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RESEARCH

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Unpacking the plural values of urban waterscapes for sustainability: local perspectives from four Indian megacities

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ABSTRACT

Urban waterscapes hold multiple values for local people and are important for ensuring the future sustainability of cities. However, few studies have examined the potential of plural values of waterscapes for mitigating urban sustainability challenges, and even fewer in the Global South. To address this gap, we applied a plural value approach to capture perceptions of both well-maintained and neglected waterscapes by 616 urban dwellers from four Indian megacities. We analysed the associations among perceived values, sustainability challenges, and socio-economic characteristics of the respondents through redundancy analysis (RDA). Our study found that relational and intrinsic values of waterscapes were more important to people than instrumental values. Older and long-term residents prioritised instrumental values and social responsibility. Frequent waterscape visitation, higher education, and income were associated with biodiversity and aesthetic values. This study highlights the importance of incorporating relational and intrinsic values into sustainable water governance.

KEY POLICY HIGHLIGHTS

- Urban waterscapes are social-ecological systems rather than just technical infrastructure or ecological assets, and they should be recognized as living spaces.
- Waterscapes provide 'experiential wellbeing' that long-term residents and elderly populations rely on.
- Stronger consideration of relational and intrinsic values leads to more effective conservation and restoration of urban waterscapes.
- Integrating relational and intrinsic values into urban policies and management plans can strengthen place-based governance of waterscapes in Global South cities.

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Urban waterscapes; plural values; urban sustainability; Global South; India

1. Introduction

Urban waterscapes such as rivers, lakes, ponds, and wetlands function as both ecological infrastructure and cultural landscapes that sustain urban life, but have declined in their number, area, and ecological quality worldwide. The loss of these waterscapes poses significant threats to urban sustainability, undermining ecological resilience and social cohesion. The consequences of such decline may be understood through a plural values perspective, which provides a more multifaceted view than an ecosystem services approach, because it recognises not only benefits or services provided to humans, but also nature's value in itself, as well as the relational values between people and nature (Pascual et al. 2017; IPBES, I.S.-P.P. on B. and E.S. 2022). By integrating ecological, cultural, social, and economic aspects into planning and decision-making, a plural values perspective offers a new framework for

nature governance (Kabisch 2015; Hill et al. 2021) and participation (Langemeyer and Connolly, 2020).

A plural values analysis of people-waterscape relations includes the consideration of people's beliefs, practices, emotions, and knowledge, and can thus help to understand and foster everyday relationships between people and urban waterscapes. Urban waterscapes play a crucial role in flood regulation, recreation, and the provision of public spaces (Keeler et al. 2019). People's socio-economic background, interaction with nature, and individual life experiences shape their perspectives of urban waterscapes (Kachler et al. 2024). Recognising these plural perspectives may build consensus on the conservation of waterscapes and elevate societal requirements for nature protection (Jones et al. 2016).

Despite the importance of plural values, their assessment in urban waterscapes of the Global South,

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specifically in India, remains scarce, as existing research has largely focused on ecosystem services (Ahmed and Meenar 2018; Nagendra and Unnikrishnan 2019; Kaur and Gupta 2022; Larbi et al. 2022; Plieninger et al. 2022; Basu et al. 2024; Derdouri et al. 2024). This work builds on a previous study that examined the potential of urban waterscapes to constitute nature-based solutions (Chowdhury et al. 2025). It advances existing analyses by assessing the plural values of waterscapes and their associations with urban sustainability challenges. As cities in India face combined ecological challenges such as flooding, pollution and water scarcity, and social challenges such as loss of community and cultural connections, understanding plural values of urban waterscapes becomes essential for building resilient cities (Mundoli et al. 2015; Nagendra and Unnikrishnan 2019; Mansur et al. 2022; Plieninger et al. 2022). Our specific objectives are:

- (1) To elicit the plural values of urban waterscapes and their relative importance;
- (2) To identify the linkages between plural values and the quality of waterscapes;
- (3) To understand the association between intrinsic, instrumental, and relational values and perceived urban sustainability challenges;

- (4) To analyse differences in the importance of intrinsic, instrumental, and relational values among people living around urban waterscapes.

