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Assessing Public Awareness and Willingness to Support Green Infrastructure: A Survey of New Delhi's Sponge City Initiatives

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Abstract

This study explores public awareness and attitudes toward adopting green infrastructure (GI) for Sponge City implementation in New Delhi, India. A primary survey was conducted with 300 respondents to assess their knowledge, perceptions, and willingness to support Green Infrastructure practices, such as permeable pavements, green roofs, and rainwater harvesting. The study examines the role of socioeconomic factors including education level, homeownership, flooding experience, and income in shaping preferences for ecosystem services, such as flood mitigation, water quality, biodiversity enhancement, and recreational spaces. To analyze the survey data, descriptive statistics, Pearson's correlation, and binary logistic regression were employed. The results indicate that respondents with higher educational attainment and homeownership were more likely to support green infrastructure projects, while those with flooding experience showed a stronger preference for flood mitigation services. Additionally, the study explores factors influencing respondents' willingness to invest in green bonds for financing such initiatives. The findings suggest that education and community engagement are key to enhancing public support for Sponge City initiatives in New Delhi. Policy recommendations are provided to promote green infrastructure adoption through targeted educational campaigns, financial incentives, and inclusive planning processes.

Keywords: Green Infrastructure (GI), Sponge City, Stormwater Management, Public Awareness, Sustainable Urban Development, Flood Mitigation, Green Bonds.

Introduction

Urbanization, combined with climate change, has significantly altered the dynamics of water management in cities worldwide. As urban populations grow and environmental conditions worsen, cities face increasing challenges related to flooding, water scarcity, and overall environmental degradation. In this context, urban green infrastructure (GI) has emerged as an innovative and sustainable solution to address these issues. Particularly, the concept of Sponge Cities has garnered attention as an effective strategy for managing stormwater, reducing urban flooding, and promoting environmental sustainability. Green infrastructure solutions, such as permeable pavements, green roofs, and rainwater harvesting, offer natural, cost-effective methods for managing stormwater while simultaneously enhancing biodiversity and public well-being.

Urban green infrastructure has become a key strategy in tackling the issues brought about by rapid urbanization. Traditional grey infrastructure, such as drainage systems, has shown limitations in addressing modern urban challenges like flooding, water scarcity, and environmental degradation (Luo et al., 2022; Ravanashree et al., 2024). Green infrastructure offers an alternative approach by integrating nature-based solutions into urban settings, which helps manage stormwater, enhances biodiversity, and improves the quality of life for residents. One prominent example of this approach is the concept of Sponge Cities, which was first introduced in China in 2012.

Sponge Cities focus on restoring the natural water cycle by using permeable surfaces, rain gardens, and wetlands to absorb, store, and filter rainwater. This methodology not only helps mitigate flooding but also reduces runoff and promotes groundwater recharge (Shi et al., 2024). Notable cities like Xi'an and Xixian New District have successfully implemented Sponge City principles, showcasing their effectiveness in managing urban flooding and improving environmental conditions (Luo et al., 2022).

The success of green infrastructure projects, including Sponge City implementations, is closely tied to public acceptance and engagement. Research indicates that public support for these projects depends on their understanding of the benefits and their willingness to invest in them. In the UK's Oxford-Cambridge Arc, for instance, public backing for GI projects was linked to the proposed funding mechanisms, with residents favoring developer contributions over direct financial involvement (Steadman et al., 2024). In China, studies on Sponge City stormwater management found that residents were open to contributing to GI projects, especially through mechanisms like stormwater fees and green bonds (Shi et al., 2024). These examples highlight the importance of public involvement and trust in the successful implementation of green infrastructure solutions.

Additionally, effective policy design and the participation of a broad range of stakeholders, including local governments, developers, and the public, are crucial for the implementation of green infrastructure. Public trust in local authorities plays a significant role in the willingness to support funding mechanisms for GI projects (Steadman et al., 2024). Involving communities in decision-making processes can foster a sense of ownership, increasing the likelihood of continued support and successful long-term adoption (Jones & Russo, 2024). This participatory approach aligns with the need for a more inclusive and collaborative urban planning model that takes both environmental and social goals into account.

For rapidly growing cities like New Delhi, the need for sustainable urban water management solutions is becoming increasingly urgent. With its sprawling urban landscape, inadequate drainage systems, and vulnerability to extreme weather events, New Delhi faces considerable challenges. These include urban flooding, water scarcity, and the worsening effects of climate change, making it an ideal candidate for the implementation of Sponge City strategies. The Indian government has implemented several initiatives aimed at protecting ecosystems. The National Urban Green Policy focuses on expanding and preserving green spaces in cities (Govindarajulu, 2014). Similarly, the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) seek to increase urban greenery and foster sustainable infrastructure (Biswas et al., 2024). The Smart Cities Mission also integrates green and blue infrastructure planning to build climate resilience (García Sánchez & Govindarajulu, 2023). Additionally, the National Green Tribunal (NGT) plays a critical role in enforcing environmental regulations and safeguarding green spaces (Tripathi & Sinha, 2024). These efforts have resulted in urban afforestation, improved air quality, and better ecosystem management (Bhadwal & Kumar, 2025). However, the success of these strategies hinges on public awareness and acceptance. Understanding the local public's perceptions of green infrastructure and their willingness to engage with such systems is essential for overcoming barriers to adoption and fostering long-term sustainability.

Research has shown that public awareness plays a central role in the effectiveness of Sponge City initiatives. In New Delhi, a city heavily impacted by both flooding and water shortages, increasing public awareness about the benefits of green infrastructure could lead to higher levels of community involvement and stronger backing for these solutions. Similar to the success seen in Xi'an, where educational campaigns raised public satisfaction with Sponge City designs, public education is crucial for creating a supportive environment for green infrastructure projects (Luo et al., 2022; Shi et al., 2024).

The rapid urbanization of New Delhi presents both challenges and opportunities for implementing green infrastructure. Unplanned land use and the fast-paced development of infrastructure often leave limited room for green spaces, which complicates the integration of GI systems (Sen & Guchhait, 2021). Additionally, the complexity of urban GI systems—ranging from flood mitigation to biodiversity enhancement—requires interdisciplinary collaboration and public understanding for successful implementation (Lampinen et al., 2023).

