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Original Article

AWARENESS AND PERCEPTIONS OF URBAN ECOSYSTEM SERVICES IN CLIMATE CHANGE ADAPTATION: AN INDIAN CASE STUDY

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ABSTRACT

Urban ecosystem services (UES) play a crucial role in reducing climate-related risks and boosting the adaptive capacity of cities, especially in the rapidly changing landscapes of the Global South Gómez-Baggethun et al. (2013), Haase et al. (2014). In India, urban growth often comes at the expense of ecological infrastructure, and public awareness is a vital yet underexplored factor in the success of ecosystem-based adaptation (EbA) strategies Nagendra et al. (2018), McPhearson et al. (2016). This research assessed public awareness of UES in Dwarka, New Delhi. Using a mixed-methods approach that combines site studies, structured interviews, and mapping of green and blue infrastructure, the study investigates how various stakeholders perceive the ecological, socio-cultural, and adaptive roles of urban ecosystems. The results indicate a strong emphasis on provisioning and regulating services, such as tree cover, shade, and air quality, while supporting and cultural services, like biodiversity support and heritage landscapes, are frequently undervalued Andersson et al. (2014), Kabisch et al. (2016). Awareness levels are shaped by factors such as education, proximity to green spaces, socioeconomic status, and civic engagement Raymond et al. (2017), Ernstson and Sörlin (2013). The findings are derived from 200 in-person surveys conducted with randomly selected visitors to parks and other areas, along with 122 Google Form responses from various stakeholders.

Keywords: Ecosystem Services, Urbanisation, Climate Change, Stakeholders and Awareness

INTRODUCTION

Urban areas worldwide are increasingly exposed to the adverse impacts of climate change, including intensified heatwaves, urban flooding, and declining air quality IPCC (2022). In response, urban ecosystem services (UES)—the benefits humans derive from ecosystems in cities—are recognized as critical assets for climate adaptation and sustainable urban living Gómez-Baggethun et al. (2013), Haase et al. (2014). UES contribute to urban resilience by regulating microclimates, managing stormwater, enhancing biodiversity, and supporting mental and physical health Elmqvist et al. (2015). As cities expand, particularly across the Global South, integrating nature-based solutions (NBS) and ecosystem-based adaptation (EbA) measures into urban planning has emerged as a priority for mitigating vulnerability Kabisch et al. (2016), Nagendra et al. (2018).

However, the effectiveness of ecosystem-based interventions largely depends on public awareness, perception, and stewardship Raymond et al. (2017), Andersson et al. (2014). Studies suggest that while policy frameworks increasingly acknowledge the role of ecosystems, community-level understanding of UES remains fragmented or limited, especially in fast-urbanising contexts

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McPhearson et al. (2016), Ernstson and Sörlin (2013). In India, urban expansion often results in ecological degradation, with wetlands, urban forests, and green spaces being systematically reduced to accommodate infrastructural growth Singh et al. (2022). Promoting public ecological literacy is essential in this scenario to foster greater civic engagement with sustainable urban development and climate resilience strategies.

Dwarka, a sub-city in the National Capital Territory of Delhi, offers a compelling case for examining public awareness of UES. Originally conceptualized as a planned urban expansion, Dwarka is now facing rapid densification, infrastructure stress, and ecological transformation, reflecting broader patterns across Indian cities. Despite a relatively high level of infrastructural development, public interaction with and perception of natural ecosystems remains underexplored. Understanding the local population's awareness of ecosystem services can thus illuminate gaps between urban planning objectives and lived environmental realities.

AIM AND OBJECTIVES

This study aims to evaluate public awareness of urban ecosystem services in Dwarka, specifically in the context of their role in climate change adaptation. Through a mixed-methods approach combining household surveys, interviews, and spatial mapping, it seeks to identify the socio-demographic and environmental factors that influence awareness levels. The research ultimately contributes to broader discussions on urban resilience, participatory planning, and the operationalization of nature-based solutions in emerging urban contexts.

STUDY AREA

The study area is Zone K-II (Dwarka Sub city) in Delhi. The Planning Zone K-II includes the Dwarka Sub-city and the area in between Bijwasan road and the National Capital Territory (NCT) of Delhi boundary and is bounded in east by Delhi Rewari railway line, on the south by National Capital Territory of Delhi boundary in the west by Najafgarh drain and in the north by Najafgarh road & Pankha road. Dwarka Sub-City, which is most of the area of zone K-II, was mainly planned as residential area to accommodate the extra population that was being attracted towards Delhi. The planning zone K-II of the Master Plan of Delhi (MPD) – 2021, with an area of 5924 hectares includes the Dwarka Sub-city and has been approved by the Central Government, on 8th March 2010. Institutions involved in planning and development of Dwarka are South Delhi Municipal Corporation (SDMC) & Delhi Development Authority (DDA).

