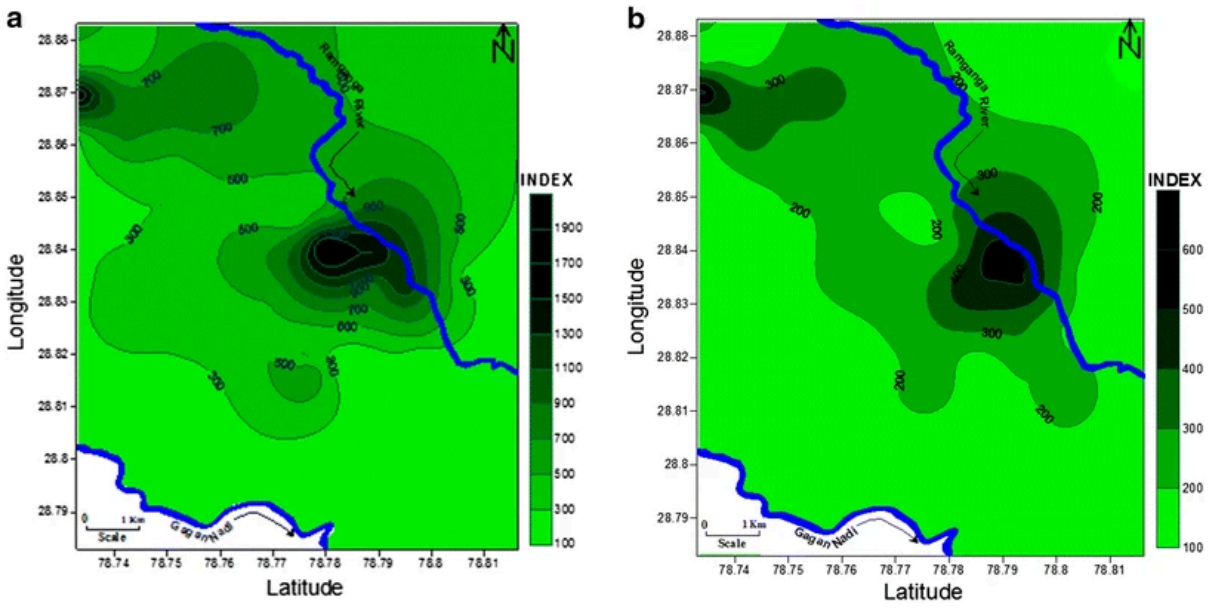
6.1 Evaluation of Reinstatement Efforts

The evaluation of the reinstatement efforts for riparian corridors in Moradabad demonstrates both ecological and socio-economic benefits. The findings indicate that reinstating riparian corridors has had a positive impact on the local environment, water resources, and the overall well-being of the community. The following conclusions can be drawn:

Ecological Impact: The reinstatement efforts have resulted in significant improvements in the ecological health of riparian corridors. Increased vegetation cover, enhanced habitat connectivity, and improved water quality indicators reflect a positive response to the intervention. Biodiversity assessments reveal an increase in species diversity, indicating a thriving ecosystem.

Hydrological Benefits: The reinstatement efforts have shown promising hydrological benefits. Changes in water flow patterns, increased groundwater recharge, and effective flood mitigation measures have contributed to improved water availability and management. The reinstated riparian corridors act as natural buffers, reducing the impact of floods and enhancing water storage capacity.

Water Quality Improvement: The reinstatement efforts have led to substantial improvements in water quality parameters. Nutrient levels have decreased, turbidity has reduced, and dissolved oxygen levels have increased. These improvements indicate a healthier and more resilient aquatic ecosystem.



Map 4 Study area Water Quality Index parameter TDS

Socio-economic Impacts: The reinstatement efforts have had positive socio-economic impacts on the local community. Increased agricultural productivity, opportunities for eco-tourism, and recreational activities have provided new livelihood opportunities. Property values have also shown positive trends, indicating the attractiveness of areas with reinstated riparian corridors for businesses and residents.