Nonetheless, as cities like New Delhi become more aware of the social, economic, and environmental benefits of green infrastructure, there is potential for more innovative solutions to emerge. For example, green projects such as the development of greenscapes along the Yamuna floodplain highlight a shift towards more sustainable urban planning approaches (Ravanashree et al., 2024).

While the literature on green infrastructure and Sponge Cities has mostly concentrated on engineering and technical solutions, there remains a gap in understanding the human aspects of these initiatives, particularly public perception and behavior (Gao et al., 2018; Venkataramanan et al., 2020). Sponge City Green Infrastructure (SCGI) solutions typically provide significant ecological and societal benefits, such as enhancing air and water quality, improving biodiversity, restoring groundwater infiltration, and mitigating urban heat island effects (BenDor et al., 2018; Nowogoński, 2021; Peng et al., 2020). However, these benefits, which directly impact public life, are often not well recognized by residents. Public awareness and acceptance of these benefits are crucial for effective implementation, as higher recognition typically leads to more positive engagement with SCGI initiatives (Gao et al., 2016).

Securing financial resources for large-scale SCGI projects also presents a significant challenge, with successful funding mechanisms being essential to scaling these projects. In countries like the USA, Australia, and Brazil, policies that collect fees for stormwater management infrastructure provide models for funding SCGI projects (Kea et al., 2016; Porse et al., 2022). Research has also explored residents' willingness to pay for GI programs, but much of this literature focuses on specific infrastructural components, rather than on the broader ecosystem services provided by SCGI (Cristiano et al., 2023).

This gap highlights the need for more research on how regional socio-economic factors and other elements influence public perceptions and preferences regarding SCGI. Understanding these factors, along with public willingness to invest in such initiatives, is critical for the successful adoption of green infrastructure solutions (Chou, 2016; Ureta et al., 2021).

Despite the growing body of literature on green infrastructure and Sponge Cities, there remains a limited understanding of the public's perception of SCGI benefits. While much of the existing research has focused on the technical and engineering aspects of SCGI, there is a noticeable gap in studies examining how residents value and understand the ecosystem services provided by these initiatives.

Additionally, while previous studies have explored willingness to pay for green infrastructure, few have investigated the socio-economic and demographic factors that shape public attitudes and behaviors toward SCGI, particularly in rapidly urbanizing regions like New Delhi. This study aims to address these gaps by exploring how regional socio-economic factors influence residents' perceptions and preferences for SCGI and by examining different financial compensation strategies for supporting sustainable stormwater management. These insights will provide valuable information for policymakers and urban planners, helping to foster a more informed, engaged public that can contribute to the creation of sustainable, resilient cities.

2. Materials and methods

2.1. The study design

This study adopts a cross-sectional survey design to assess public awareness, perceptions, and willingness to adopt green infrastructure solutions for Sponge City implementation in New Delhi, India. The design allows for a snapshot of public opinion and attitudes at a single point in time, facilitating the collection of data on factors such as socio-economic status, environmental awareness, and support for nature-based solutions. The use of a survey questionnaire ensures that a wide range of opinions can be captured from various demographics within the city.

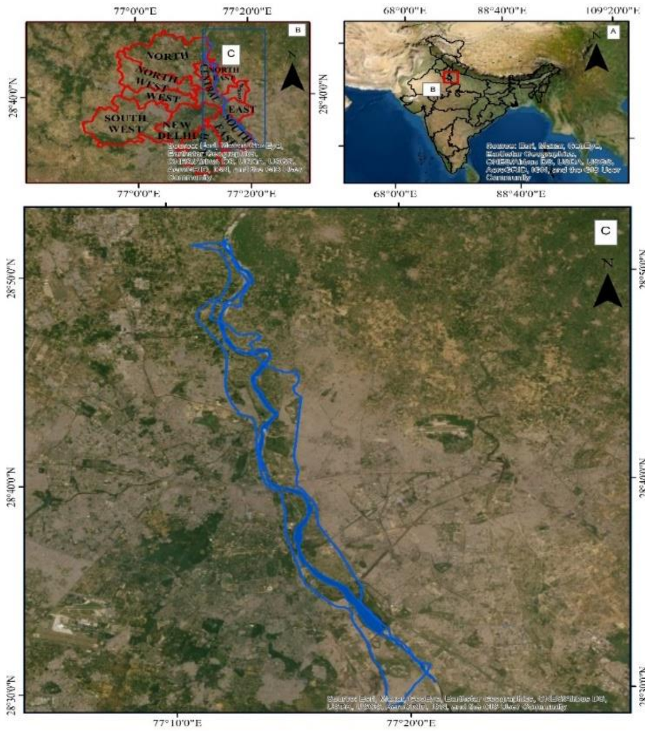
2.2. The study area:

Delhi, or the National Capital Territory (NCT) of India, is a large metropolitan area and megacity in India. Delhi is the fifth most populous city in the world and the largest city in India area-wise. Delhi has a rapidly growing population, which was estimated at 18.6 million in 2016 and had nearly doubled to an estimated 34.6 million by 2025.

It covers a large area, totalling around 1,484 square kilometers. The city has a population density of 29,259.12 people per square mile, which is one of the highest in the world (Figure 1). This sprawling metropolis is characterized by dense populations, inadequate drainage systems, and vulnerability to extreme weather events, such as heavy rainfall and heat waves, exacerbated by climate change. The city has been experiencing floods of various magnitudes in the past due to floods in the Yamuna and the Najafgarh Drain system.

The Yamuna crossed its danger level (fixed at 204.83m) twenty-five times during the last 33 years. The city saw a significant 49% rise in the number of critical waterlogging locations in 2023 compared to the previous year, shows data provided by Delhi Traffic Ploic to Delhi Govt. The past few years reveal a consistently upward trend. In 2020, there were 136 such spot, which increased to 195 in 2021 and 207 in 20222 and 308 in 2023 (Rajput, 2024). New Delhi faces major environmental challenges, including flooding, water scarcity, and pollution, which make it an ideal candidate for the implementation of green infrastructure solutions like Sponge Cities.