Figure 1

Figure 1 Location of Dwarka
Source: Comprehensive Mobility Plan Dwarka (K-II Area)

LITERATURE STUDY

In urban environments, even modest green areas can deliver significant ecosystem services if they are thoughtfully designed. For instance, small wetlands can enhance urban water management by filtering pollutants and preventing floods, as noted by Pankratz et al. Additionally, green roofs can reduce the energy costs associated with heating and cooling buildings and mitigate stormwater runoff. These rooftops also contribute to local biodiversity, supporting not only the initial plantings but also attracting beetles, spiders, birds, and other plants that subsequently inhabit the area. Another crucial ecosystem service is the potential to improve air quality in cities. In the United States, urban trees remove 711,000 tons of air pollutants each year, which equates to an economic benefit of $3.8 billion. Expanding urban greenery can also capture significant amounts of carbon, potentially having a

greater impact on carbon budgets than trees located outside urban areas. Urban forests, including public parks and gardens, offer substantial recreational and relaxation benefits, which are often not reflected in market transactions and thus lack a market price. Consequently, these non-market benefits are frequently overlooked or undervalued by policymakers when considering urban development strategies.

MATERIALS AND METHODS

METHODOLOGY

The methodology for this paper was adopted as a mixed approach method which included the questionnaire survey, site visit and data collection from online and offline both the sources. The survey was designed to collect information on urban ecosystems, related policies and planning instruments. The survey was conducted to gather information from academicians, researchers, people working on the same domain and other stakeholders to gather different opinions and experiences. The goal of the survey was to understand people's awareness of the concept of ecosystem services and climate change. Indicators that can play an important role in developing comprehensive Eco-City indicators which can be evaluated and analyzed. This survey is aimed at different stakeholders involved in the process. Researchers developed a structured questionnaire, with a few open questions and with the option to add their existing knowledge and observation along the process of answering

- The questionnaire was divided into six sections:
- Section I – Basic information of the interviewee.
- Section II – Awareness of Urban Ecosystem Services.
- Section III – Perception of climate change Impact-related questions.
- Section IV-Role of Urban Ecosystem Services in Climate Change Adaptation.
- Section V- Implementation and Challenges in Urban Ecosystem Services.
- Section VI-Community Engagement and Future Actions.

The survey was administered through an online platform and was carried out voluntarily. Policymakers, stakeholders and researchers were invited through:

- E-mailing.
- Presentation of the initiative during conferences and seminars.
- Personal contacts.

SCOPE AND LIMITATION

Despite the increasing emphasis on talks about climate change and related issues. There is a lack of comprehensive studies focusing on the role of ecosystem services in climate change adaptation. Previous research has mostly focused on general indicators which are not focused specifically on the role of ecosystem services in climate change adaptation. The research scope is to examine how different urban ecosystems can be studied in an area and the importance of these urban ecosystem services. However, the study area chosen may provide some of the urban ecosystem services which have an impact on the micro level and may not apply to other areas or sites.

RESULTS AND DISCUSSIONS

DATA ANALYSIS

The researchers also assessed the level of awareness of people based on certain principles of urban eco system services. To accomplish this, the researchers drafted a formal survey questionnaire with questions relating to the individuals' perception towards urban eco system services. These questions addressed opinions about aesthetics, management, people's participation, willingness to pay and awareness of rules, laws and policies under governance.

Figure 2

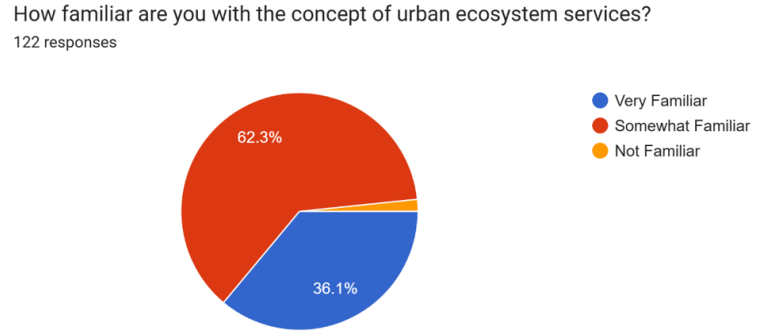

Figure 2 Understanding the Concept of Urban ESS
Source: Google Form Questionnaire by the Author

People in Delhi-NCR are familiar with the concept of urban ecosystem services. Most people know something about the urban ecosystem services, as something to do with green areas, but not exactly how it works overall as supporting and regulating climate change.