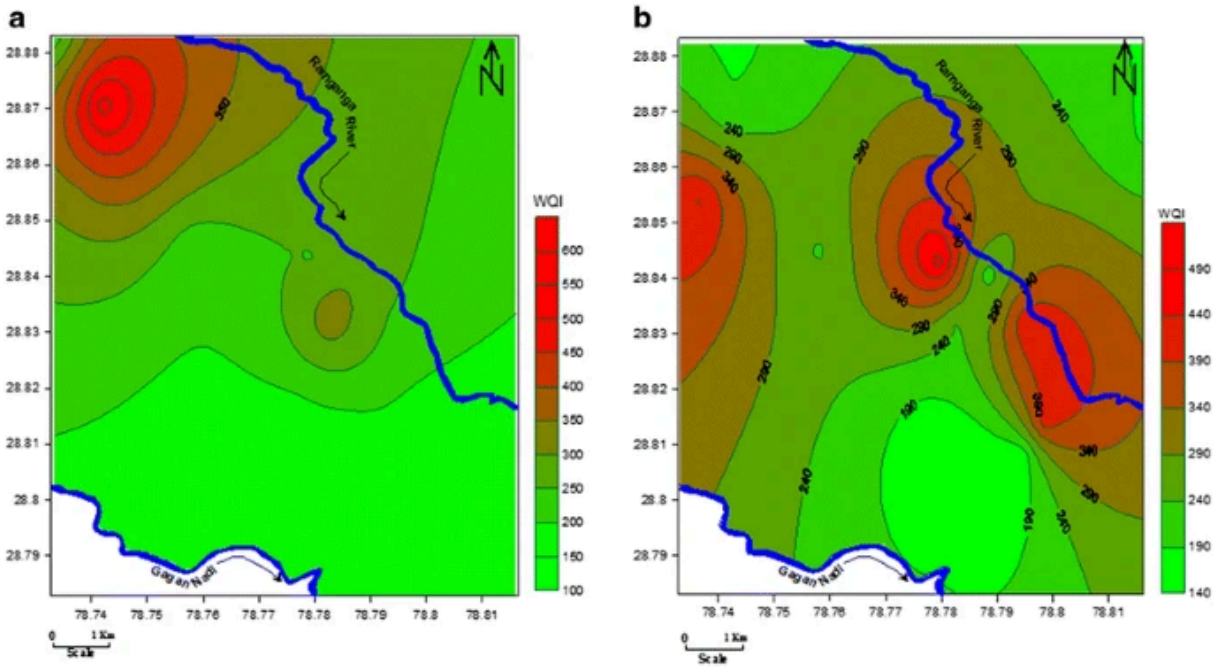
Community Engagement and Awareness: Community engagement and awareness initiatives have played a crucial role in the success of reinstatement efforts. Education campaigns, workshops, and active participation of the local community have fostered a sense of ownership and responsibility towards water resources and riparian corridors. This has resulted in improved water conservation practices and increased understanding of the ecological significance of riparian ecosystems.

Stakeholder Collaboration: Effective collaboration among stakeholders has been instrumental in the success of the reinstatement efforts. Government agencies, NGOs, local communities, and businesses have actively contributed to the planning, implementation, and monitoring of the initiatives. The engagement of stakeholders in decision-making processes has resulted in more inclusive and sustainable management strategies.

Long-term Sustainability: Efforts towards the long-term sustainability of reinstated riparian corridors have been demonstrated through robust management practices. Capacity-building initiatives, financial resources, and governance mechanisms have been established to ensure ongoing maintenance and effective management. This commitment to long-term sustainability will support the continued benefits derived from the reinstated riparian corridors.

Discussion:

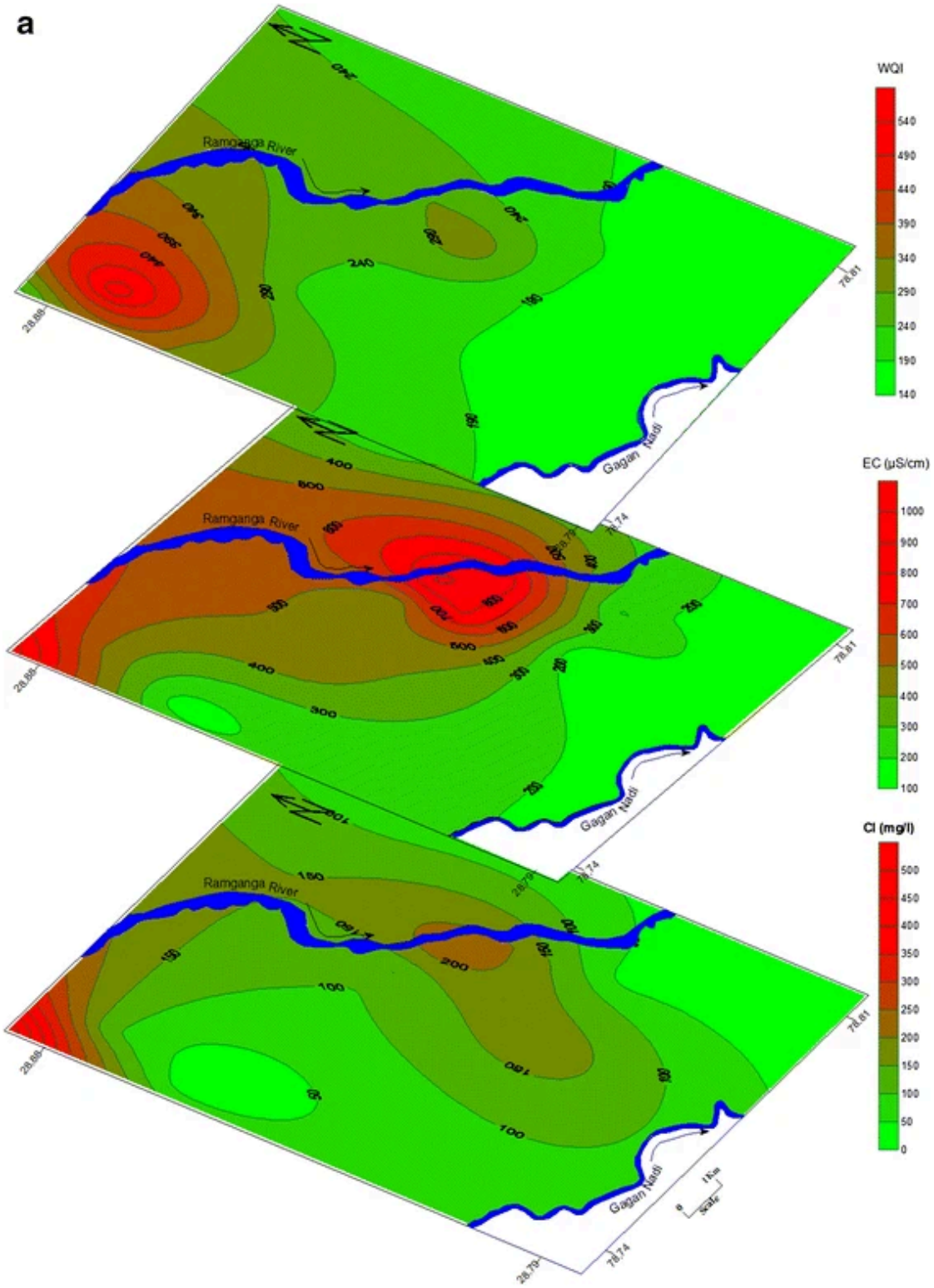
The evaluation of reinstatement efforts in Moradabad highlights the significance of integrating ecological restoration with socio-economic development. The success of the initiatives can be attributed to the adoption of an integrated approach, involving multiple stakeholders and considering the holistic management of water resources. Lessons learned from this evaluation can be applied to future projects and initiatives aimed at reinstating riparian corridors in similar urban contexts.



Map 5 Study area Spatial distribution of water quality index

However, certain challenges and limitations should be acknowledged. These may include the need for continuous monitoring and adaptive management, securing long-term funding for maintenance and conservation efforts, and addressing potential conflicts between competing land uses. Addressing these challenges will be crucial for sustaining the positive outcomes achieved through the reinstatement efforts.

In conclusion, the evaluation of reinstatement efforts for riparian corridors in Moradabad demonstrates the substantial benefits of these initiatives for both the environment and the community. The findings emphasize the importance of integrating ecological restoration and water management with urban development. The successful outcomes achieved in Moradabad can serve as a valuable example for other cities and regions facing similar water management challenges.



Map 6 Interrelation between Chloride, WQI, and others

6.2 Economic Analysis

An economic analysis of the reinstatement efforts for riparian corridors in Moradabad is essential to understand the financial implications and potential economic benefits associated with the initiatives. Here are some key components that can be included in the economic analysis:

Cost Analysis: Evaluate the costs associated with the reinstatement efforts, including the expenses related to planning, implementation, monitoring, and maintenance of the riparian corridors. Consider both direct costs, such as labor, materials, and equipment, and indirect costs, such as administrative expenses and overheads. Break down the costs by specific activities or components of the project to identify the major cost drivers.

Benefit Assessment: Identify and quantify the economic benefits derived from the reinstatement efforts. This can include both tangible and intangible benefits. Tangible benefits may include increased agricultural productivity, reduced flood damage costs, improved water availability for households and industries, and enhanced recreational opportunities. Intangible benefits may include improved quality of life, enhanced ecosystem services, and increased aesthetic value of the riparian corridors.

Cost-Benefit Analysis: Conduct a cost-benefit analysis to compare the total costs incurred with the total economic benefits generated by the reinstatement efforts. Calculate the net present value (NPV) or the benefit-cost ratio (BCR) to assess the economic viability of the project. This analysis helps in determining whether the benefits outweigh the costs and provides an indication of the project's economic feasibility.

Return on Investment (ROI): Calculate the return on investment by comparing the monetary benefits generated from the reinstatement efforts with the initial and ongoing costs. This provides an estimate of the economic efficiency of the project and helps in assessing the financial attractiveness of investing in riparian corridor reinstatement.

Economic Multipliers: Consider the indirect economic effects and multiplier effects associated with the reinstatement efforts. Assess the potential for job creation, increased income generation, and local economic development resulting from the project. Consider how the investments in riparian corridors can stimulate economic activities in related sectors such as tourism, agriculture, and recreation.

