INTEGRATING ECOSYSTEM SERVICES ASSESSMENT WITH PES: A CASE STUDY OF GODAVARI RIVER IN NASHIK, INDIA

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INTEGRATING ECOSYSTEM SERVICES ASSESSMENT WITH PES: A CASE STUDY OF GODAVARI RIVER IN NASHIK, INDIA

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Abstract:

"The healthy rivers underpin economies" With this seed idea, the research is envisioned to integrate a conservatory approach for water-related ecosystem services in a holistic manner of urban development, capitalising on their synergies to achieve long-term water security and resilience, whilst creating fiscal capacity expansion and sustainable urban environments. Rivers contribute significantly to environmental, economic, and social benefits. Despite carrying the potential of a strong importance, it often faces pressure and degradation due to increasing anthropogenic activities. This study assesses the integration of the Payment for Ecosystem Services (PES) framework with Ecosystem Services (ES) assessment to facilitate sustainable riverside management. The site area Godavari River in Nashik is assessed on four different types of ecosystem services listed in Millennium Ecosystem Services (MEA). The study uses a multi-criteria evaluation approach to map and analyse ES along selected urban stretches of the river, using a matrix-based methodology. The initiative builds on the historic character of a river as a lifeline for human survival, which is particularly evident in the selected site of the "Godavari River Influenced Zone" in Nashik, Maharashtra. The study concludes that the integration of ES assessments into urban river policy frameworks, through the use of PES instruments, can facilitate inclusive economic planning and environmental sustainability. The results have implications for the formulation of development control regulations (DCRs) that respect ecological thresholds, the institutional design of PES initiatives, and river-sensitive planning. The purpose of this approach is to guide Nashik toward a river-centric urban development model that aligns with the SDG objectives for biodiversity, climate, and water.

Keywords: Godavari River, Ecosystem Services, Payment for Ecosystem Services, River-Sensitive Planning, Sustainable Urban Development, MEA Framework

1. Introduction

Rivers are said to be the lifeline for living beings, as all types of development directly or indirectly relate to them. Since ancient times, rivers have served as the foundation of the economic engine for the survival of humans. Early civilisations like the Indus Valley on the Indus River, Egypt on the Nile River, and Mesopotamia between the Euphrates and Tigris are examples of planning innovations that were established for trade, agriculture, and safe livelihood.

Rivers are essential to the urban metabolism of cities, which refers to the complex flow of resources that support urban existence. They function as essential water supply sources, facilitate drainage and stormwater management, serve as channels for waste management, and significantly enhance a city's cultural identity and economic interactions, historically acting as trade routes and settlement foundations. In modern urban planning, rivers are widely acknowledged as ecological corridors that enhance biodiversity by connecting fragmented habitats and enabling species migration. They constitute the foundation of blue-green infrastructure, a planning approach that integrates water systems with plants to mitigate urban flooding, purify water, diminish heat islands, and improve public spaces. Renowned landscape architect Ian McHarg, in Design with Nature (1969)(Yang & Li, 2016), highlighted the design need in line with biological systems, a theme currently reflected in contemporary frameworks such as Nature-based Solutions (NbS) and Sponge City models in China. These frameworks promote collaboration between cities and natural hydrological processes, employing strategies such as permeable surfaces, regenerated wetlands, and riverbank buffers to establish climate-resilient and sustainable urban landscapes. Rivers should be seen as urban assets to be respected, restored, and integrated, not as burdens to be managed. Many urban design projects have been considered as a solution to the urban river issues, e.g., Thames revitalisation (UK), Sabarmati riverfront (Ahmedabad in India), or Cheonggyecheon stream restoration Project (South Korea). (Shinde et al., 2024)

The river's value is often overlooked in urban economics because of the absence of formal acknowledgement and assessment of the various environmental services it offers. But this absence causes a disjunction between natural capital and financial capital, wherein rivers are perceived as passive backdrops rather than active contributions to urban productivity and resilience. By neglecting to integrate these services into economic frameworks, cities jeopardise ecological stability and miss potential revenue sources that may be derived from mechanisms such as Payment for Ecosystem Services (PES), ecotourism, or investments in green infrastructure. Identifying, delineating, and appreciating these concealed

contributions is therefore an essential measure for developing river-sensitive urban areas that harmonise ecological well-being with economic advancement.

The selected site for the project, the Godavari River, is an identity of Nashik, one of the oldest cities situated along the riverbanks. With the relevance of the Ramayana, the Mahabharata, and numerous heritage and natural sites, the city is not only known as the spiritual capital of Maharashtra but also contributes to the Indian economy, attaining a district GDP of more than 33 billion, including agricultural, automobile, and industrial sectors. The multi-layered land use around the river stretch is a beneficial aspect for the growth of the city. However, it also increases the human dependency on rivers, contributing to the drivers of ecosystem degradation. The water ecosystem present in Nashik provides a range of benefits (services) that are not formally valued due to its free availability.