2. Conceptual framework

Individual preferences for the future of urban nature can be categorised into three primary dimensions of values: ecology-centred intrinsic values, human means- or use-centred instrumental values, and relational values centred on meaningful interactions between humans and nature (Pereira et al. 2020). When assessing these plural value categories, different viewpoints can be observed, as summarised in Figure 1, in which one value type prevails at each corner: (i) *Urban natural future* (green colour), where nature has value in itself and safeguarding ecological functions is of highest priority, even if not delivering direct benefits to humans; (ii) *Urban social future* (blue colour), which includes a variety of uses and benefits for humans (Pascual et al. 2017); (iii) *Urban cultural future* (orange colour), which finds expression in local ecological knowledge systems where people's identities are linked to nature and where

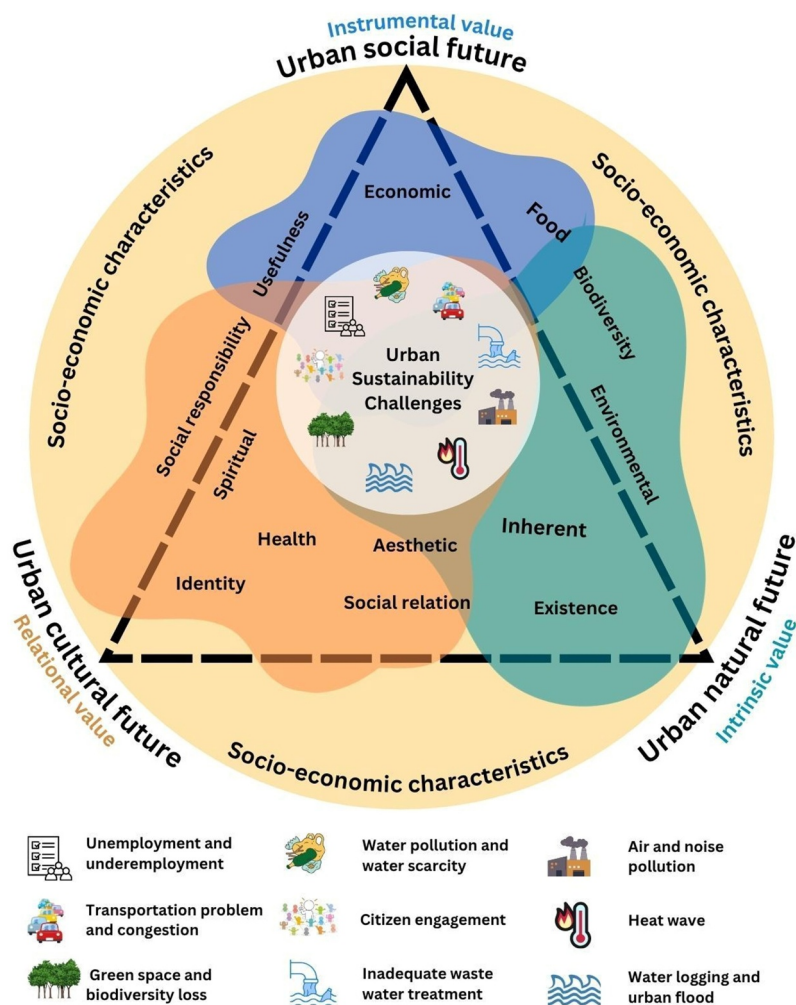


Figure 1. Conceptual framework.

culture and nature have shaped each other (Chan et al. 2016). These three perspectives are closely inter-linked. For example, culture evolves based on how society interacts with nature and how nature maintains itself. Therefore, urban futures depend on the interactions of these three value domains (Mansur et al. 2022).