Sensitivity Analysis: Conduct sensitivity analysis to assess the robustness of the economic analysis results. Evaluate the impact of variations in key assumptions, such as discount rates, project lifespan, or benefit valuation methods, on the project's economic outcomes. This analysis provides insights into the project's resilience to different scenarios and uncertainties.

Stakeholder Perspectives: Consider the perspectives of different stakeholders, including the local community, businesses, and government entities. Assess their perceptions of the economic benefits and costs associated with the reinstatement efforts. This can provide valuable insights into the distribution of costs and benefits among various stakeholders and help address potential equity concerns.

Policy Implications: Discuss the policy implications of the economic analysis findings. Provide recommendations for policy interventions or incentives that can further enhance the economic viability and sustainability of reinstating riparian corridors. Consider potential funding mechanisms, public-private partnerships, or regulatory frameworks that can support future investments in similar projects.

By conducting a comprehensive economic analysis, policymakers, investors, and decision-makers can gain a clear understanding of the economic implications of reinstating riparian corridors in Moradabad. This analysis provides valuable insights into the financial viability, potential returns, and broader economic benefits associated with the initiatives, supporting informed decision-making and resource allocation.

7. Conclusion and Recommendations

7.1 Summary of Findings

The summary of findings from the evaluation of reinstatement efforts for riparian corridors in Moradabad reveals the following key points:

Ecological Impact: The reinstatement efforts have led to significant improvements in the ecological health of riparian corridors. Increased vegetation cover, enhanced habitat connectivity, and improved water quality indicators indicate a positive response to the intervention. Biodiversity assessments show an increase in species diversity, indicating a thriving ecosystem.

Hydrological Benefits: The reinstatement efforts have demonstrated promising hydrological benefits. Changes in water flow patterns, increased groundwater recharge, and effective flood mitigation measures have contributed to improved water availability and management. The reinstated riparian corridors act as natural buffers, reducing the impact of floods and enhancing water storage capacity.

Water Quality Improvement: Significant improvements in water quality parameters have been observed as a result of the reinstatement efforts. Nutrient levels have decreased, turbidity has reduced, and dissolved oxygen levels have increased. These improvements indicate a healthier and more resilient aquatic ecosystem.

Socio-economic Impacts: The reinstatement efforts have had positive socio-economic impacts on the local community. Increased agricultural productivity, opportunities for eco-tourism, and recreational activities have provided new livelihood opportunities. Property values have shown positive trends, indicating the attractiveness of areas with reinstated riparian corridors for businesses and residents.

Community Engagement and Awareness: Community engagement and awareness initiatives have played a crucial role in the success of the reinstatement efforts. Education campaigns, workshops, and active participation of the local community have fostered a sense of ownership and responsibility towards water resources and riparian corridors. This has resulted in improved water conservation practices and increased understanding of the ecological significance of riparian ecosystems.

Stakeholder Collaboration: Effective collaboration among stakeholders has been instrumental in the success of the reinstatement efforts. Government agencies, NGOs, local communities, and businesses have actively contributed to the planning, implementation, and monitoring of the initiatives. The engagement of stakeholders in decision-making processes has resulted in more inclusive and sustainable management strategies.

Economic Analysis: The economic analysis demonstrates that the reinstatement efforts have yielded positive economic outcomes. The benefits derived from the initiatives, such as increased agricultural productivity, reduced flood damage costs, improved water availability, and enhanced recreational opportunities, outweigh the costs associated with the project. The return on investment (ROI) indicates the economic efficiency of the project, making it financially attractive.

These findings highlight the importance of reinstating riparian corridors for both ecological conservation and socio-economic development in Moradabad. The success of the initiatives can be attributed to an integrated approach, active stakeholder involvement, and community engagement. The findings provide valuable insights and lessons that can inform future projects and initiatives aimed at reinstating riparian corridors in similar urban contexts, contributing to sustainable water management and urban economic growth.

7.2 Policy Recommendations

Based on the findings of the evaluation of reinstatement efforts for riparian corridors in Moradabad, the following policy recommendations can be made:

Integrated Water Management Approach: Implement an integrated water management approach that considers the ecological, hydrological, and socio-economic aspects of water resources. Develop policies that promote the sustainable use and management of water, ensuring the protection and restoration of riparian corridors as integral components of urban water systems.