Figure 3

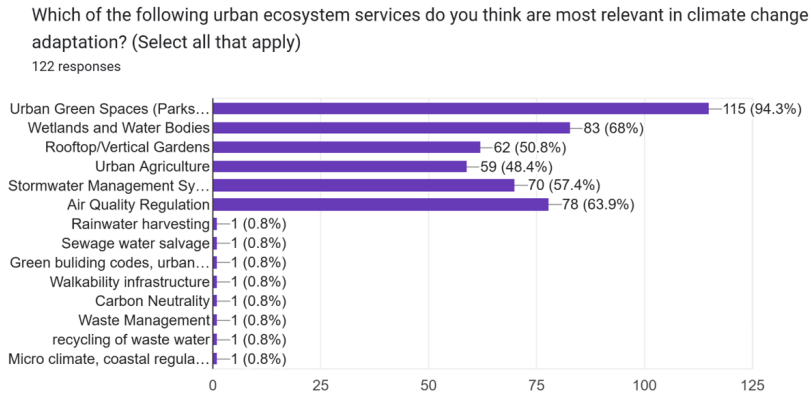

Figure 3 Most Relevant Urban ESS
Source: Google Form Questionnaire by the Author

Urban Green Spaces (Parks, Gardens, Trees), Wetlands and Water Bodies & Air Quality Regulation are the most relevant in climate change adaptation.

Figure 4

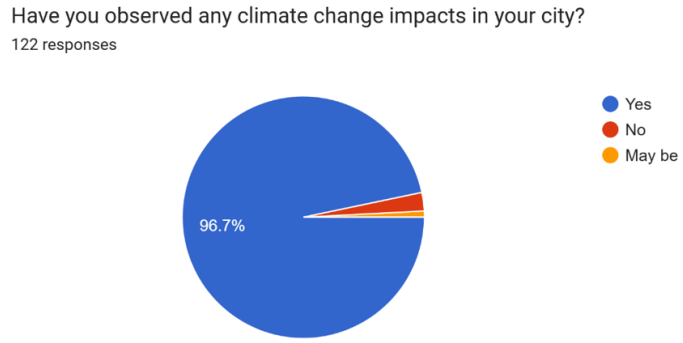

Figure 4 Climate Change Impact
Source: Google Form Questionnaire by the Author

The climate change impacts are very evident in Delhi NCR. Most of the people have answered yes for the observation in the climate change of Delhi

Figure 5

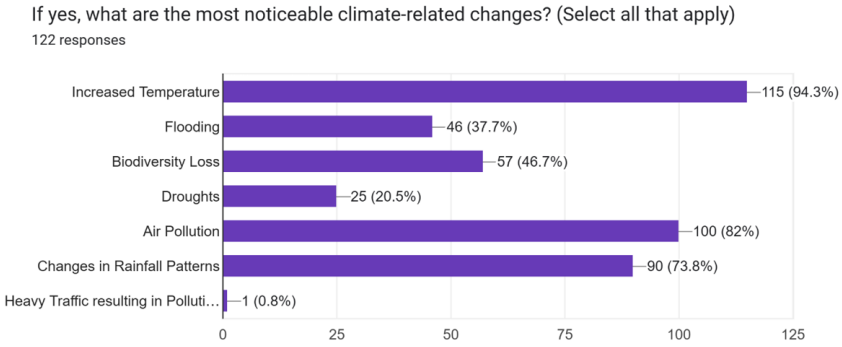

Figure 5 Most Noticeable Climate Related Change
Source: Google Form Questionnaire by the Author

Increased Temperature, Air Pollution & changes in Rainfall Patterns are the most commonly noticed changes due to climate change.