The *Waterscapes for urban natural future* (intrinsic value) (Figure 1) view illustrates how waterscapes enhance the ecological function of the city by providing space for nature and biodiversity without direct human interference. For example, waterscapes increase ecological connectivity (Samanta 2019; Flaminio et al. 2022).

In the *Waterscapes for urban social future* (instrumental value) view, waterscapes provide different material benefits to people living around waterscapes, including food, materials, clean air, and water (Plieninger et al. 2022). Other important non-material benefits are wastewater treatment, flood management, and water pollution prevention.

The *Waterscapes for urban cultural future* (relational value) view emphasises the relationship between people and waterscapes as expressed through culture. Such a perspective helps understand waterscapes as cultural landscapes, in which aspects such as identity, spirituality, social responsibility, collective memory, and experiential dimensions such as aesthetic appreciation and place-based well-being are central. This includes active participation in activities such as morning walks and visits with friends that promote social unity, a sense of belonging, cultural heritage, and responsible management of the natural environment (Arias-Arévalo et al. 2017).

3. Methods

3.1. Study area

Our study focused on diverse urban waterscapes in India. We selected waterscapes that are located entirely within urban boundaries, and focused on four megacities: Bengaluru, Hyderabad, Kolkata, and Mumbai (Figure 2). The waterscapes included urban lakes, ponds, and riverfronts.

Bengaluru was founded by a local chief of Vijaynagar, Kempe Gowda, in 1537, and many waterscapes were created within the town over several centuries. It has, therefore, been called the ‘City of Lakes’. In the post-independence era of the 1960s, the city experienced significant economic expansion, leading to an increase in population. With the establishment of the IT sector in the 1990s, the city experienced urban sprawl, and has been termed the ‘Silicon Valley of India’. In consequence of these rapid developments, many waterscapes have been destroyed and cover a small fraction of Bengaluru’s total area today (Aithal et al. 2013). We selected Madiwala Lake, Sarakki Lake, and Mallathahalli Lake, as representatives of the city’s traditional lake (kere) systems. These systems were historically developed for water storage, irrigation and are currently appreciated for their ecological, hydrological, recreational, and other socio-cultural significance.

Hyderabad, founded in 1501, is characterised by its unique urban morphology. The iconic Hussain Sagar Lake was established during the mid-sixteenth century and became a cultural icon of modern Hyderabad city. This lake was built on a tributary of the Musi River to act as a water reservoir and a buffer against flooding, after an especially devastating flood in 1908. In the 1970s, the city had over 3000 lakes, of which many