The research seeks to balance the river's ecological health with its economic functions. The mapping of human dependence on water services will help build interconnections between the city and the river, which urban planning solutions will solve. The identification of critical zones along the 19 km stretch of the river in NMC boundary involves mapping areas of high ecosystem degradation against areas with preserved natural assets, as well as estimating the economic value of these services to emphasize their importance for Nashik's economy and urban fabric. (Reid & Mooney, 2016a)

2. River Ecosystem Services and Key Issues in Urban River Management

Among all the urban water assets, rivers play an important role in providing a wide range of ecosystem services that support livelihood, biodiversity, and development. The rivers provide many tangible and intangible benefits, but these services are not formally valued. During the post-industrialisation phase, economists and environmentalists were finding difficulties in assessing environmental health. Quantification methods and concepts have been proposed to maintain accountability of the natural assets. Further, the benefits we humans draw from the environment are termed "ecosystem services" to establish the value of the environment. Further, the Millennium Ecosystem Assessment (MEA) categorized these ecosystem services into four major types, i.e., provisioning services (drinking water, agricultural usage of river water), regulating services (microclimate regulation, flood control), cultural services (pilgrimage tourism along ghats, recreation), and supporting services (soil formation, nutrient cycling). (Chopra et al., 2022; Reid & Mooney, 2016a)

Rivers have been a focal point for settlement growth due to the accessibility of water, transport, recreation, etc. Also, from the

ancient period, rivers have been praised as deities and referred to as a sacred component. Later, with technological advancement, traditional factors started diminishing, and industrialisation occurred. (Shinde et al., 2024) With this historical shift, the river, once a sacred source of living, transformed into a force serving human wants.

On one hand, humans still celebrate rivers, especially in areas where daily spiritual practices and festivals are being performed. However, this also results in degradation by dumping waste, over-extraction of water, and bathing/washing activities in the river. There remains a general lack of awareness among humans about the potential benefits they get from the river. Therefore, to foster sensitivity towards this issue, planning must incorporate river consideration for optimal utilisation.

Urban rivers face increasing pressure to supply services due to technological advancement and the needs of an increasing population. These services include industrial water supply, waste disposal, bathing, and washing in the river, which in turn causes heavy degra

3. Study Area: The Godavari River in Nashik

The River Godavari (also known as Dakshina Ganga) is the second-largest watershed in peninsular India and originates from the Brahmagiri Mountain, Trimbakeshwar, which is approximately 30 km distant from Nashik city. The river stretch plays an important role in Nashik's urban setting, flowing approximately 19 km within the jurisdiction boundaries of the Nashik Municipal Corporation. Starting from the Gangapur reservoir, land use follows agricultural stretches along the river. As the river moves towards the city core, the zoning shifts to residential, institutional and old city heritage zoning, followed by the industrial zone of Maharashtra Industrial

Development Corporation (MIDC). The multi-layered land use around the river stretch is a beneficial aspect for the growth of the city. However, it also increases the human dependency on rivers, contributing to the drivers of ecosystem degradation. The water ecosystem present in Nashik provides a range of benefits (services) that are not formally valued due to its free availability. By making these water services visible and quantifiable, the project aims to enhance the city's economy, raise awareness about conservation practices, and re-engineer land-use zoning and sustainable mechanisms. Nashik City contains high development potential, with diverse economic value, as the new proposals of the Delhi-Mumbai Industrial Corridor (DMIC) and six-lane Surat-Chennai expressway are planned to pass through the region. Apart from these, the developing city of Maharashtra is well-known for its “Simhastha Kumbh Mela” festival, which happens once in 12 years. The Hindu religious rituals performed at the ghats of the Godavari hold prominent cultural value of the river while also promoting opportunities for pilgrimage tourism. (*GodavariRiver_ComprehensiveStudyReport*, 2016)

The ecology of the riparian edge and the natural experience of the river edge have been manipulated by religious events, inviting development projects. Thus, the project is conceptualised to promote sustainable development while ensuring protection from water-related activities from intrusion and encroachment that diminish the natural landscape setting. The dynamics give Nashik a prime case in point for studying the interaction between urban growth and riverine ecosystems. (Dahake, n.d.; Grzyb, 2024) The city is carrying out significant planning initiatives through programs such as the Smart Cities Mission, creating chances to integrate ecological service valuation with spatial planning activities.

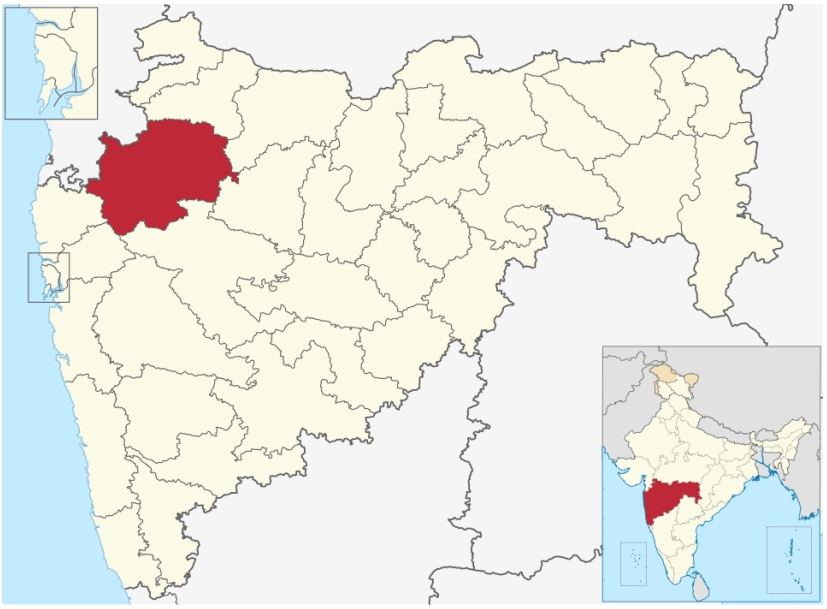

Figure 2: Location Map of Nashik District in Maharashtra-India (Source: Wikipedia)