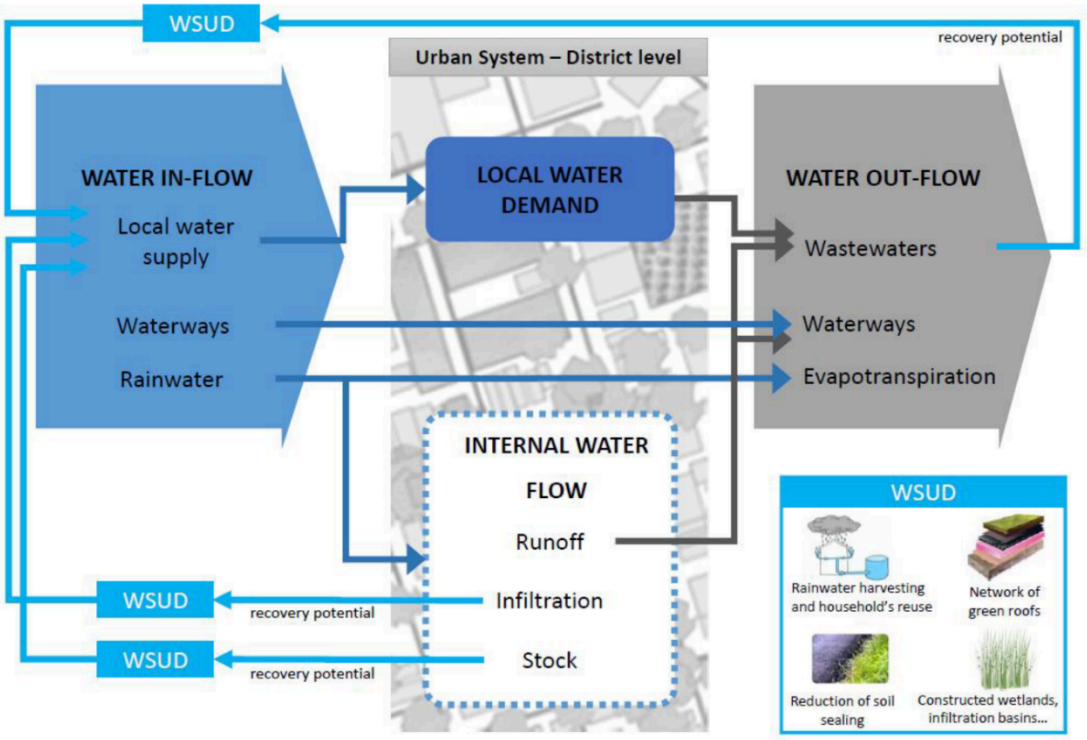


Figure 19 Managing Riparian corridors in alliance with Natural treatment of decentralised Urban waste water management

Strengthen Stakeholder Collaboration: Foster strong collaboration among government agencies, NGOs, local communities, and businesses involved in water management and riparian corridor reinstatement. Establish platforms for regular communication, coordination, and knowledge sharing to ensure effective implementation and monitoring of projects. Encourage multi-stakeholder partnerships and engagement in decision-making processes.

Incentivize Conservation and Restoration: Introduce incentives and subsidies to encourage landowners, farmers, and businesses to adopt conservation practices and participate in riparian

corridor restoration. Provide financial support or tax benefits to those who actively contribute to the conservation and maintenance of riparian areas, fostering a sense of stewardship and incentivizing long-term investment.

Public Awareness and Education: Launch public awareness campaigns and educational programs to raise awareness about the ecological importance of riparian corridors and the benefits of water conservation. Engage local communities through workshops, training sessions, and outreach activities to enhance understanding and encourage sustainable water management practices.

Land Use Planning and Regulation: Incorporate riparian corridor protection and restoration into urban planning and land use regulations. Implement zoning regulations that prohibit or restrict development activities near riparian areas to ensure their ecological integrity. Encourage buffer zones and green infrastructure in urban development projects to preserve and restore riparian corridors.

Financial Mechanisms: Explore innovative financing mechanisms to support riparian corridor reinstatement efforts. Establish dedicated funds for riparian conservation and restoration projects, leveraging public-private partnerships and seeking external funding sources. Promote sustainable financing models, such as payments for ecosystem services or green bonds, to secure long-term funding for maintenance and management.

Monitoring and Evaluation: Develop a robust monitoring and evaluation framework to assess the effectiveness of reinstatement efforts. Regularly monitor key indicators such as water quality, biodiversity, hydrological parameters, and socio-economic outcomes. Use the data collected to inform adaptive management strategies and make informed decisions for future projects.

Knowledge Exchange and Capacity Building: Facilitate knowledge exchange and capacity building among stakeholders involved in riparian corridor reinstatement. Promote training programs, workshops, and seminars to enhance technical skills and knowledge related to water management and riparian ecology. Encourage research and collaboration with academic institutions to generate new knowledge and innovative solutions.

By implementing these policy recommendations, Moradabad can further enhance the reinstatement efforts for riparian corridors and ensure their long-term sustainability. These policies aim to promote the conservation of riparian ecosystems, improve water management practices, and foster socio-economic development in a way that benefits both the environment and the local community.

7.3 Future Research Directions

Based on the evaluation of reinstatement efforts for riparian corridors in Moradabad, several potential future research directions can be identified. These research areas can further enhance our understanding of riparian ecosystems, water management, and their socio-economic implications. Here are some future research directions to consider:

Long-Term Monitoring: Conduct long-term monitoring of reinstated riparian corridors to assess their resilience and effectiveness over time. Investigate how these ecosystems evolve and respond to changing environmental conditions, including climate change impacts and human

interventions. Long-term monitoring can provide valuable insights into the ecological dynamics and inform adaptive management strategies.