Figure 1



Source: *Tomar et al., 2021* ***(****Study area map Delhi NCT (National Capital Territory)* ***(B)*** *with respect to India* ***(A)****, and floodplain of NCT Delhi* ***(C)****).*

2.3. Questionnaire design

The questionnaire was structured in four main sections, drawing from the format used by Shi et al. (2024) in their study. The first section gathered socio-economic data from respondents, including gender, age, education level, employment status, household income, homeownership in the area, and previous experiences with property damage due to flooding or waterlogging. This demographic information provides essential context for analyzing public attitudes and behaviors toward green infrastructure.

The second section focused on assessing respondents' awareness and preferences regarding green infrastructure, specifically the Sponge City Stormwater Management (SCSM). It included questions on respondents' familiarity with the SCSM and their perception of the ecosystem services provided by Sponge City Green Infrastructure (SCGI), such as stormwater retention and biodiversity enhancement.

The third section, the survey explored respondents' willingness to invest in the construction of Sponge Cities, focusing on three different forms of investment: public investment and purchase of green bonds. The questions aimed to assess public support for government-funded projects, interest in green bonds (special bonds designed to raise funds for environmental protection and sustainable development). These multidimensional investment methods were included to understand how different financial approaches could be leveraged for Sponge City construction.

2.4 Sample size justification:

The sample size of 300 respondents was selected based on statistical considerations to ensure the results are representative of New Delhi's population and to achieve a high level of confidence in the findings. The sample size calculation for this study is based on the formula for estimating sample size for proportions:

$$n = \frac{Z^2 \cdot p(1-p)}{E^2}$$

Where:

n= required sample size

Z= Z-value (1.96 for a 95% confidence level)

p= estimated proportion (0.5 for maximum variability)

E= margin of error (0.05)

Substituting these values:

$$n = \frac{1.96^2 \cdot 0.5(1-0.5)}{0.05^2} = 384.16$$

To account for non-responses and incomplete data, the sample size was rounded up to 300 respondents, ensuring robust results and a margin of error of 5%.

2.5. Data collection:

Data collection was conducted through both face-to-face surveys and online questionnaires to maximize reach and diversity. The face-to-face surveys were carried out in various public areas across New Delhi, including parks, and community centers, to capture opinions from different regions of the city. The online survey was shared through social media, community groups, and email lists to further extend the reach. Data collection was conducted over three months, with the aim of ensuring equal representation of respondents from different socio-economic backgrounds and geographic areas.

2.6: Data analysis:

Data analysis in this study involved both descriptive statistics and statistical evaluation, using binary logistic regression model, chi-square tests and Pearson's correlation. The survey collected 300 responses, which were meticulously compiled, organized, and analyzed following the methodology outlined by Shi et al. (2024) in their study.

To assess the relationships between socio-economic factors and perceived knowledge of stormwater management, the chi-square test was employed. A significance threshold of $p < 0.05$ was applied to interpret the results.

In addition, Pearson's correlation was utilized to examine the relationships between continuous or ordinal socio-economic variables and respondents' preferences for ecosystem service benefits provided by green infrastructure. This test is ideal for identifying the strength and direction of associations between variables measured on an interval or ratio scale.

For analysing respondents' investment decisions, which were recorded as dichotomous variables (YES = 1, NO = 0), we applied a binary logistic regression model. This model is well-suited for analysing choices that involve binary outcomes and integrates concepts from utility maximization models and psychological choice behaviour. The binary logistic regression model was selected to assess respondents' willingness to invest in Green Infrastructure initiatives, with investment decisions treated as a binary outcome. Shi et al. (2024)

The model is defined by the following equations:

$$\text{Logit}[P(Y=1)] = \log\left(\frac{P(Y=1)}{1-P(Y=1)}\right)$$

$$P(Y=1) = \frac{e^{(\beta_0+\beta_1 x_1+\cdots+\beta_n x_n)}}{1+e^{(\beta_0+\beta_1 x_1+\cdots+\beta_n x_n)}}$$

In these equations:

β_0 is the intercept.

$\beta_1, \beta_2, \dots, \beta_n$ are the regression coefficients for each independent variable.

$Y = 1$ indicates a positive willingness to invest response (YES), while $Y = 0$ represents refusal to invest (NO).

P represents the probability of willingness to invest, and the odds ratio (OR) quantifies the relationship between explanatory variables and the dependent variable. The odds ratio is defined as the ratio of the probability of an event occurring (willingness to invest) to the probability of it not occurring.

The binary logistic regression model thus helped quantify the influence of various socio-economic factors and awareness levels on the respondents' willingness to support Sponge City initiatives through different investment strategies.

3. Result and Discussion

3.1 Demographic Details of the Participants

The demographic table:1 presents a comprehensive overview of the key socioeconomic characteristics of 300 respondents from New Delhi, India, offering valuable context for understanding the factors that may influence preferences for ecosystem service benefits. The sample includes respondents from various demographic backgrounds, including gender, age, educational attainment, employment status, household income, homeownership status, and experience with flooding or waterlogging.

These characteristics are particularly pertinent in examining the relationship between socioeconomic variables and the willingness to support or invest in environmental initiatives.In terms of gender, the sample consists of 49% male and 51% female respondents, ensuring balanced representation across genders. This distribution enhances the generalizability of the findings to the broader population of New Delhi, allowing for a more inclusive exploration of how gender may intersect with other socioeconomic factors in shaping preferences for ecosystem services. This balanced representation is critical, as gender has been identified in previous research as a factor influencing environmental attitudes and behaviors (Gökmen, 2021).