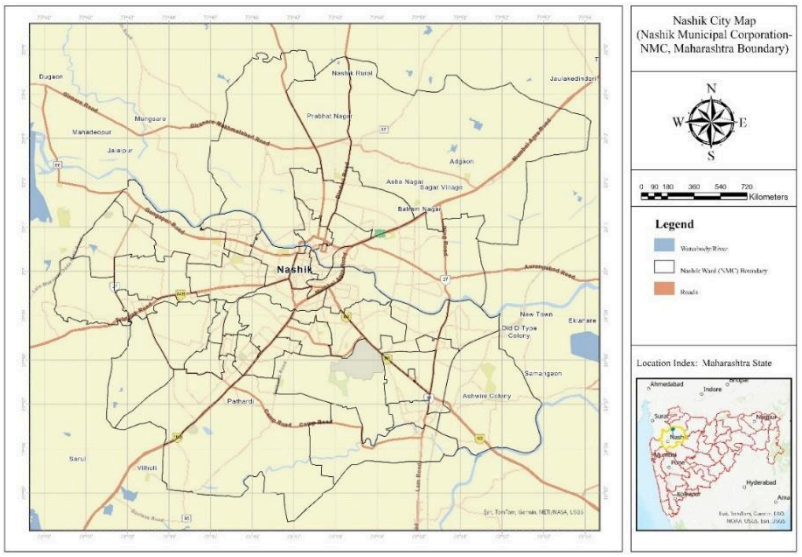

Figure 3: Nashik City Map (NMC) (Source: Author)

The riverfront is challenged with a variety of land uses that are frequently incompatible, such as high-density housing, informal settlements, religious infrastructure, and limited verdant buffers. The Godavari is susceptible to pollution, inundation, and the degradation of ecosystem services due to the absence of a continuous ecological buffer zone. There are opportunities to incorporate green infrastructure and transform underutilised or congested areas into multifunctional spaces that meet urban requirements and restore ecological health. The settlement structure of Nashik was centred on the Godavari, with residential clusters (Gaothans) and markets developing naturally around water access sites. This traditional strategy aligned with the local terrain and seasonal hydrological patterns. The standard water systems were naturally sustainable and compatible with the region's natural hydrology. Urban development in recent decades has disrupted the spatial and functional connectivity between people and water. (*2010-11_Nashik_DSA_Agri Crop Data 5_2*, n.d.; *Ann__3a__Preliminary_Report__*, n.d.)

4. Methodology

4.1. Phase 1

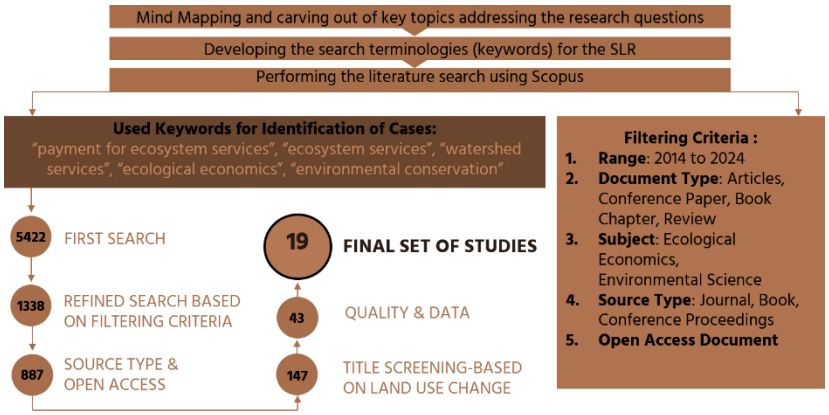

Figure 4: SLR Methodology for the study of the effectiveness of the PES Concept

(Source: Author)

In this study, a systematic (SLR) approach was initiated to select and analyse case studies (material) focused on the relationship between land use change, human activity, and watershed services degradation. The literature search was performed using the Scopus search database. Since PES is performed on a unique basis depending upon geological conditions and the farmer's landowner's willingness to pay, different parameters supporting the period range for the study are not taken into consideration but extracted based on keywords, title, abstract and quality of data. The literature review not only contains conference papers but also articles, journals, reports, book chapters etc. The subject area selected was "Environmental Science", and "Environmental Economics"; Source title selected as "Environmental Services", and "Ecological Economics"; Final publication stage and open access material.

Followed by the development of search terminologies for SLR the initial dataset of 5422 documents were found, which later got refined through time period i.e. 2014 to 2024, received 1338 literature documents. Selection was again filtered by putting limitation to type of the document i.e. articles, book chapters, conference paper by which 887 documents were obtained. 147 research papers, gathered using targeted keywords – Payment for Ecosystem Services, Watershed Services and Case Studies; was progressively refined by specific relevance criteria: first, focusing on watershed-related cases which extracted getting 87 materials, and then narrowing to studies on land use change impacts. By title screening of the material 19 cases were collected. This led to a final selection of 10 cases, chosen for data quality and relevance for which thorough reading was purposefully done. The documents collected for the case studies are all open access. A literature review informed the development of a parameter list guiding analysis, which was conducted using a synthesis matrix to comparatively examine and summarize the cases. This methodology ensures a focused, high-quality dataset supporting robust conclusions about land use impacts on watershed services. The synthesis matrix for the comparative assessment of cases is performed with the help of MS Office Excel.