Figure 6

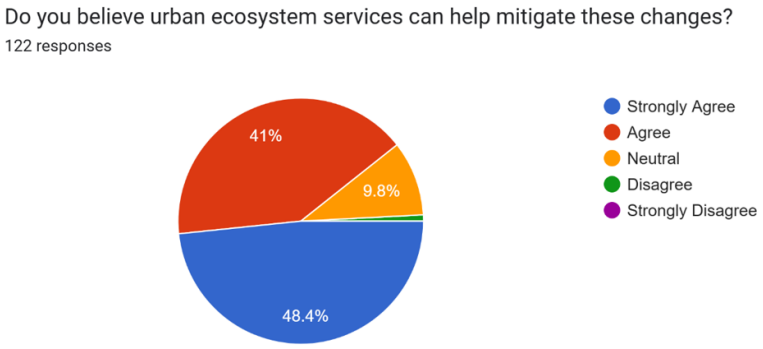

Figure 6 F Mitigation of Climate Change
Source: Google Form Questionnaire by the Author

Urban Ecosystem Services can play an important role in mitigating these changes.

Figure 7

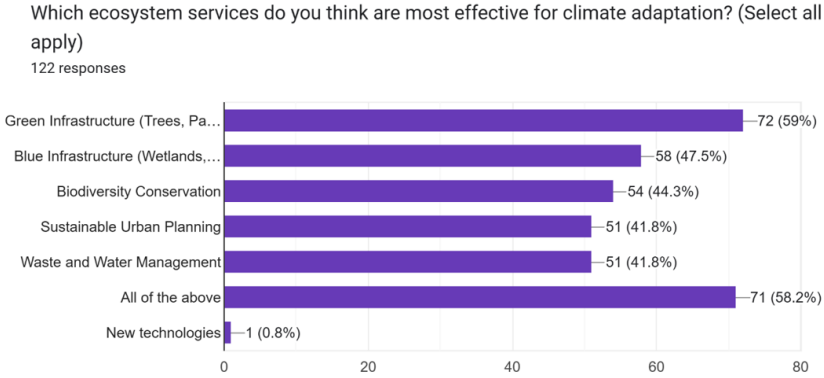

Figure 7 Role of Urban ESS in Mitigation of Climate Change
Source: Google Form Questionnaire by the Author

Green Infrastructure (Trees, Parks, Green Roofs), Blue Infrastructure (Wetlands, Lakes, Rivers), Biodiversity Conservation, Sustainable Urban Planning & Waste and Water Management all of these are effective measures for climate change adaptation.

Figure 8

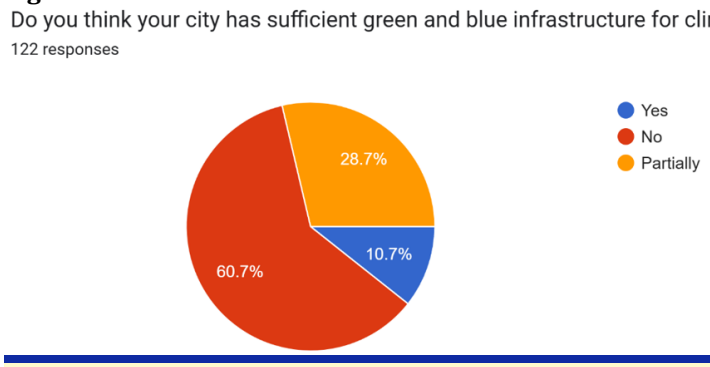

Figure 8 Sufficiency of Green & Blue Infrastructure
Source: Google Form Questionnaire by the Author

Most of the people don't think that Delhi has sufficient green and blue infrastructure for climate change adaptation.

Figure 9

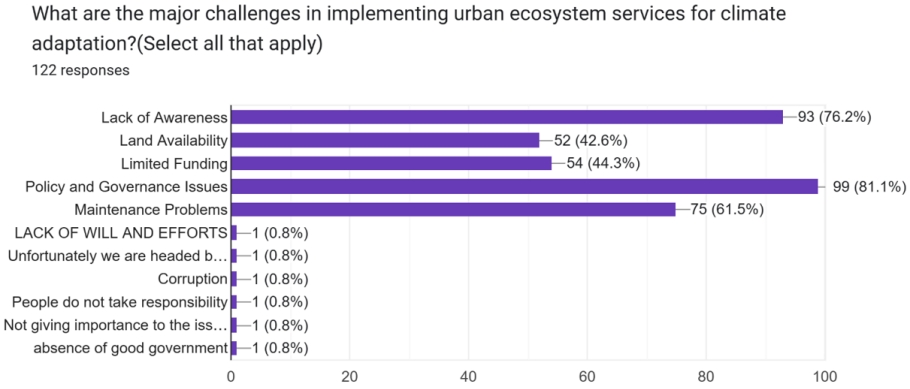

Figure 9 Challenges in Implementing Urban ESS
Source: Google Form Questionnaire by the Author

Major challenges in implementing urban ecosystem services for climate change adaptation are as follows: lack of awareness, maintenance problems and policy and governance issues.