Table: 1 Demographic Breakdown of Survey Participants

Demographic Characteristic	Category	Frequency	Percentage (%)
Gender	Male	147	49%
	Female	153	51%
Age	18–35	96	32%
	36–45	81	27%
	46 and above	123	41%
Level of Education	High School	57	19%
	Intermediate	87	29%
	Graduate/post-graduate	108	36%
	Higher Education	48	16%
Employment Status	Employed Full-Time	144	48%
	Employed Part-Time	54	18%
	Unemployed	42	14%
	Student	36	12%
	Retired	24	8%
Monthly Household Income	₹30,000 - ₹59,999	90	30%
	₹60,000 - ₹79,999	72	24%
	Above ₹80,000	138	46%
Homeownership	Yes	174	58%
	No	126	42%
Flooding or Waterlogging Experience	Yes	126	42%
	No	174	58%

Source: computed by the author

The age distribution shows that the largest proportion of respondents falls within the 46 and above category (41%), followed by those in the 18–35 (32%) and 36–45 (27%) groups. This age distribution is reflective of New Delhi's demographic composition, where the working-age population is concentrated in the 18–45 age group, while the older population holds significant socio-political and economic influence. Age has been shown to impact environmental consciousness and preferences for sustainable practices, with older individuals often demonstrating higher levels of concern for long-term environmental impacts (Bord, O'Connor, & Fisher, 2000). With respect to education level, 36% of the respondents hold graduate/post-graduate degrees, followed by those with intermediate (29%) and high school education (19%). This education distribution aligns with New Delhi's relatively high literacy rate and the growing emphasis on higher education within the urban middle and upper-middle classes. Higher educational attainment is frequently linked to greater awareness of environmental issues and a higher likelihood of engaging with policies or investments that promote sustainability Therefore, the sample's educational profile suggests that respondents with higher education levels may be more inclined to value ecosystem services that enhance environmental quality.

Regarding employment status, 48% of respondents are employed full-time, while 18% are employed part-time. A smaller portion of the sample is unemployed (14%) or retired (8%), with students comprising 12% of the sample. This distribution reflects the diverse economic backgrounds of the respondents, with employed individuals likely having more disposable income and a greater capacity to engage in sustainable investments or behaviors. Full-time employment, in particular, has been found to influence individuals' financial stability and their ability to prioritize environmental investments (Rashed & Shah, 2020). The monthly household income category shows that 46% of respondents earn above ₹80,000, with 30% earning ₹30,000 - ₹59,999, and 24% falling within the ₹60,000 - ₹79,999 bracket. This income distribution reflects New Delhi's substantial middle and upper-middle class, which plays a central role in shaping consumer preferences and willingness to invest in sustainable and green financial products. Higher-income households are often more likely to engage in environmentally responsible behaviors and support public investments aimed at improving environmental sustainability, such as investing in green bonds or supporting flood mitigation initiatives

In terms of homeownership, 58% of respondents own their homes, a factor that significantly influences preferences for public investments in infrastructure and environmental services. Homeowners typically exhibit a stronger interest in services that enhance their immediate living environment, including flood mitigation and biodiversity conservation, as these services directly affect property values and long-term quality of life

(Nojedehi et al., 2025) This finding underscores the importance of homeownership as a key determinant of environmental attitudes and behaviors in urban settings.

Finally, flooding or waterlogging experience is a critical factor in the study, with 42% of respondents reporting direct experience with these issues. Given the increasing frequency of urban flooding in New Delhi, particularly in low-lying areas, this experience likely shapes individuals' views on the importance of flood mitigation and related ecosystem services. Research has consistently shown that individuals with direct experience of environmental hazards are more likely to support policies and initiatives aimed at mitigating those risks

3.2 Relationships Between Socio-Demographic and Socioeconomic Factors and Awareness of Sponge City Stormwater Management (SCSM)

The table: 2 presents the results of a chi-squared analysis examining the relationships between socio-demographic and socioeconomic factors and awareness of or experiences with the Sponge City Stormwater Management (SCSM) concept. The analysis reveals that several variables, including gender, age, education level, employment status, monthly household income, homeownership, and prior experiences with flooding or waterlogging, significantly influence individuals' engagement with SCSM.

First, gender was found to have a statistically significant association with SCSM awareness, as indicated by a chi-squared value of 4.00 (p = 0.046). This suggests that awareness of stormwater management may vary between genders, with one gender potentially exhibiting greater concern or awareness. Age also showed a significant relationship ($\chi^2 = 13.52$, p = 0.02), indicating that individuals of different age groups demonstrate varying levels of awareness or concern regarding SCSM, with older individuals possibly being more aware of the concept.

Table: 2 Results of Chi-squared test

Socio-Demographic Variable	Chi-Squared Value (χ^2)	P-value
Gender	4.00	0.046 *
Age	13.52	0.02 **
Education Level	20.55	0.001 **
Employment Status	6.88	0.076 *
Monthly Household Income	8.20	0.04 *
Homeownership	6.40	0.011 **
Flooding or Waterlogging Experience	10.33	0.001 **

Significance levels: *p <1%, **p<5%, Source: computed by the author

Education level was another significant factor (χ^2 = 20.55, p = 0.001), highlighting that individuals with higher educational attainment are more likely to be aware of or engaged with SCSM initiatives. This is consistent with the literature suggesting that education fosters a greater understanding of environmental issues. Employment status, though marginally significant (χ^2 = 6.88, p = 0.076), suggests that employment may influence individuals' involvement in stormwater management, likely due to differences in income and time availability.

Similarly, monthly household income (χ^2 = 8.20, p = 0.04) was significantly related to SCSM awareness, with individuals from higher-income households being more likely to exhibit awareness or engagement in such initiatives. Homeownership (χ^2 = 6.40, p = 0.011) also emerged as a significant predictor, likely reflecting the direct interest of homeowners in flood-related issues and their involvement in long-term solutions like stormwater management.

Finally, previous experiences with flooding or waterlogging were strongly associated with SCSM awareness (χ^2 = 10.33, p = 0.001). This finding aligns with expectations, as individuals who have directly experienced flooding or waterlogging are more likely to be aware of and concerned about measures aimed at mitigating these issues.

The results indicate that demographic and socioeconomic factors such as education, age, income, homeownership, and personal experiences with flooding significantly influence awareness of SCSM. These findings suggest that interventions aimed at promoting stormwater management should be tailored to these socio-demographic factors, ensuring that the most affected and engaged populations are effectively reached.