4.2. Phase 2

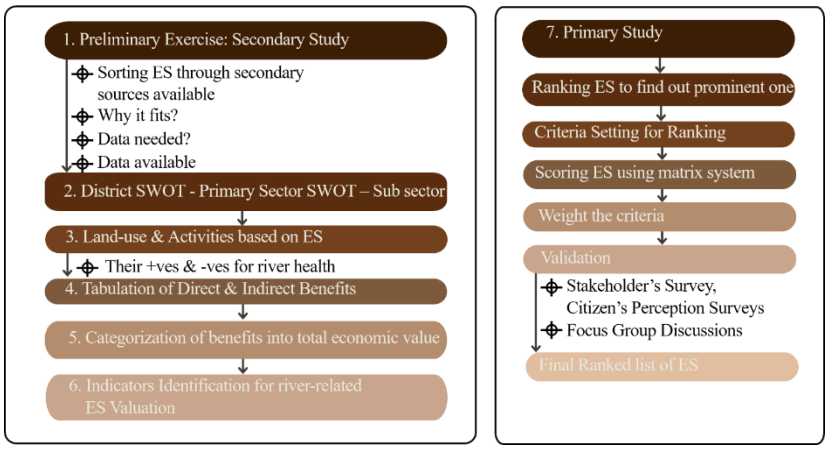

Figure 5: Methodology for Identification of Ecosystem Services (Source: Author)

Phase 2 aims to achieve identification of the ecosystem services (ES) offered by the Godavari River. This phase is categorised into secondary and primary studies. The secondary study starts with initial exercises of categorising environmental services based on existing literature, analysing their significance, and assessing data availability. A district-level SWOT analysis evaluates the main sectors and their sub-sectors, maps land use and activities related to ecosystem services, and assesses their positive and negative impacts on river health. The direct and indirect advantages of these services have been structured and classified of economic value given in MEA. Indicators are also identified to assist in the pricing of river-related ecosystem services. The principal study involves stakeholder participation, wherein ecosystem services are prioritised through a matrix-based scoring system. Criteria are established, and weights are assigned to facilitate systematic assessment. Validation is conducted via stakeholder interviews, public perception surveys, and focus group discussions, resulting in a final ranked list of ecosystem services informed by community viewpoints and their perception about river health.

5. Results and Analysis: Ecosystem Services Assessment

5.1. Phase 1 – PES Study

The analysis of several case studies on watershed services showed that unsustainable land-use practices are the primary drivers of watershed degradation. These include extensive deforestation, overgrazing, and unsustainable agriculture methods, all of which disturb natural land cover and result in ecological instability. In other cases, ancillary pressures like unregulated surface runoff and agricultural encroachment into ecologically vulnerable areas contributed to watershed degradation. These activities over time affect the hydrological balance of the watershed, increasing sedimentation and diminishing the land's ability to regulate water flows. As a result, essential ecosystem services, water quantity, water quality, and biodiversity have been severely impacted. The

deterioration of these services adversely impacts downstream users, aquatic ecosystems, and regional climate resilience. Most of the PES (Payment for Ecosystem Services) programs examined in the literature have mostly been government-driven, utilizing regulatory instruments and public funding for implementation tactics. In areas where local populations are engaged and responsive, Public-Private Partnership (PPP) (*Payments for Ecosystem Services: A Best Practice Guide*, n.d.) models have demonstrated effectiveness in finance and execution. These PES projects have demonstrated significant post-implementation effects, including increased forest cover, enhanced carbon sequestration, improved soil and streamflow management, and quantifiable benefits in water quality and quantity. Some projects focused on reforestation, afforestation, and agroforestry, resulting in significant changes in land use, including the rehabilitation of degraded regions and the restoration to native vegetation.

PES schemes are showing the ability to improve rural livelihoods by encouraging revenue-generating land-use practices and promoting community control of natural resource management, in addition to ecological restoration. These advantages boost long-term sustainability, as communities adopt stewardship over their respective environments. The research shows that the successful implementation of PES programs is not guaranteed; it necessitates robust institutional frameworks, clearly delineated property rights, ongoing stakeholder involvement, and dependable finance mechanisms. (*PES USAID Guidelines*, n.d.)

5.2. Stakeholder-Based Matrix Scores

With the help of primary data, the analysis has been divided into 2 matrix-based studies and GIS-based studies. The first stage is the Classification of land use and land cover classes - Supervised Classification and Reconnaissance Survey and Mapping through Google Imagery. The 2nd stage covers the Identification of ES, with the help of all Services defined by the TEEB (2010) & Exercises conducted on reconnaissance survey, associated with each identified land use. 3rd stage includes a Survey regarding the ecosystem services existing in selected wards- a scoring system - sent to the group of key actors, and a sum of the highest-scoring ES to identify the priority services. (*Van Der Ploeg 2010_The TEEB Valuation Database_overview of Structure, Data and Results*, n.d.)

5.2.1. Matrix-Based Study 1: Multi-Criteria Assessment of Ecosystem Services Along the Godavari

This matrix-based study adopts multi-criteria assessment (MCA) methodology to systematically evaluate and prioritise the ecosystem services (ES) provided by the Godavari River in the Nashik region. The main goal is to determine the spatial and functional distribution

of essential ecosystem services and evaluate their relative importance in promoting environmental health, urban sustainability, and socio-economic development.

- **Key Objectives of the Matrix:**
    a) To measure and evaluate the comparative contributions of diverse landscapes to various ecosystem services.
    b) To prioritise critical zones along the river corridor for conservation, restoration, or sustainable development.