Figure 10

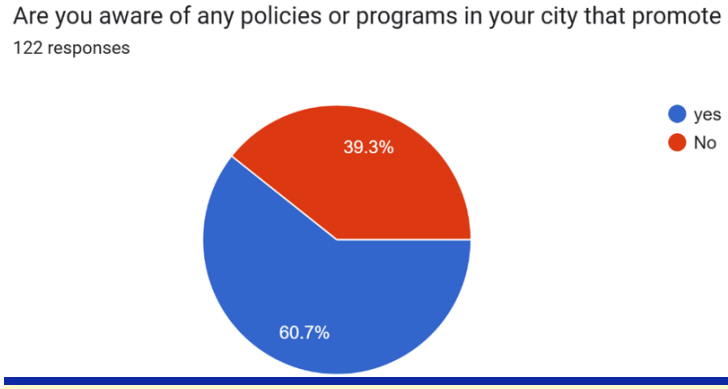

Figure 10 Awareness About Programs
Source: Google Form Questionnaire by the Author

Since the survey has been conducted with all the stakeholders, mostly the people working in this field or the allied fields know about this, but the common people don't have in-depth knowledge.

Figure 11

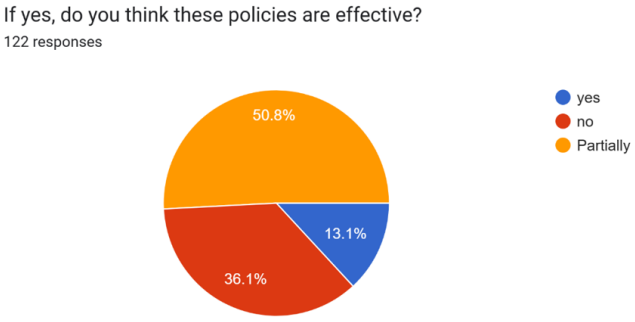

Figure 11 Effectiveness of Policies

Source: Google Form Questionnaire by the Author

Most people think that the policies are partially effective.

Figure 12

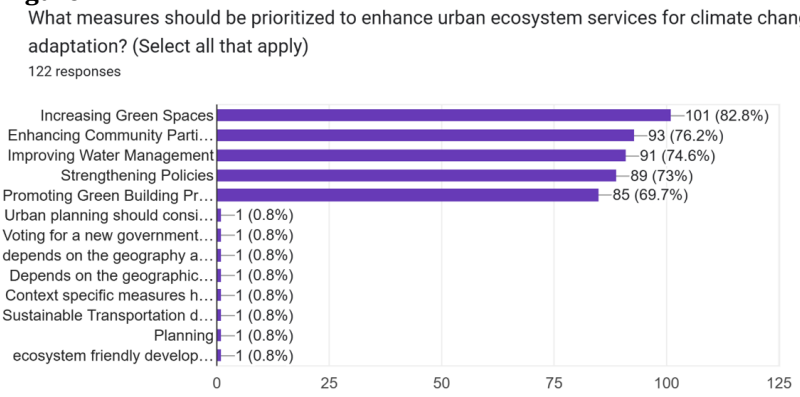

Figure 12 Measures for Enhancing urban ESS

Source: Google Form Questionnaire by the Author

Increasing Green Spaces, Enhancing Community Participation, Improving Water Management, Strengthening Policies & Promoting Green Building Practices measures should be prioritised to enhance urban ecosystem services.

Figure 13

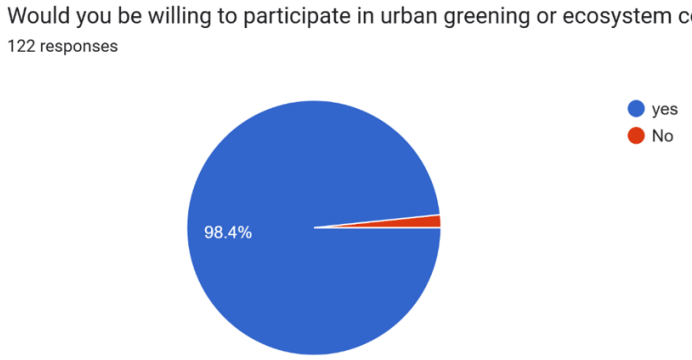

Figure 13 Initiatives for Conserving Urban ESS

Source: Google Form Questionnaire by the Author

Most people want to participate in urban greening or ecosystem conservation initiatives.