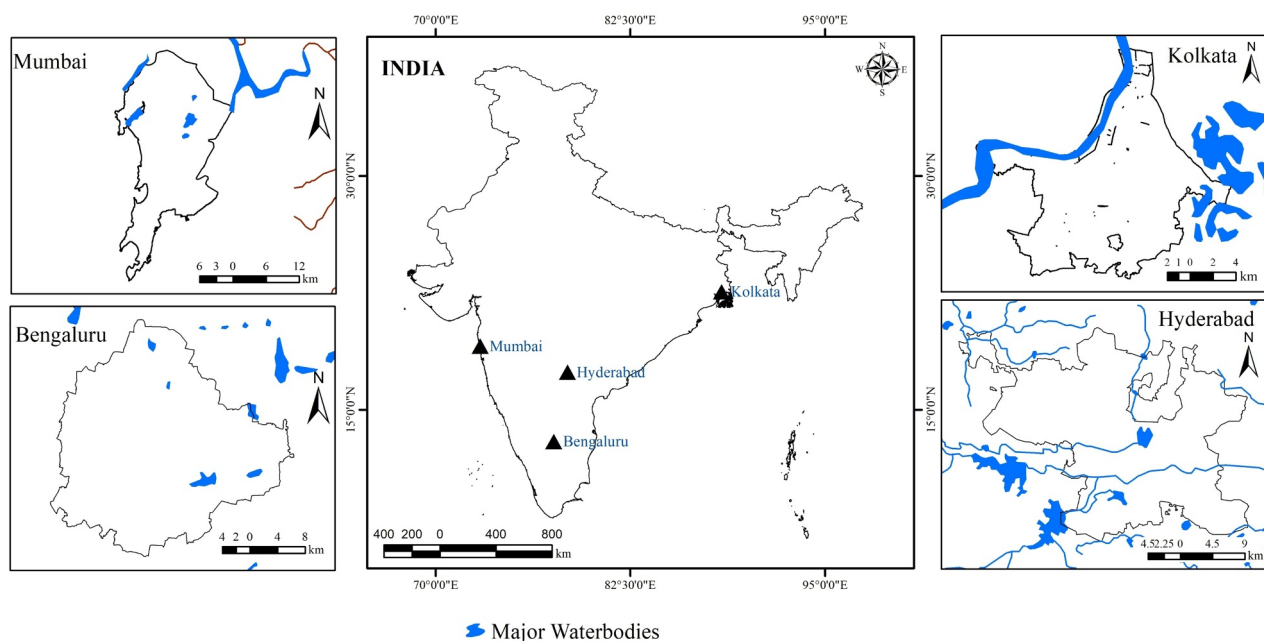


Figure 2. Location of the study areas.

have either disappeared or been diminished (Seth 2012). Hyderabad has a large network of lakes that were originally built for water supply, irrigation and flood regulation purposes but have been modified extensively due to rapid urbanisation. To represent these large urban lake networks and their diverse ecological and socio-cultural values, we selected Malkam Cheruvu, Durgam Cheruvu, and Nallagandla Lake.

Mumbai is a coastal city and the financial hub of India. Mumbai developed from a cluster of seven islands. It has a complex network of coastal areas, creeks, mangroves, streams, lakes, and ponds that have served as primary sources of water and shaped the city's development. Major projects, such as the Vihar Water Works in 1856, marked significant milestones in water management in Mumbai. As with many other Indian cities, Mumbai's waterscapes started declining since the mid-twentieth century because of rapid urbanization and land reclamation (Haynes 2020). A large proportion of its lakes, ponds, and creeks are vanishing or shrinking (Seth 2012). In 2005, floods exposed Mumbai's vulnerability, spurring efforts like the Mithi River Revitalization and Wetland Conservation – and highlighting the needs of inclusion of waterscapes into urban planning. We selected Mithi River and Powai Lake as representative urban waterscapes. Mithi River is a highly modified urban river and major drainage channel, whereas Powai Lake is valued for its biodiversity, recreational, and aesthetic significance.

Kolkata is a river-based city that was developed on land reclaimed from a swamp. Kolkata was the place where the British first established their capital in India. With colonial expansion, the city of Kolkata also grew (Figure 2b) (Bhattacharyya 2018). In the late nineteenth century, Kolkata developed rapidly, and people from the countryside started coming to Kolkata to work in industries. As a result, the government started reclaiming swamps for residential projects in 1921 (Roy 2015). Kolkata lost around 12 km² of blue cover between 1998 and 2002 (Goswami et al. 2022), and a large fraction of the city's waterscapes has been filled up over the last two decades (Roy, 2013). Our surveys were conducted around Adi Ganga, Rabindra Sarovar, Bikramgarh Lake, and Santoshpur Lake, representing both riverine and pond systems.

3.2. Data collection

We designed a questionnaire to obtain information about waterscapes, their values, and urban sustainability challenges from local communities. Our questionnaire contained closed questions to acquire quantitative data for analysis and had the following thematic parts: 1) plural values of waterscapes, 2) sustainability challenges faced, and 3) socio-economic characteristics of the households. Local enumerators, who spoke local

languages, performed the survey. The first author trained the enumerators in-person and via video meetings.