- **The study is divided into 4 parts:**
    a) Criteria Identification
    b) Validation of Criteria through experts
    c) Stakeholders Survey & Citizen Perception Survey
    d) Weight-Based Prioritisation

This matrix-based multi-criteria methodology develops a foundational comprehension of ecosystem service dynamics within the Godavari River landscape of Nashik, aligning with the overarching objective of utilising natural assets for sustainable urban growth and economic resilience.

a) Criteria Identification

The process consists of the selection of suitable indicators that can effectively assess the significance, relevance, and risk status of diverse ecosystem services (ES) provided by the Godavari River in Nashik. The chosen criteria seek to represent the multifaceted significance of ES, covering social, economic, cultural, ecological, and institutional dimensions.

Process of Criteria Selection:

1. Literature Review: A thorough examination of academic journals, governmental papers, and international frameworks (e.g., Millennium Ecosystem Assessment, TEEB – The Economics of Ecosystems and Biodiversity, and IPBES) was performed to find out frequently utilised assessment criteria for ecosystem services. (*13_Methdology for Sample Collection*, n.d.; *36_Study Area*, n.d.; Reid & Mooney, 2016b)
2. Contextualisation to Nashik-Godavari River Basin: The preliminary long list of criteria was customised to the regional context of Nashik, taking into account the urban-river interface, the religious and cultural importance of the Godavari, and the livelihood dependence of residents.

b) Expert Consultation and Validation:

The criteria were tested to guarantee relevance and correctness through five experts-

Interviews and conversations with the expert – local specialists, including urban planners, urban designers, hydrologists, ecologists, and sociologists from the Nashik Municipal Corporation (NMC).

1. Feedback workshops with important stakeholders engaged in riverfront development, water management, and religious tourism.
2. Casual validation during field visits, wherein local stakeholders (e.g., fishers, priests, sellers) were inquired about their interactions with and appreciation for the river's services.

Final List of Criteria:

Table 1: Evaluation Criteria (Source: Author)

Criteria	Why It Matters	Rationale
Extent of Use	How many people depend on this ES (e.g. drinking water for 5 lakh people)	Reflects how widely the service is utilised
Frequency of Use	Daily (drinking), seasonal (agriculture), occasional (Kumbh)	Captures how often the service is accessed
Economic Dependence	Employment, livelihood (fisheries, religious tourism, sand mining)	Shows the livelihood or income reliance
Cultural Importance	Historical, spiritual, and traditional relevance (e.g. Godavari Ghat rituals)	Highlights traditional or spiritual values
Environmental Impact	Whether it helps improve or worsen river health	Considers ecological significance
Policy/Institutional Support	Whether it's recognized in policies (DP, River Rejuvenation Plan, AMRUT, NMC riverfront development)	Indicates enforceability and support
Vulnerability / Threat Level	Level of degradation or threats faced by the ES	Accounts for the risk of degradation or loss

Each criterion was specified with a specific rationale and justification, as illustrated in the matrix. This clarity guarantees accuracy in scoring and improves the scientific precision of the multi-criteria evaluation. (*59_Mainstreaming Urban River Report - Compressed*, n.d.;

River_Sensitive_Urban_Planning_NMCG_1737536820, n.d.; Alvarado-Arias et al., 2023; Basak et al., 2021; Grzyb, 2024)

c) Stakeholders Survey & Citizen Perception Survey

The surveys were intended to obtain qualitative and quantitative insights about the perceptions, dependencies, and interactions of various groups with the ecosystem services of the Godavari River in Nashik.

Objectives:

1. To understand public awareness about ES.
2. To gain insights regarding livelihood dependency, cultural significance, and perceived dangers to the river.
3. To identify priorities for conservation and development from both institutional and civic perspectives.

Methodology:

Structured questionnaires were created via Google Forms, specifically designed for stakeholders (technical/institutional) and the general public. The questionnaires comprised:

1. Multiple-choice questions,
2. Likert-scale ratings,
3. Open-ended responses.

The form templates are attached in the Appendix of the thesis for reference.

Data Collection:

1. Google Forms were circulated via digital platforms such as WhatsApp groups, emails, local academic networks, and professional connections.
2. On-site surveys were executed in important sites, including Godavari Ghats, riverfront markets, residential areas, and temples to guarantee participation from diverse user groups.

Responses were collected from a diverse mix of stakeholders, including:

1. Urban planners and municipal officials (NMC)
2. Nashik Smart City Officials,
3. MIDC and MPCB Officials
4. Water Resource Department Officials
5. Local NGOs and environmental activists – Nashik Ploggers
6. Business owners, especially near the river, retail shopkeepers, hawkers, etc.
7. Religious leaders and devotees
8. Fishermen, vendors, and informal workers
9. General citizens and students

Sample Size and Coverage: A total of 162 responses have been collected, including 122 from digital formats and 40 from in-person interactions. The sample guaranteed an equitable split of age demographics, professions, and proximity to rivers.

Data Analysis: Survey data was compiled, classified, and examined to identify:

1. Dominant ecosystem services
2. Observed changes in river health throughout time
3. Degrees of awareness and confidence in institutional initiatives
4. Principal issues (e.g., pollution, encroachment, water deficiency)

With the help of these responses, the weight-based prioritisation has been created for each type of criteria and a detailed classification of each type of ecosystem service. Following is the matrix prepared for representation. The total score in the matrix represents an overall rating of the service, community perception about the particular service and supply of the service by the river in Nashik.