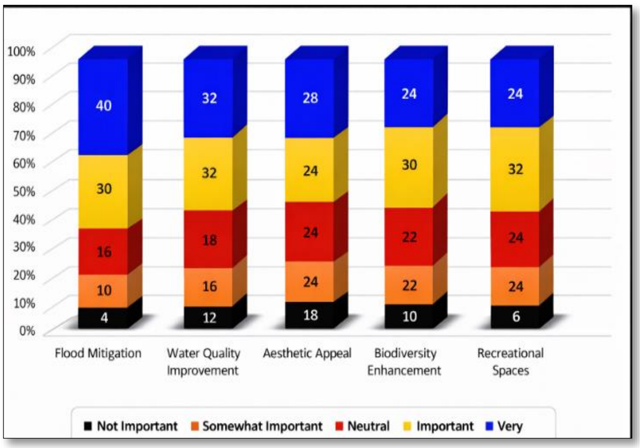
3.3 Public Perception of Ecosystem Services Provided by Sponge City Green Infrastructure (SCGI)

The Figure:2 provides an overview of New Delhi respondents' perceptions regarding the importance of various ecosystem services that could be potentially provided by Sponge City Green Infrastructure (SCGI). The table categorizes responses across five ecosystem services: flood mitigation, water quality improvement, aesthetic appeal, biodiversity enhancement, and recreational spaces. Respondents were asked to evaluate the importance of each service on a four-point scale, ranging from "Not Important" to "Very Important."

The results reveal that flood mitigation is regarded as the most important ecosystem service that could be provided by SCGI, with 40% of respondents indicating that it is "Very Important" and an additional 40% rating it as "Important." This underscores the critical role of flood management in New Delhi, particularly in the context of increasingly frequent extreme weather events and urban flooding. The high level of importance placed on flood mitigation aligns with global trends, where flood control is prioritized in urban resilience strategies.

Water quality improvement is the second most valued service, with 32% of respondents considering it "Very Important" and 42% viewing it as "Important." Given the growing concerns about water pollution and the need for sustainable water management practices in New Delhi, this high level of importance reflects public awareness of the potential benefits of SCGI in enhancing water quality, particularly in urban settings where contamination of water resources is a significant challenge.

Figure: 2 Ecosystem Services provided by Sponge City Green Infrastructure



Source: Graph plotted by the Author.

Aesthetic appeal ranks third in terms of importance, with 27% of respondents rating it as "Very Important" and 34% as "Important." This highlights the role that SCGI could play in enhancing New Delhi's urban landscapes, not only for environmental but also for social and psychological well-being. The aesthetic benefits of green infrastructure could contribute to making urban spaces more livable, fostering a sense of place and improving the quality of life for residents.

Biodiversity enhancement is similarly valued, with 24% of respondents deeming it "Very Important" and 44% considering it "Important." This indicates that a significant portion of the population recognizes the potential of SCGI to support biodiversity in New Delhi's urban environments. The preservation and promotion of urban biodiversity are increasingly seen as essential for ecological health, contributing to ecosystem stability and resilience.

Recreational spaces are considered important by a majority, with 46% of respondents rating it as "Important" and 24% as "Very Important." These findings emphasize the importance of integrating green spaces into New Delhi's urban planning to provide recreational areas for residents, which are essential for promoting physical and mental well-being in densely populated cities.

The data highlights a strong public preference for ecosystem services that address both environmental and social concerns. Flood mitigation and water quality improvement, in particular, were rated as crucial, reflecting the increasing awareness of climate change and its impacts on urban infrastructure. These findings suggest that there is considerable public support for the potential benefits of SCGI in New Delhi, with residents recognizing its multifaceted advantages in creating sustainable, resilient, and livable urban environments.

3.4 Correlation between various socioeconomic variables and the preference for ecosystem service benefits

The heatmap provides a visual representation of the correlation between various socioeconomic variables and the preference for ecosystem service benefits in New Delhi. The independent socioeconomic variables include gender, age, education level, employment status, monthly household income, homeownership, and flooding or waterlogging experience, while the dependent variables are flood mitigation, water quality, aesthetic appeal, biodiversity enhancement, and recreational spaces.

From the heatmap, it is evident that certain socioeconomic factors are more strongly associated with preferences for specific ecosystem services. For instance, flood mitigation and biodiversity enhancement exhibit stronger positive correlations with flooding or waterlogging experience and homeownership. This suggests that individuals with firsthand experience of flooding or those who own homes are more likely to prioritize these services. This finding aligns with the understanding that personal experience with environmental challenges, such as flooding, fosters a greater appreciation for services that mitigate these challenges or support ecological sustainability.

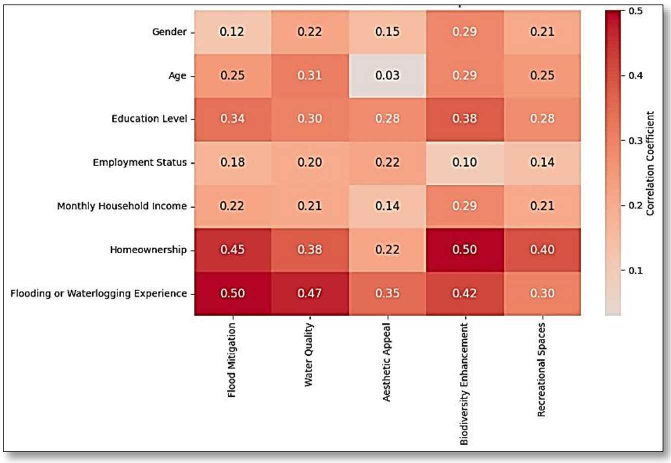
Water quality shows a moderate positive correlation with education level and homeownership, indicating that individuals with higher education or homeownership tend to place a higher value on water quality. This may reflect a broader awareness of the environmental and health impacts of poor water quality. Similarly, both aesthetic appeal and recreational spaces demonstrate positive correlations with monthly household income and homeownership. This could suggest that wealthier individuals and homeowners are more likely to value these services, potentially due to their ability to invest in improving their living environments or access to green spaces.

In contrast, age and gender show relatively weaker correlations with ecosystem service preferences. While these factors may still play a role in shaping preferences, they appear to be less influential than factors such as homeownership or flooding experience. Overall, the heatmap highlights the complex relationships between socioeconomic characteristics and preferences for ecosystem services, underscoring the importance of demographic and socio-economic factors in shaping public attitudes toward environmental policies and investments. Understanding these correlations can help guide more targeted and effective interventions in urban planning and sustainability efforts.

3.5 Binary Logistic Regression Results for Willingness to Support Public Investment in New Delhi

In Table 3: level of education emerged as a significant factor, particularly for individuals with higher education levels (graduate/post-graduate and higher education), who demonstrated an increased likelihood of supporting public investment (OR = 3.078, $p = 0.006$). This finding aligns with research indicating that education is a key determinant of support for public policy and investment decisions (Barman, B. 2023). Monthly household income categories did not show statistically significant results ($p > 0.05$), indicating that income level may not play a major role in the decision to support public investment in this context. However, homeownership was a strong predictor of willingness to support public investment (OR = 79.072, $p < 0.001$), suggesting that homeowners are significantly more likely to support investments in infrastructure and environmental initiatives.