Based on the conceptual framework presented in section 2, we formulated questions about the plural values of waterscapes, covering intrinsic, instrumental, and relational values. After reviewing seminal papers and studies on nature values, we refined value definitions taking into account urban social-ecological setting and urbanisation history. We assigned each value to the respective value domain of the conceptual framework (see Supplementary Tables A1 and A2) and enumerators explained values in local languages to ensure respondents' understanding. Respondents rated the level of importance they attribute to each value on a 5-point Likert scale (1-not important to 5-very important), and identified the top five sustainability challenges they face in their localities. The list of challenges was selected from Raymond et al. (2017) and from the results of a field pilot survey, and included economic, social, and environmental sustainability challenges (Supplementary Table A4). Unemployment, economic inequality, and transportation congestion are examples of economic problems. Social challenges include social isolation, displacement, mental health issues, and a lack of participation in decision-making. Environmental issues comprise air and noise pollution, urban flooding, waterlogging, and wastewater problems. Questions on socio-economic characteristics, such as age, gender, income, and level of education, were asked at the end of the questionnaire and were framed as open or multiple-choice questions.

Households were selected within one-kilometre radii around each waterscape, as people living close to the waterscape typically express clear opinions on values and significance (Chowdhury and Behera 2021). We surveyed approximately 150 respondents in each city, covering 616 respondents across the four cities. The survey took place between July and December 2023. Stratified random sampling was used to select the households. The stratification was based on housing types classified as owner-occupied and rented houses, which are key socioeconomic indicators of community characteristics and their proximity to the waterscape. On average, each interview took 15 to 20 min. All data were collected through the KoboCollect toolbox. Before performing the survey, we obtained verbal consent from all respondents.

We categorised waterscapes into neglected and well-maintained ones. The assessment was based on visual indicators, including water appearance such as water clarity and the absence of visible solid waste. Waterscapes displaying these characteristics were classified as well-maintained, whereas those showing visible signs of pollution and poor maintenance were considered neglected. No physical or chemical water quality measurements were conducted.

We surveyed four waterscapes in Kolkata, two in Mumbai, and three each in Bengaluru and Hyderabad.

Out of these waterscapes, in Kolkata two were neglected and two were well-maintained, in Bengaluru all three were well-maintained, in Hyderabad one was neglected and two were well-maintained, and in Mumbai one was neglected and one was well-maintained.

3.2.1. Data analysis

To analyse the Likert data on plural values, we first calculated Cronbach's Alpha to measure the consistency and reliability of the data. Cronbach's Alpha represents the equivalence of the data set and allows to assess data reliability (Taber 2018). Cronbach's Alpha value of our data set was 0.78, which shows relatively high reliability. Subsequently, we combined the responses to the individual Likert items and conducted a comparison between neglected and well-maintained waterscapes visually by using the 'Likert' (Bryer and Speerschnieder 2013) and 'HH' (Heiberger 2006) R packages. We calculated Cramer's V (CV) for each variable to compare between neglected and well-maintained waterscapes. Cramer's V ranges from 0 to 1, where values close to 0 indicate little difference and values closer to 1 indicate large differences between neglected and well-maintained waterscapes.

Second, we used redundancy analysis (RDA), i.e. a multivariate multiple linear regression, to understand the association between plural values and sustainability challenges using the *vegan* package in R (Oksanen et al. 2022). In this model, we considered values as response variables and sustainability challenges as explanatory variables, focusing on connections rather than causal links. Explanatory variables were binary variables (1 = yes, 0 = no) to understand whether respondents perceived a sustainability challenge in their locality. This helped us to capture the perceived presence or absence of specific urban challenges. We included those sustainability challenges that received responses from more than 25% of total respondents.

Similarly, RDA analysis was used to identify socio-economic factors associated with preferences of values. We considered values to be response variables, while socio-economic (i.e. age, gender, education, and income levels), frequency of visits to waterscapes, and duration of residence were categorised as explanatory variables. The categorical variable 'gender' was transformed into a dummy binary variable (1 = male, 0 = female). Categorical variables age, education, and income level were transformed into ordinal variables. 78% of our respondents were male, possibly because men more frequently understood themselves as household heads. The average number of years that people had lived around waterscapes was 20.3 years. Residents near neglected waterscapes had lived there longer, averaging 22.3 years, compared to 18.8 years for those near well-maintained waterscapes. Approximately 70% of the respondents were between 31 and 60 years old. 80% of respondents held a high school or higher degree, and

the average annual household income was between 500 and 10,000 Euros (Supplementary Table A3).