Output:

ES Type	Ecosystem Services	Extent of Use	Frequency of Use	Economic Dependence	Cultural Importance	Environmental Impact	Policy/ Institutional Support	Total Score
Provisioning Services	Drinking Water Supply	5	5	4	3	5	5	27
	Industrial Water Supply	3	4	4	1	2	4	18
	Irrigation for Agriculture	4	4	5	2	3	3	21
	Fisheries	2	3	3	2	4	2	16
	Sand & Sediment Extraction	3	3	3	1	1	1	12
	Timber & Fuelwood	1	2	2	1	3	1	10
Regulating Services	Groundwater Recharge	4	5	3	2	5	4	23
	Carbon Sequestration	2	4	1	1	4	3	15
	Microclimate Regulation	3	3	1	2	4	2	15
	Flood Regulation	5	4	2	2	5	5	23
	Pollution Control	5	5	2	2	5	5	24
	Natural Filtration and Water Purification	4	4	3	2	5	5	23
	Soil Erosion Prevention	3	3	2	2	4	3	17
Cultural Services	Pilgrimage and Religious Tourism	4	3	4	5	3	5	24
	Recreational Activities	3	3	3	3	3	4	19
	Heritage	2	2	2	5	3	4	18
	Festival and Community Activities	4	3	3	5	2	4	21

Figure 6: Weight-Based Prioritization - Matrix 1(Source: Author)

5.2.2. Matrix-Based Study 2: To identify which ES contributes the most in each land use zone using a score-based matrix

Based on the tangible benefits, scores allotted to 5 economic values listed in the Millennium Ecosystem Assessment (MEA), this matrix-based study aims to identify the most significant ecosystem services (ES) within various land use zones by employing a score-based evaluation method. The approach utilises the five categories of economic value as defined in the **MEA** framework to assess and compare tangible benefits derived from ecosystem services.

Expert Validation: The initial matrix values have been verified through discussions with subject matter experts: Water Management

& Environment Specialist at NIUA, Environmental Planner - Worked on Varanasi in a similar context. The Google form used for the validation is attached to the appendix. These experts provided insights on assigning appropriate weightage to different values, helping refine the matrix to ensure contextual accuracy and practical relevance. The finalised values are given below:

1. Direct Use Value - **5**
2. Indirect Use Value - **4**
3. Optional Value - **3**
4. Bequest Value - **3**
5. Existence Value - **4**

Key Informant Interviews (KII): To take into account local and institutional perspectives, Key Informant Interviews (KII) were executed utilising the following tools:

1. Mentimeter for interactive, real-time feedback.
2. Matrix-based survey forms shared via email and WhatsApp.

Participants included representatives from:

1. **Urban and Infrastructure Bodies:** Town Planners, Smart City SPV officials, NMC (Nashik Municipal Corporation), MIDC (Maharashtra Industrial Development Corporation), PWD
2. **Environmental and Regulatory Authorities**: MPCB (Maharashtra Pollution Control Board), Agriculture Department, Water Resource Department, Irrigation Department
3. **Academic and Research Institutions:** NIUA Experts

The stakeholders shared feedback regarding the importance of each ecosystem service based on their sectoral expertise, refining the ratings and verifying assumptions generated in previous phases. A total of 20 responses were collected and tabulated in a matrix format.

Output:

ES Type	Ecosystem Services	Residential Zones	Commercial Zones	Industrial Zones	Recreational Zone	Agricultural Zones	Public/Semi Public Zones
Provisioning Services	Drinking Water Supply	5	5	5	5	5	5
	Industrial Water Supply	3	4	5	3	3	4
	Irrigation for Agriculture	3	3	3	3	5	3
	Fisheries	3	3	3	4	4	3
	Sand & Sediment Extraction	3	3	4	3	3	3
	Timber & Fuelwood	3	3	3	3	4	3
	Total Values	**20**	**21**	**23**	**21**	**24**	**21**
Regulating Services	Groundwater Recharge	4	4	4	5	5	4
	Carbon Sequestration	3	3	3	4	5	4
	Microclimate Regulation	4	3	3	5	5	4
	Flood Regulation	3	3	3	4	5	5
	Pollution Control	3	3	4	4	4	4
	Natural Filtration and Water Purification	4	3	3	5	5	5
	Soil Erosion Prevention	3	3	3	4	5	5
	Total Values	**24**	**22**	**23**	**31**	**34**	**31**
Cultural Services	Pilgrimage and Religious Tourism	3	3	3	3	3	5
	Recreational Activities	4	3	3	5	3	4
	Heritage	3	3	3	3	3	4
	Festival and Community Activities	4	4	3	4	3	5
	Total Values	**14**	**13**	**12**	**15**	**12**	**18**
TOTAL ECONOMIC VALUE		**58**	**56**	**58**	**67**	**70**	**70**

Figure 7: Matrix 2-Based Analysis Output (Source: Author)

5.2.3. Inferences

Two matrices have been developed to assess ecosystem services (ES) regarding the Godavari River's impact on Nashik's urban environment:

Matrix 1 concentrated on the identification and evaluation of ecosystem services according to land use classifications, utilising secondary data and expert validation.

Matrix 2 featured stakeholder-driven prioritising of identical ecosystem services via score-based evaluation grounded in public perception, sectoral dependence, and neighbourhood knowledge.

1. **Public Perception Strongly Validates Cultural Importance.** Among 162 survey sample respondents, the majority prioritised cultural and religious services as the most significant. Frequent visits to Ghats and engagement in rituals show strong emotional and spiritual relationships.
2. **The dependency on provisioning services is Universally Acknowledged** –
   Respondents from both core and peri-urban wards showed major dependency on the river for potable water, irrigation, and everyday sanitation activities, validating secondary findings.
3. **Awareness of Environmental Issues Exists but is Limited –**
   Numerous residents noticed degradation in water quality and encroachments, but very few understood their ecological effects, such as habitat destruction or pollution-induced ecosystem degradation.
4. **Economic Utilisation Rated Higher Than Ecological Regulation –**
   While Provisioning and cultural services were often acknowledged, regulating services (such as flood control and microclimate benefits) were less appreciated or valued by the overall public.