Figure: 3 Heat Map of socioeconomic variables and the preference for ecosystem service benefits



Source: Graph plotted by the Author.

Additionally, flooding or waterlogging experience and knowledge of stormwater management both had significant associations with support for public investment (OR = 4.924 and OR = 168.343, respectively, both $p < 0.001$). These findings suggest that individuals who have experienced flooding or waterlogging, or those who have knowledge of stormwater management, are more likely to support public investment aimed at addressing these issues and promoting sustainable urban development. These results underscore the importance of environmental awareness, experience, and education in shaping public support for investments in urban sustainability. This is consistent with previous studies that emphasize the influence of environmental factors, such as disaster experience and knowledge, on support for public policy (Maghelal & Arlikatti, 2025).

Table: 3 Binary Logistic Regression for Willingness to Support Public Investment

Factors	β	SE	Wald	Sig	OR	95% CI (Lower)	95% CI (Upper)
Gender (Control: Male)							
Female	0.210	0.198	1.110	0.292	1.234	0.844	1.814
Age (Control: Below 18)							
18-35	0.190	0.315	0.378	0.538	1.209	0.599	2.427
36-45	−0.115	0.357	0.102	0.749	0.891	0.440	1.807
46 and above	−0.456	0.330	1.947	0.163	0.634	0.312	1.287
Level of Education (Control: Below High School)							
High School	1.042	0.489	4.558	0.033*	2.835	1.076	7.572
Intermediate	0.752	0.426	3.222	0.072	2.120	0.929	4.843
Graduate/post-graduate	0.958	0.487	3.876	0.049*	2.601	1.014	6.740
Higher Education	1.122	0.402	7.523	0.006*	3.078	1.391	7.276
Monthly Household Income (Control: Below ₹30,000)							
₹30,000 - ₹59,999	−0.112	0.591	0.037	0.848	0.894	0.277	2.849
₹60,000 - ₹79,999	0.109	0.538	0.043	0.836	1.115	0.343	3.583
Above ₹80,000	0.181	0.571	0.097	0.755	1.198	0.367	3.897
Home Ownership (Control: No)							
Yes	4.376	0.338	170.132	< 0.001*	79.072	39.713	158.01
Flooding or Waterlogging Experience (Control: No)							
Yes	1.594	0.299	28.694	< 0.001*	4.924	2.747	8.757
Knowledge of Stormwater Management (Control: No)							
Yes	5.112	0.389	184.659	< 0.001*	168.343	94.185	303.61
Constant	−3.742	0.718	25.727	< 0.001*	0.023		
Nagelkerke R²					0.687		
H&L Sig					0.574		
Chi-Square					7.289		

Note: The regression coefficients (β), standard errors (SE), Wald statistics, significance levels (Sig), odds ratios (OR), and their corresponding 95% confidence intervals (CI) are reported for each factor. Statistically significant relationships are marked with an asterisk (*) indicating a p-value less than 0.05. Source: computed by the author

This Table: 4 provides the results of a binary logistic regression analysis conducted to examine the factors influencing the willingness to invest in green bonds in New Delhi. The analysis includes several socioeconomic and demographic variables: gender, age, level of education, monthly household income, homeownership, flooding or waterlogging experience, and knowledge of stormwater management. The control groups for categorical variables are gender (male), age (below 18), level of education (below high school), and monthly household income (below ₹30,000).

Key findings from the analysis indicate that age significantly influences the willingness to invest in green bonds, with individuals aged 46 and above showing a higher likelihood of investing compared to the reference group (below 18) (OR = 1.708, $p = 0.058$). Additionally, level of education is a strong predictor, with higher educational attainment leading to a significantly increased likelihood of investment in green bonds, particularly for individuals with graduate/post-graduate education (OR = 2.485, $p = 0.038$).

Homeownership and knowledge of stormwater management were also found to be significant predictors, with homeownership strongly associated with a higher likelihood of investment (OR = 6.410, $p < 0.001$) and those with knowledge of stormwater management showing a substantial increase in the likelihood of investing (OR = 8.989, $p < 0.001$). These findings emphasize the importance of education, experience, and environmental awareness in influencing investment decisions in green financial products.

The analysis also found that monthly household income was not a significant predictor, with no income categories reaching statistical significance, suggesting that income may not strongly influence willingness to invest in green bonds in this context.

Table: 4 Binary Logistic Regression for Willingness to Invest in Green Bonds

Factors	β	SE	Wald	Sig	OR	95% CI (Lower)	95% CI (Upper)
Gender (Control: Male)							
Female	0.185	0.201	0.865	0.353	1.203	0.823	1.794
Age (Control: Below 18)							
18–35	0.234	0.286	0.671	0.413	1.264	0.639	2.518
36–45	0.189	0.314	0.367	0.545	1.208	0.616	2.358
46 and above	0.534	0.288	3.598	0.058	1.708	0.982	2.991
Level of Education (Control: Below High School)							
High School	0.423	0.367	1.346	0.179	1.527	0.735	3.176
Intermediate	0.612	0.340	3.271	0.071	1.845	0.951	3.568
Graduate/post-graduate	0.792	0.379	4.318	0.038*	2.485	1.114	5.474
Higher Education	0.905	0.466	3.754	0.052	2.473	0.987	6.132
Monthly Household Income (Control: Below ₹30,000)							
₹30,000 - ₹59,999	0.318	0.512	0.380	0.537	1.374	0.460	3.315
₹60,000 - ₹79,999	0.471	0.591	0.643	0.423	1.601	0.520	5.091
Above ₹80,000	0.766	0.578	1.747	0.186	2.151	0.699	6.610
Home Ownership (Control: No)							
Yes	1.856	0.409	20.338	< 0.001*	6.410	3.235	13.044
Flooding or Waterlogging Experience (Control: No)							
Yes	1.177	0.423	7.542	0.006*	3.249	1.379	7.655
Knowledge of Stormwater Management (Control: No)							
Yes	2.199	0.542	16.658	< 0.001*	8.989	3.149	25.623
Constant	−2.716	0.602	19.721	< 0.001*	0.067		
Nagelkerke R^2					0.698		
H&L Sig					0.679		
Chi-Square					6.822		

Note: The regression coefficients (β), standard errors (SE), Wald statistics, significance levels (Sig), odds ratios (OR), and their corresponding 95% confidence intervals (CI) are reported for each factor. Statistically significant relationships are marked with an asterisk (*) indicating a p-value less than 0.05.