For both models, i.e. socio-economic and sustainability focused, we performed RDA analysis because the first DCA axis was less than 3 units (0.894) as recommended in Šmilauer and Lepš (2020). We performed a Monte Carlo permutation test (999 permutations) to determine the significance of the models. All data analyses were performed in R software version 4.3.3 (R Core Team 2023).

4. Results

4.1. Plural values and their relative importance

Overall, respondents placed stronger emphasis on relational and intrinsic values than on instrumental values for waterscapes (Figure 3). Two relational values (social responsibility: 85.7% of respondents; identity: 75.5%), and an intrinsic value (existence value: 69.8%) were perceived as important or very important among the respondents of all four cities. Other values, including intrinsic values (such as biodiversity (61.5%), environmental value (55.4%), and inherent value (50.2%)) and relational values (such as social relations (59.4%) and spiritual value (57.5%)) were also regarded as important or very important. In contrast, instrumental values such as usefulness, economic value, and food value were considered less important or not important by 44.5%, 45.3% and 42.0% of respondents, respectively.

4.2. Comparison between neglected and well-maintained urban waterscapes

Social responsibility, identity, spirituality, and existence values were perceived similarly across both well-maintained and neglected waterscapes (Cramer's V: 0.10 to 0.15) (Figure 4). However, perceptions of relational values (e.g. aesthetics, health) and instrumental values (e.g. economic income, usefulness, food) showed higher Cramer's V values in well-maintained waterscapes. For example, the aesthetic value of well-maintained waterscapes was perceived by 72.5% of respondents to be important, whereas only 15.4% of respondents perceived this value as important for neglected waterscapes. Conversely, economic value was perceived to be of less importance (39.2%) for well-maintained waterscapes than for neglected waterscapes (53.7%).

4.3. Association between plural values and sustainability challenges

Figure 5 summarises the associations between plural values and urban sustainability challenges. The model was significant (Supplementary Table A5). Eight

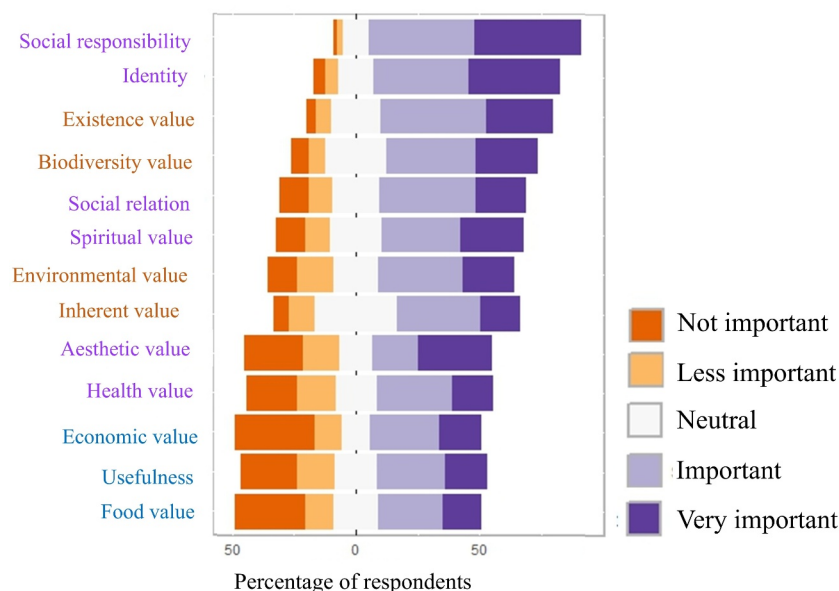


Figure 3. The perceived importance of plural values from urban waterscapes.