6. Recommendations: Integrating ES Assessment with PES

6.1. Why PES for Urban Rivers?

PES is a market-based mechanism that ensures that those who sustainably use ecosystem services are compensated by their beneficiaries. This may cover the following in the context of an urban river:

1. Encouraging communities to maintain riparian vegetation through payment.
2. Offering tax rebates to developers who incorporate ecological buffers.
3. Developing ecological payments that are based on spiritual tourism to support clean-up initiatives.

6.2. Recommendations and Implementation Strategy for Nashik

Polluter Pays Principle - Involving Polluting Industries in Reforestation Initiative

The Godavari River in Nashik is a prime example of an unsettling paradox: despite the fact that it provides the city with substantial ecological, economic, and cultural advantages, it is subjected to a disproportionate amount of degradation as a result of uncontrolled urbanisation and industrialisation. The alarming water pollution levels recorded in the region are particularly indicative of this "benefit without responsibility" dynamic. Nashik's MIDC (Maharashtra Industrial Development Corporation) cluster had a Water Pollution Index score of 57.5 out of 100 in 2017, as per the Central Pollution Control Board's Comprehensive Environmental Pollution Index (CEPI) report. This score indicates a "severely polluted" water environment. This index is a composite of the levels of enforcement of pollution control norms, the impact on ecosystems and people, and the concentration of pollutants. This situation demonstrates the pressing urgency of transitioning from an exploitative water resource use model to an ecosystem-based management approach. The Godavari's integrity can be safeguarded for future generations by incorporating ecosystem services assessment and Payment for Ecosystem Services (PES) to restore balance, which will create economic incentives for conservation and assign responsibility to beneficiaries.

Recommendation 1 – Godavari Eco-Adoption Program

In exchange for maintaining, greening, and protecting that river segment, the adopter receives public recognition, branding benefits, CSR reporting validation, and tax-linked incentives. The program turns passive corporate responsibility into measurable environmental service delivery, aligning directly with the Polluter Pays Principle and ecosystem restoration goals. NMC will maintain a public-facing digital dashboard showing: Adopted stretches & their status, Industry

contributors, Impact metrics (e.g., trees planted, waste removed, NDVI score), Annual awards for top performers.

Recommendation 2 – Identification of Polluters, Service Receiving Areas, High Potential Service Areas

Plastic & food-processing units (11 factories received show-cause (Fined) notices in Tapovan/Satpur). 22 High chemical & Plastic-Based polluting industries have been found through the Ministry of Micro, Small, and Medium Enterprises (MSME) Industrial data report 2023. 9 High Water Extracting Industries in NMC & 9 in the outer area have been mapped. Considering Reconnaissance Survey - High Service Zones have been mapped.

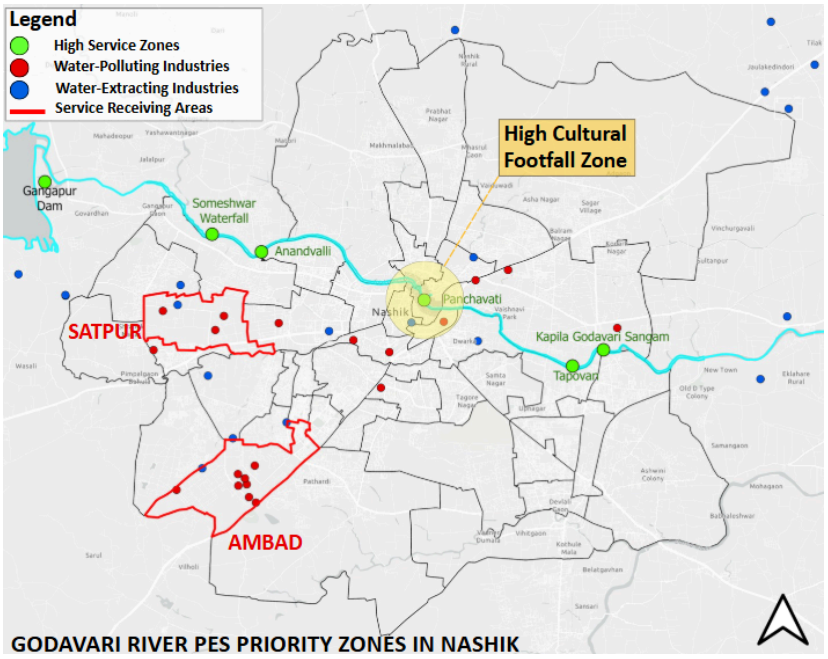

Figure 8: Godavari River PES Priority Zones in Nashik (Source: Author)

Recommendation 3 - Restoration Mandate in Degraded Riparian Buffer Zones Via NMC & Forest Department

Through a Polluter Pays–based Riparian Reforestation Mandate, identified polluting and water-intensive industries will contribute funds or in-kind support for the restoration of degraded riparian areas, facilitated jointly by the Nashik Municipal Corporation and the Forest Department. This model flips the burden from the public bearing the cost of damage to the polluter investing in restoration and formalises this exchange under a Payment for Ecosystem Services (PES) program. Reforestation zones are designated within 50–150 meters of the river edge, and degraded canals (Nallas) primarily in degraded stretches near industrial zones. Under CSR obligations, industries: Fund plantation of native riparian trees, Support soil erosion control and vegetative fencing, Commit to a 5-year

maintenance cycle, Monitoring is led by NMC/Forest Dept., with geotagged audits and third-party NDVI verification.