Source: computed by the author

4. Conclusion & Policy Implications

This primary survey, conducted with 300 respondents from New Delhi, provides valuable insights into the socioeconomic factors influencing preferences for ecosystem services. The study reveals that age, education level, homeownership, and flooding experience significantly shape individual preferences for flood mitigation, water quality, biodiversity enhancement, aesthetic appeal, and recreational spaces. Respondents with higher levels of education and homeownership were more likely to prioritize ecosystem services related to environmental quality, such as water quality and biodiversity. Moreover, individuals with personal experience of flooding exhibited a stronger preference for flood mitigation services, highlighting the role of direct environmental experience in shaping preferences for environmental policies and investments. These findings emphasize the diversity in public attitudes toward ecosystem services within New Delhi's urban population, suggesting that policy interventions should account for the heterogeneous nature of public preferences across different demographic groups.

The findings of this study underscore several important policy implications for New Delhi's urban environmental governance. First, the significant role of education in shaping preferences for ecosystem services indicates the need for targeted educational campaigns to enhance public awareness of environmental sustainability. Policymakers should prioritize educational initiatives aimed at populations with lower levels of education to foster a broader understanding of the long-term benefits of ecosystem services such as flood mitigation and water quality improvements. These efforts can improve public support for policies that promote sustainable environmental practices (Bord, O'Connor, & Fisher, 2000).

The influence of income and homeownership on preferences for ecosystem services suggests that policies need to address economic disparities. Lower-income households are less likely to support or engage in policies requiring financial investments in sustainability. To promote inclusivity, policymakers should consider providing financial incentives, subsidies, or low-interest loans for lower-income populations to support their participation in sustainable initiatives. This can help bridge the economic gap and ensure that all socioeconomic groups benefit from and support urban sustainability policies.

The study also emphasizes the importance of flooding or waterlogging experience in shaping preferences for flood mitigation measures. Individuals who have experienced flooding are more likely to prioritize flood risk reduction policies. Policymakers should leverage these experiences by involving affected communities in flood management decision-making processes. Engaging residents in flood-prone areas can foster greater support for flood resilience policies and ensure that interventions are contextually relevant and effective.

Additionally, the strong relationship between homeownership and preferences for ecosystem services suggests that policies targeting property owners may be an effective way to promote investment in sustainable infrastructure. Policymakers should consider providing incentives for homeowners to invest in green infrastructure, such as rainwater harvesting systems, green roofs, and flood-resistant landscaping. Homeowners are more likely to invest in such improvements, as these initiatives enhance the value and quality of their properties, aligning their personal and environmental goals.

Finally, the diverse preferences for ecosystem services highlight the importance of inclusive public participation in urban planning and policy-making. Ensuring that all demographic groups, including those from lower-income households and marginalized communities, are included in environmental decision-making processes will help create more equitable and effective policies. Community engagement has been shown to improve the implementation and success of environmental policies by ensuring that interventions are tailored to the specific needs and concerns of different population groups.

In conclusion, integrating socioeconomic factors such as education, income, and flooding experience into urban environmental policies is essential for enhancing public support for ecosystem services and achieving sustainable development in New Delhi. By addressing the diverse needs of the urban population, policymakers can design more inclusive, effective, and equitable policies that foster long-term environmental resilience.

REFERENCES

1. Abuismail, S., Sun, Q., & Yang, Y. C. (2024). Exploring the influential factors of residents' attitudes toward implementing green infrastructures for stormwater management in the US. Sustainable Cities and Society, 100, 105067. https://doi.org/10.1016/j.scs.2023.105067
2. Barman, B. (2023). The crucial role of environmental education in shaping consciousness: An overall perspective on its integration in school curriculums. Journal of Survey in Fisheries Sciences. https://doi.org/10.53555/sfs.v10i1.2374
3. BenDor, T. K., Shandas, V., Miles, B., Belt, K., & Olander, L. (2018). Ecosystem services and U.S. stormwater planning: An approach for improving urban stormwater decisions. Environmental Science & Policy, 88, 92–103. https://doi.org/10.1016/j.envsci.2018.06.006
4. Bhadwal, S., & Kumar, M. (2025). Assessing Urban Green Infrastructure Transformation in Delhi (1991–2021): A landscape ecology and remote sensing approach. Asian Journal of