explanatory variables: air and noise pollution (ANP), heat waves (HW), inadequate wastewater treatment (IWT), water logging and urban floods (WLUF), lack of green spaces and biodiversity loss (GSBL), transportation problems and congestion (TCTJ), lack of citizen engagement (LCENG), and unemployment and under-employment (UNEMP) explained 12.0% of the variation in the significance of the values (Supplementary Table A6). Cumulatively, axis 1 and axis 2 explained 66.6% of

the variance in the response data, which can be attributed to the explanatory data (Supplementary Table A7). The first unrestricted axis (PC1) has an eigenvalue (6.8) significantly higher than the sum of the eigenvalues of all constrained axes (2.6). The first axis of the RDA explained 40.5% of the variance, and the second axis of the RDA explained 26.1% of the variance.

The results indicated that respondents who considered health, aesthetic, inherent, and environmental

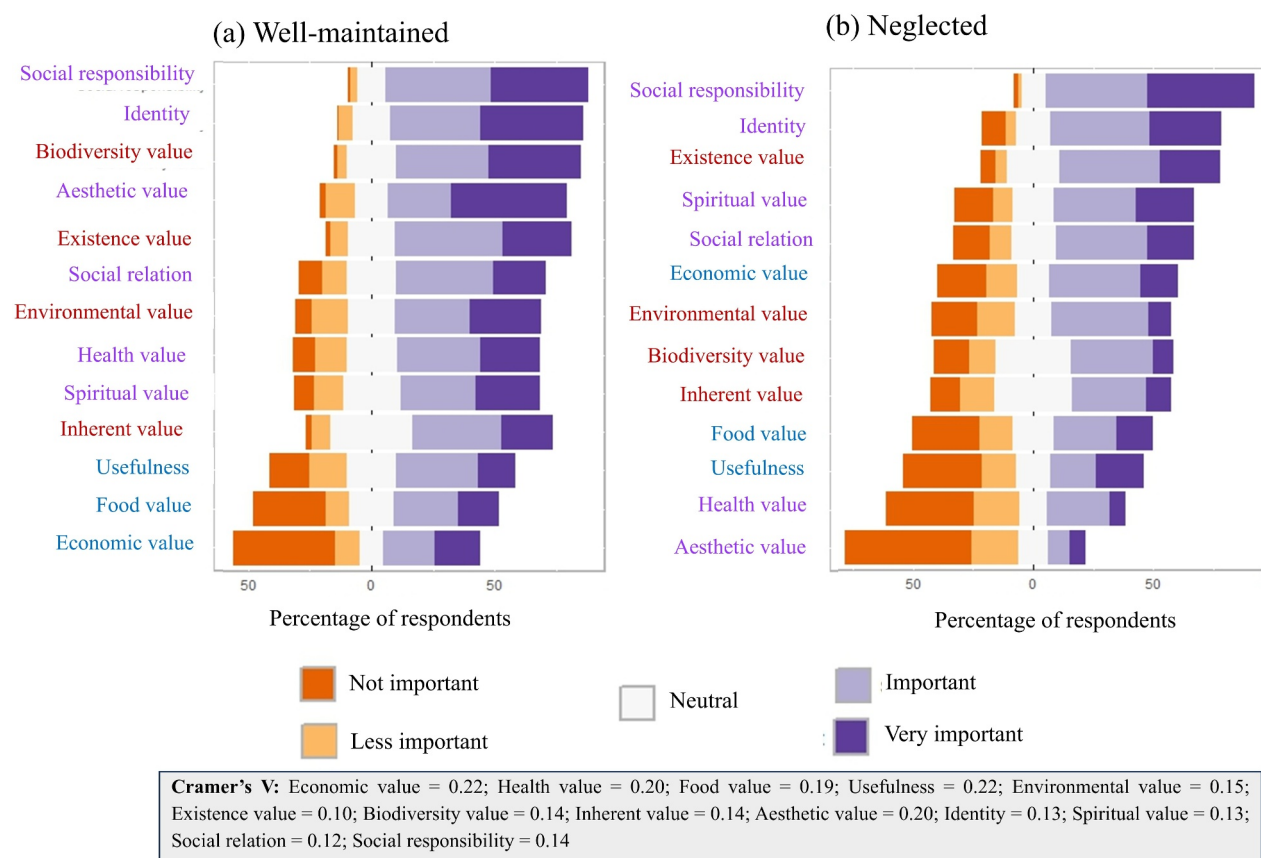


Figure 4. Differences in the importance of plural values between (a) well-maintained and (b) neglected waterscapes.