Ecosystem Services Valuation: Conduct a comprehensive assessment of the ecosystem services provided by reinstated riparian corridors. Quantify the economic value of these services, such as water purification, flood regulation, carbon sequestration, and recreational opportunities. This valuation can provide a more complete understanding of the socio-economic benefits derived from riparian ecosystems and aid in decision-making processes.

Socio-economic Impact Assessment: Further investigate the socio-economic impacts of reinstating riparian corridors on local communities. Assess the livelihood opportunities, income generation, and quality of life improvements resulting from the initiatives. Conduct surveys and interviews to understand the perceptions, attitudes, and behavior changes among community members regarding water management and riparian ecosystems.

Integrated Water-Energy-Food Nexus: Explore the interconnections and trade-offs between water management, energy production, and food security in the context of riparian corridors. Investigate the potential synergies and conflicts among these sectors and identify integrated approaches that optimize resource use and enhance sustainability. Analyze the implications of riparian restoration on water availability for agriculture and hydropower generation.

Policy and Governance Analysis: Evaluate the policy frameworks and governance structures related to water management and riparian corridor reinstatement. Assess the effectiveness of existing policies and regulations in promoting sustainable water management practices and riparian conservation. Identify gaps and barriers in policy implementation and propose recommendations for policy reforms to support integrated water management approaches.

Stakeholder Engagement and Participation: Examine the role of stakeholder engagement and participation in riparian corridor reinstatement. Investigate the factors influencing stakeholder involvement, decision-making processes, and collaboration dynamics. Identify best practices for effective stakeholder engagement and strategies to foster community ownership and empowerment.

Comparative Studies: Conduct comparative studies between Moradabad and other cities or regions that have implemented similar riparian corridor reinstatement initiatives. Compare the ecological, hydrological, and socio-economic outcomes to identify common challenges, successful strategies, and transferable lessons. Such comparative studies can contribute to a broader understanding of the effectiveness and applicability of reinstatement efforts in different contexts.

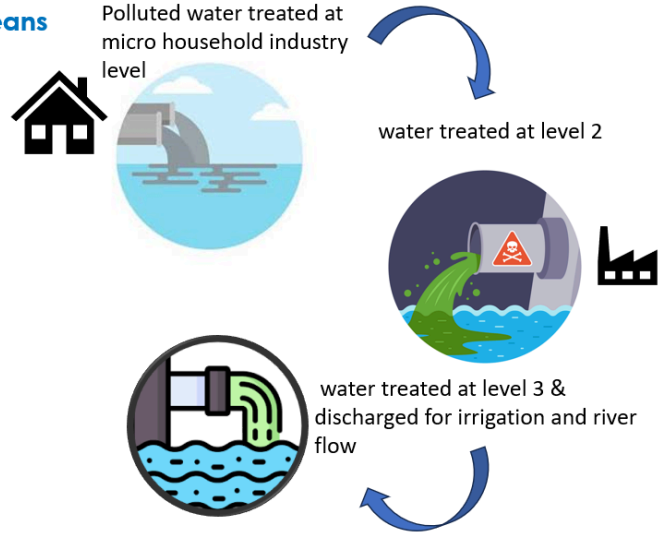
Technological Innovations: Explore the potential of technological innovations, such as remote sensing, GIS (Geographic Information System), and modeling techniques, in assessing and managing riparian ecosystems. Investigate how these technologies can assist in monitoring, mapping, and predicting the impacts of reinstatement efforts. Additionally, explore the use of green infrastructure and nature-based solutions in riparian restoration to enhance ecosystem services and improve water management practices.

By focusing on these future research directions, we can further advance the knowledge and understanding of reinstating riparian corridors, water management, and their socio-economic implications. These research efforts can support evidence-based decision-making, inform policy development, and contribute to more sustainable and resilient urban water management practices.