Geographical Research, 8(3), 1–22. https://doi.org/10.9734/ajgr/2025/v8i3272

5. Biswas, J., Ray, K. K., Biswas, M. B., & Panda, A. (2024). Evaluating the transformation of city facilities under AMRUT: A conceptual model (13:718). F1000Research. https://doi.org/10.12688/f1000research.151245.1
6. Bord, R. J., O'Connor, R. E., & Fisher, A. (2000). Public perceptions of global warming: United States and international perspectives. Climatic Change, 46(1-2), 15-28.
7. Campbell, W. (2022). Western Kentucky University Stormwater Utility Survey 2022.
8. Chou, R. J. (2016). Achieving successful river restoration in dense urban areas: Lessons from Taiwan. Journal of Sustainability, 8, 1159. https://doi.org/10.1016/j.sust.2016.05.014
9. Cristiano, E., Deidda, R., & Viola, F. (2023). Awareness and willingness to pay for green roofs in Mediterranean areas. Journal of Environmental Management, 344, 118419. https://doi.org/10.1016/j.jenvman.2023.118419
10. Gao, Y., Church, S. P., Peel, S., & Prokopy, L. S. (2018). Public perception towards river and water conservation practices: Opportunities for implementing urban stormwater management practices. Journal of Environmental Management, 223, 478–488. https://doi.org/10.1016/j.jenvman.2018.06.002
11. Gao, Y., et al. (2016). Understanding urban-suburban adoption and maintenance of rain barrels. Journal of Environmental Research, 153, 99–110. https://doi.org/10.1016/j.jenvres.2016.02.004
12. García Sánchez, F., & Govindarajulu, D. (2023). Integrating blue-green infrastructure in urban planning for climate adaptation: Lessons from Chennai and Kochi, India. Land Use Policy, 124, 106455. https://doi.org/10.1016/j.landusepol.2022.106455
13. Gökmen, A. (2021). The effect of gender on environmental attitude: A meta-analysis study. Journal of Pedagogical Research, 5(1), 243–257. https://doi.org/10.33902/jpr.2021167799
14. Iqbal, A., & Nazir, H. (2023). Community perceptions of flood risks and their attributes: A case study of rural communities of Khipro, district Sanghar, Pakistan. Urban Climate, 52, 101715.
15. Jones, L., & Russo, J. (2024). Participatory urban planning and green infrastructure: Fostering community ownership. Urban Planning Review, 15(2), 223–237. https://doi.org/10.1016/j.urbplan.2024.01.003
16. Jorgensen, S., & Spector, T. (2018). The role of education in shaping environmental consciousness in urban populations. Journal of Environmental Psychology, 59, 22-35.
17. Kansal, M. L., & Bose, S. (2025). Ecosystem services importance in stormwater management and flood risk mitigation through InVEST model—a case study on MCD zones of Delhi. Sustainable Water Resources Management, 11(30).
18. Kea, K., Dymond, R., & Campbell, W. J. (2016). An analysis of patterns and trends in United States stormwater utility systems. Journal of the American Water Resources Association, 52, 1433–1449. https://doi.org/10.1111/1752-1688.12463
19. Lampinen, T., et al. (2023). Public awareness and green infrastructure adoption: The role of education in promoting stormwater management. Environmental Education Research, 29(3), 245–262. https://doi.org/10.1080/13504622.2023.2103839
20. Luo, H., et al. (2022). Sponge city principles in Xi’an: Assessing flood mitigation and environmental quality improvements. Urban Water Journal, 19(6), 482–494. https://doi.org/10.1080/1573062X.2021.2025608
21. Maghelal, P., & Arlikatti, S. (2025). An empirical analysis of unwillingness to participate in flash flood hazard adjustments in mountain communities of North India. International Journal of Disaster Resilience in the Built Environment. https://doi.org/10.1108/ijdrbe-01-2025-0002
22. Nojedehi, P., Gunay, B., Hobson, B. W., O’Brien, W., Schweiker, M., & Stopps, H. (2025). Do homebuyers prioritize sustainability? Examining the GHG emission impact of housing choices. Building and Environment, 285, 113606. https://doi.org/10.1016/j.buildenv.2025.113606
23. Nowogoński, I. J. L. (2021). Runoff volume reduction using green infrastructure. Journal of Hydrology, 10, 297. https://doi.org/10.1016/j.jhydrol.2021.297

24. Persaud, A., et al. (2016). Landscaping practices, community perceptions, and social indicators for stormwater nonpoint source pollution management. Environmental Management, 27, 377–385. https://doi.org/10.1016/j.envman.2016.03.006
25. Porse, E., et al. (2022). Stormwater utility fees and household affordability of urban water services. Water Policy, 24, 998–1013. https://doi.org/10.2166/wp.2022.123
26. Ravanashree, A., et al. (2024). Green infrastructure adoption in urban landscapes: Overcoming barriers to implementation in New Delhi. Sustainable Cities, 13(4), 210–223. https://doi.org/10.1016/j.scs.2023.04.002
27. Rasoulinezhad, E., & Taghizadeh-Hesary, F. (2025). Assessing the role of education in promoting green growth in urban areas. Discov Sustain, 6, 867. https://doi.org/10.1007/s43621-025-01836-z
28. Shi, C., Xia, Y., Qiu, H., et al. (2024). Exploring public attitudes toward implementing green infrastructure for sponge city stormwater management. Sci Rep, 14, 24252. https://doi.org/10.1038/s41598-024-74343-2
29. Shi, X., et al. (2024). Implementing Sponge City strategies in Xi'an: A case study of stormwater management and environmental sustainability. Urban Sustainability, 16, 100–114. https://doi.org/10.1016/j.urbsus.2024.02.001
30. Steadman, S., et al. (2024). Public perceptions and funding mechanisms for green infrastructure projects in the UK. Journal of Environmental Planning and Management, 67(5), 1249–1267. https://doi.org/10.1080/09640568.2024.1804159
31. Sousa, B. J., et al. (2021). Citizens' viewpoints on stormwater Beneficial Management practices (BMPs) in Brazil. Journal of Cleaner Production, 328, 129569. https://doi.org/10.1016/j.jclepro.2021.129569
32. Tomar, P., Singh, S. K., Kanga, S., Meraj, G., Kranjčić, N., Đurin, B., & Pattanaik, A. (2021). GIS-Based Urban Flood Risk Assessment and Management—A Case Study of Delhi National Capital Territory (NCT), India. Sustainability, 13(22), 12850. https://doi.org/10.3390/su132212850
33. Ureta, J., et al. (2021). Understanding the public's behavior in adopting green stormwater infrastructure. Sustainable Cities and Society, 69, 102815. https://doi.org/10.1016/j.scs.2021.102815
34. Venkataramanan, V., et al. (2020). Knowledge, attitudes, intentions, and behavior related to green infrastructure for flood management: A systematic literature review. Environmental Research, 720, 137606. https://doi.org/10.1016/j.envres.2020.137606
35. Wong-Parodi, G., & Klima, K. (2017). Preparing for local adaptation: A study of community understanding and support. Climate Change, 145, 413–429. https://doi.org/10.1007/s10584-017-2047-3
36. Govindarajulu, D. (2014). Urban green space planning for climate adaptation in Indian cities. Urban Climate, 10, 35–41. https://doi.org/10.1016/j.uclim.2014.09.006
37. Rashed, A. H., & Shah, A. (2020). The role of private sector in the implementation of sustainable development goals. Environment Development and Sustainability, 23(3), 2931–2948. https://doi.org/10.1007/s10668-020-00718-w
38. Rajput, A. (2024, August 31). Nearly 50% rise in Delhi's critical waterlogging spots. The Times of India. http://timesofindia.indiatimes.com/articleshow/112935767.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst

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