Figure 14

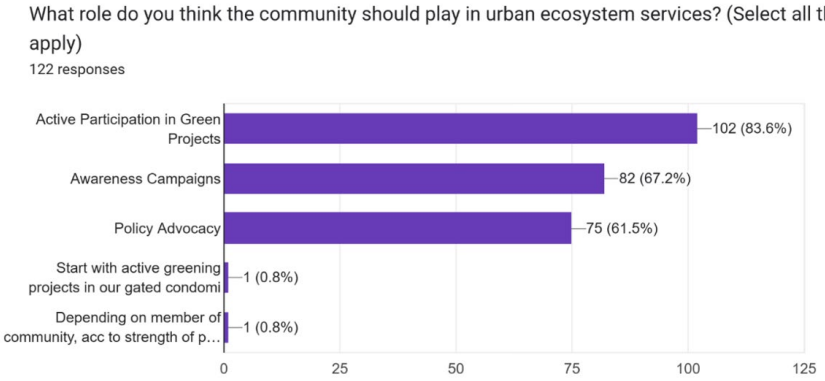

Figure 14 Role of Community in Urban ESS
Source: Google Form Questionnaire by the Author

Active Participation in Green projects, Awareness campaigns & policy advocacy are the areas in which the community should play in urban ecosystem services.

CONCLUSION

Ecosystem services in urban areas are well known, and most people know the basic concept of urban greens but don't know the details of urban ecosystem services. Most of the people understand the urban greens (parks, forests, landscaping areas) and urban blues as ecosystem services. The difficulty of defining what constitutes an ecosystem becomes particularly evident in urban environments. Yet, the gradual continuum between natural and human influences—which shapes the potential for ecosystem services—is a challenge present across all types of environments, not just urban ones.

Climate change is very evident, and most of the respondents know about this. In case of Delhi the climate change is most visible in terms of increased temperature, air pollution & changes in rainfall patterns are the most noticed changes due to climate change. The urban ecosystem services will impact climate change and help to mitigate this climate change. This is also a known fact for most of the respondents. Most of the respondents think that Green Infrastructure (Trees, Parks, Green Roofs), Blue Infrastructure (Wetlands, Lakes, Rivers), Biodiversity Conservation, Sustainable Urban Planning & Waste and Water Management all of these are effective measures for climate change adaptation. But there is a lack of green and blue infrastructure in Delhi as a city to provide enough urban eco system services.Major challenges in implementing urban ecosystem services for climate change adaptation are as follows: lack of awareness, maintenance problems and policy and governance issues. The major challenge from a conceptual perspective, existing ecosystem service frameworks can indeed be applied to natural, managed, constructed, and heavily modified systems. However, when dealing with urban ecosystems, it is crucial to incorporate the roles of human intervention, modification, and the current ecological status. There is a pressing need to clarify how key terms—such as "ecosystem," "urban," and "nature"—are defined and interpreted within these frameworks. From a methodological standpoint, ensuring comparability between different ecosystem service assessments requires greater transparency. This includes making explicit the theoretical foundations (such as normative assumptions and conceptual relationships), as well as the practical considerations (such as data limitations and methodological constraints) and their implications.

Increasing Green Spaces, Enhancing Community Participation, Improving Water Management, Strengthening Policies & Promoting Green Building Practices measures should be prioritised to enhance urban ecosystem services. Since the survey has been conducted with all the stakeholders, mostly the people working in this field or the allied fields know about this, but the common people don't have in-depth knowledge. Moreover, there is a strong need for more case studies involving modified ecosystems. These studies can deepen our understanding of the mechanisms that shape ecosystem service bundles and trade-offs. Identifying the barriers that disrupt ecosystem connectivity can also guide planning efforts—such as the development of green infrastructure and nature-based solutions. Most people want to participate in urban greening or ecosystem conservation initiatives Overall, advancing research in this field demands comprehensive approaches that integrate multiple ecosystem services, ecosystem conditions, and degrees of human input and modification. One of the key challenges ahead lies in identifying thresholds related to the extent of human influence and the self-organizing capacity of ecosystems. Addressing this will be crucial to enabling a more integrated analysis of ecosystem services across varied environmental contexts.

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