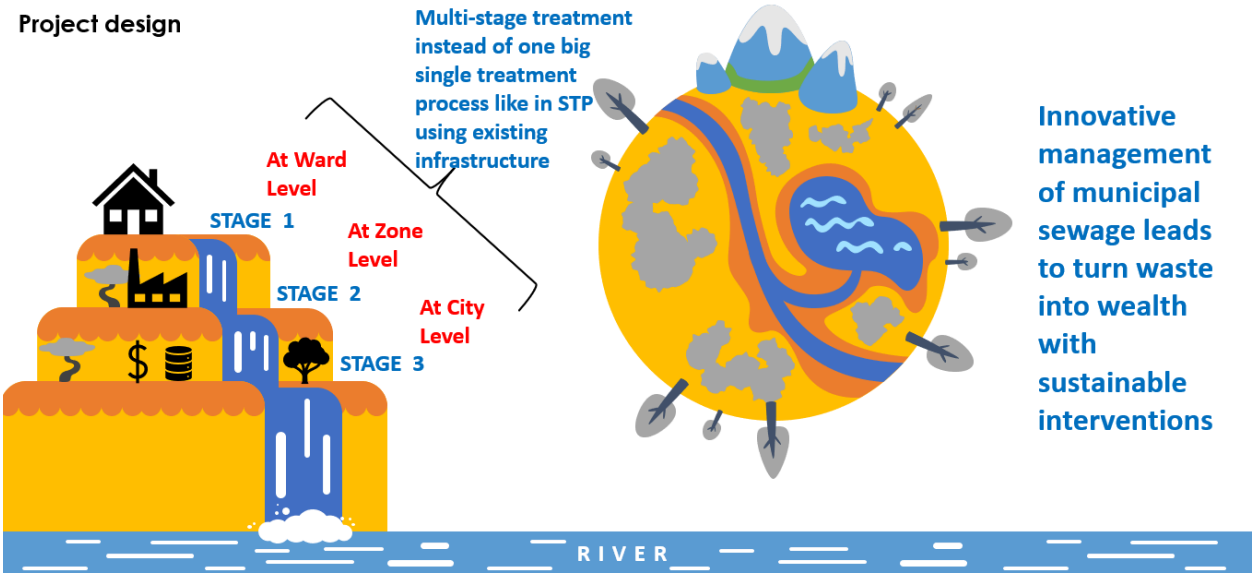
8. Project Details

Project idea + innovation

Treatment of waste water through natural means at various stages while reaching to its final destination as sell-able product



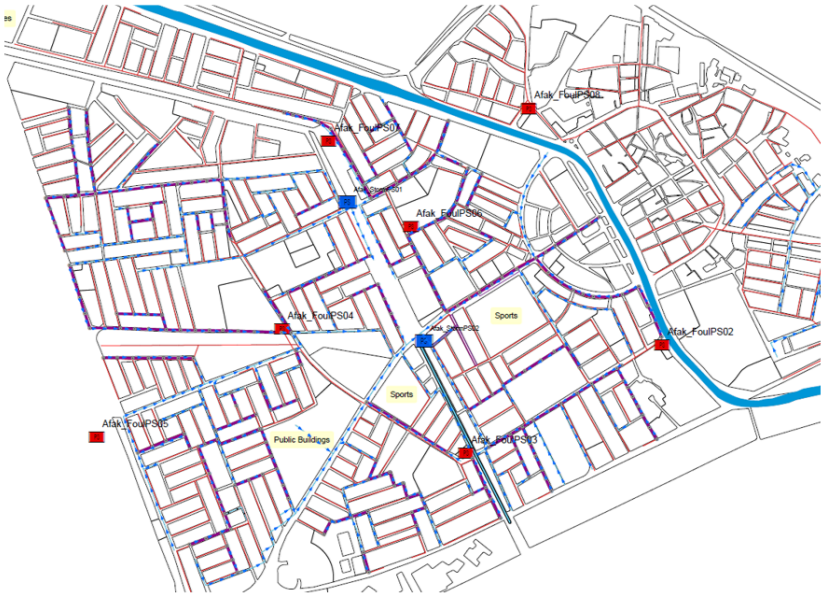
Project design



Innovative management of municipal sewage leads to turn waste into wealth with sustainable interventions

Project practicality

- **Use of existing sewage infrastructure with little interventions and care,**
- **No additional new infrastructure required**



Way forward & Economic benefit

Treated Water can be sold to :