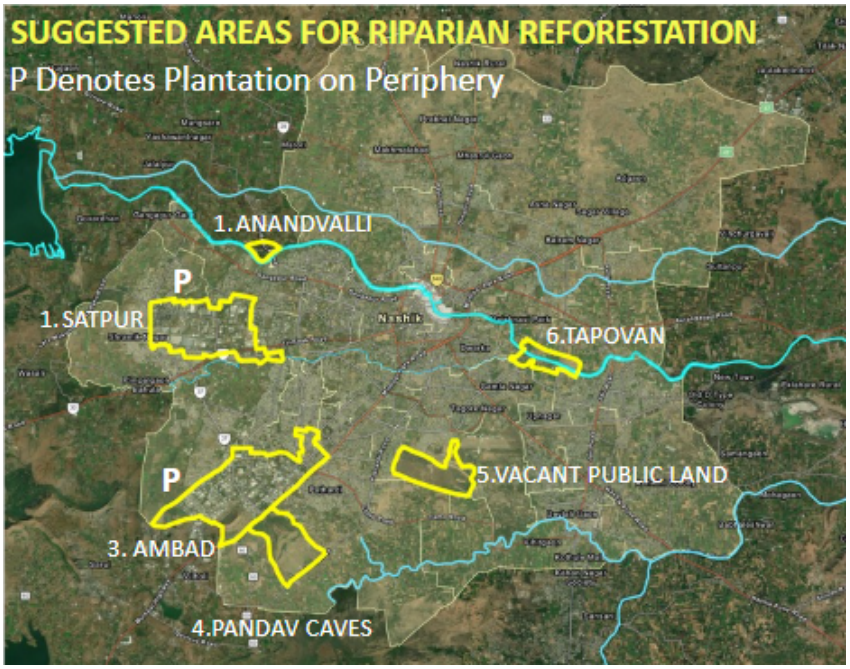

Figure 9: Suggested Areas for Riparian Reforestation (Source: Author)

Recommendation 4 – Mandate Green Offset for Environmental Clearance

This policy mandates that any new industry within a defined proximity to the Godavari River (1 km) must commit to "Green Offset" - reforestation commitment for environmental clearance approval (under MPCB norms). Integrated into the Environmental Impact Assessment (EIA) and MPCB Consent to Operate. The Green Offset would be fulfilled by: Direct reforestation of degraded river buffers, Storm water harvesting systems installation, Constructed wetlands, or
Contributing to a Godavari Restoration Fund managed by the NMC/Forest Department.

Recommendation 5 - Eco-Performance Based Tax Rebates/ Incentives

Industries that treat and reuse at least 50% of their wastewater for cooking, cleaning, or landscaping should be eligible for a partial property tax rebate (e.g., 5–10%). Introduces a system where industries, water users that actively participate in ecosystem restoration, pollution reduction, or sustainable practices receive property tax rebates, fast-track clearances, or ESG recognition. Reduces extraction from the Godavari or municipal supply, lowers pollutant discharge into the river system, promotes adoption of Zero Liquid Discharge (ZLD) technologies, and fits under CSR and ESG performance indicators.

7. Conclusion

The critical study of ecosystem services (ES) assessment as a foundational pillar for sustainable riverfront planning is shown in this chapter, particularly in urban contexts where natural systems are being progressively compromised by anthropogenic pressures. The Godavari River in Nashik, with its distinctive combination of ecological functions and cultural significance, provides a compelling argument for the significant need for integrated planning approaches. The city's environmental health is supported by a living socio-ecological system that sustains livelihoods, provides spiritual solace, and is not merely a waterbody. The study notes that the spatial distribution and intensity of ecological benefits can be visualised by planners and policymakers by assessing and mapping ecosystem services using a matrix-based methodology. This knowledge is indispensable for the purpose of making well-informed decisions regarding infrastructural development, conservation priorities, and land use. This research guarantees a comprehensive comprehension of the Godavari River's importance in the realm of urban resilience and sustainability by employing a multi-criteria evaluation of ecosystem services, which includes provisioning, regulating, cultural, and supporting functions.

Critically, the chapter suggests the implementation of the Payment for Ecosystem Services (PES) framework as a practicable and innovative approach to institutionalising ecological compensation. PES can transform the paradigm from reactive conservation to proactive ecological stewardship. A scalable fiscal instrument is provided to incentivise preservation efforts, particularly in ecologically sensitive or culturally significant zones, when it is adapted to the urban river context. PES can generate sustainable financial flows for river rejuvenation without over-reliance on state budgets by utilising mechanisms such as green bonds, eco-taxes, or faith-based donations associated with pilgrimage activities.

This ES–PES model, which is integrated, not only contributes to local environmental governance but also aligns with broader national and international development agendas, including the Smart Cities Mission, AMRUT, National Biodiversity Action Plan, and the Sustainable Development Goals (notably SDG 6: Clean Water and Sanitation, SDG 11: Sustainable Cities and Communities, and SDG 15: Life on Land). Urban local entities, such as the Nashik Municipal Corporation (NMC), can cultivate a river-centric development ethos that is founded on sustainability, equity, and resilience by incorporating ecological valuation into statutory frameworks like Development Control Regulations (DCRs).

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