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Appendix -I

Table 3 Results of chemical analysis of groundwater samples in mg/l

S. no.	Location	Ca	Mg	Na	K	HCO_3	Cl	SO_4	NO_3	SiO_2	F	pH	EC (µSeimens)	TDS	Hardness
1	Harthala	40	24	90	0	207	26	192	3.4	68	0.56	7.41	420	269	200
2	Harthala P O	22	25	79	0	205	20	181	1.9	46	0.38	7.82	343	219	160
3	H. Bone Mill	64	61	102	28	193	165	226	1.2	37	0.72	7.18	2680	1714	824
4	Sonakpur	21	38	79	1	208	26	169	6.1	45	0.55	8.12	436	279	208
5	Fakhirpura	35	45	200	8	208	256	250	24	62	0.56	7.31	1105	707	312
6	Tubewell Clny	21	27	69	4	247	45	120	9.2	23	0.18	7.34	891	570	164
7	Z. Parishad Clny	16	23	160	4	156	74	246	51	16	0.45	8.25	903	579	340
8	Daulatbagh	19	23	128	38	208	97	188	8.1	37	0.56	7.79	942	603	264
9	Shantinagar	27	32	69	0	169	34	179	3.3	35	0.66	8.17	459	294	200
10	Lal Masjid	72	61	201	26	104	298	451	165	57	0.77	7.32	2950	1890	712
11	Faizganj	35	89	180	8	350	213	337	55	35	0.47	7.33	2370	1516	452
12	Katghar	90	43	80	4	182	60	177	23	62	0.74	7.55	896	575	284
13	HafizSahab	16	32	106	5	257	20	175	3.9	21	0.63	8.06	486	311	172
14	Locoshed Clny	19	20	110	12	234	37	159	3.9	63	0.29	7.61	752	481	132
15	Mirpur	26	42	63	4	208	26	187	2.2	22	0.6	7.85	475	304	236
16	Khushalpur	19	29	90	2	143	17	156	3.1	60	0.35	7.81	437	280	168
17	Mayanagar	19	31	110	2	244	14	197	2	61	0.25	7.63	403	258	176
18	Tigri	34	15	148	0	252	20	177	4.5	43	0.47	7.71	360	230	144
19	Prakashnagar	34	35	100	17	273	54	181	0	64	0.23	7.38	896	574	228
20	Chiria Tola	32	21	122	7	221	43	160	3.2	62	0.29	7.85	757	484	168
21	Dhakka	40	18	122	5	182	23	181	2.8	32	0.4	7.73	501	321	172
22	Jaintipur	29	26	126	9	260	62	167	3	29	0.4	7.59	796	509	180
23	Das Sarai	32	24	90	17	195	82	187	60	29	0.25	7.78	1104	707	260
24	Barwala	24	14	100	20	221	23	195	5.7	25	0.55	7.62	419	268	116
25	Khanpur	24	18	85	4	208	26	187	1.7	39	0.33	7.71	466	298	132
26	Dadupur	27	13	90	7	234	45	153	2.5	59	0.28	7.61	788	504	120
27	Near Dhela	24	19	102	14	234	23	179	2.2	31	0.25	7.68	466	299	140
28	S. Khata	18	36	122	15	208	28	165	2.5	21	0.26	7.59	606	388	192
29	Tajpur	18	23	132	4	283	23	169	1.8	21	0.41	7.54	445	285	140
30	Bhtawali	24	20	120	8	260	20	174	1.6	41	0.25	7.68	458	293	144
31	Mau	24	64	90	7	232	94	199	48	28	0.18	7.49	1056	675	324
32	Muqarrabpur	32	50	126	16	195	128	165	101	21	0.58	7.2	1712	1095	284
33	Officers Colony	22	39	148	4	221	48	196	7.1	56	0.55	7.65	735	471	216
34	Chandranagar	19	19	100	8	195	28	166	1.6	38	0.4	7.97	464	297	124
35	Kanjhri Sarai	26	57	250	5	273	310	192	66	36	0.49	7.54	1096	702	296
36	Malviyanagar	22	19	164	22	169	65	186	5.8	25	0.5	7.46	835	534	132
37	Pakkabagh	43	50	150	13	195	190	189	2.4	54	0.48	7.17	1696	1086	312
38	Mughalpura	24	86	95	8	247	103	197	6	62	0.4	7.56	1231	787	412
39	Jama Masjid	27	39	250	32	351	255	107	7.7	19	0.6	7.28	2010	1285	196
40	Pital basti	21	38	245	30	330	92	392	90	20	0.4	7.3	290	185.6	208
41	Baldevpuri	90	43	160	20	355	130	250	20	19	0.2	7.3	190	121.6	284
42	Milak nagaliya	18	36	280	27	439	150	245	50	28	0.3	7.5	340	217.6	192
43	Pandit Nagla	16	38	230	35	438	75	196	70	22	0.5	7.6	520	332.8	172
44	Mainather	24	18	210	22	410	32	214	40	27	0.9	7.4	832	532.5	132
45	Gulabari	43	50	165	28	340	150	235	60	25	1.63	6.1	2019	1292	312
46	Prabhat market	22	25	298	40	360	146	360	30	26	1.2	6.7	998	638.7	160
47	Sivpuri	19	31	240	30	350	192	251	35	21	0.8	6.6	1211	775	176

Source -UPPCB Reports

CERTIFICATE OF COMPLETION

This is to certify that this thesis project titled "**Reinstating the Riparian Corridors for Boosting the Urban Economics: A Case of Moradabad, U.P.**" was carried out by Mr. **Shishir Verma**, a student of **Masters in Urban and Regional Planning**, at the **Babu Banarasi Das University, Lucknow**. The research for this project was undertaken under the guidance of the afore-mentioned institute and completed during the period of **February 2023 to June 2023.**

This project was shortlisted under the *Sponsored Thesis Project Competition on "RE-IMAGINING URBAN RIVERS" (Season- 3)* hosted by the National Institute of Urban Affairs (NIUA) and the National Mission for Clean Ganga (NMCG).

This report has been submitted by the student as a final deliverable under the competition. All parts of this research can used by any of the undersigning parties.

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