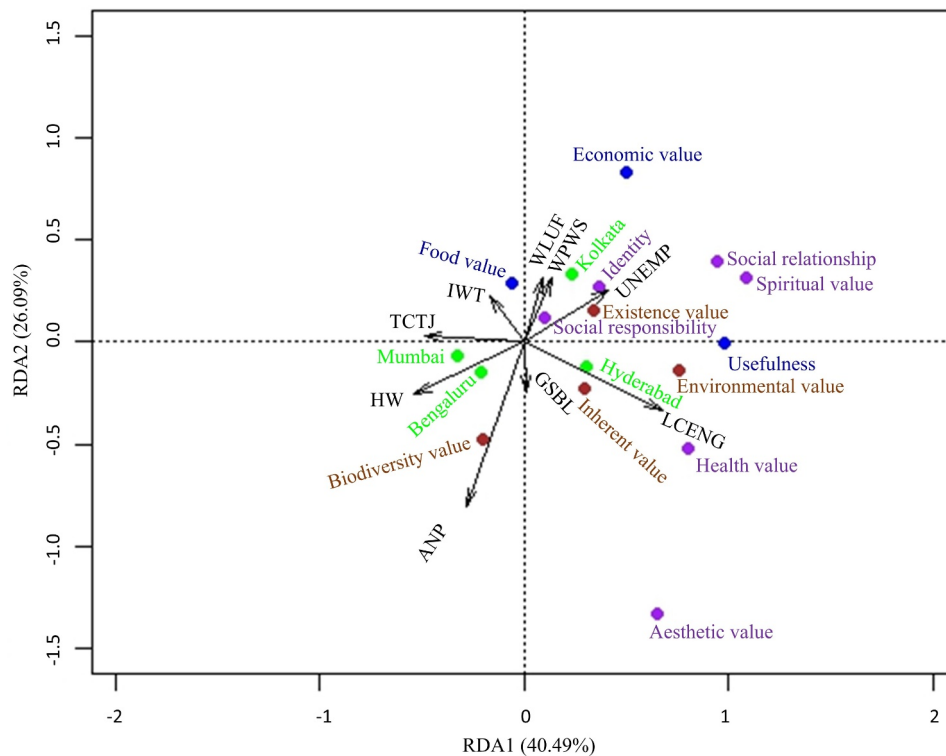


Figure 5. Association between plural values; Cities (green), instrumental (blue), intrinsic (maroon), relational (purple) values, and sustainability challenges (black) of waterscapes. (ANP = air and noise pollution; HW= heat waves; IWT = inadequate waste water treatment; WPWS = water pollution and water scarcity; WLUF = water logging and urban flood; GSBL = lack of green spaces and biodiversity loss; TCTJ = transportation problems and congestion; LCENG = lack of citizen engagement; UNEMP = unemployment and underemployment.).

values of waterscapes important were also identified lack of citizen engagement and biodiversity loss as key sustainability challenges. Respondents who considered biodiversity as an important value were more likely to identify air and noise pollution and heat waves as sustainability challenges. These associations were primarily found among residents of Bengaluru and Mumbai. Similarly, respondents who considered instrumental values important were more likely to identify challenges such as un-/underemployment, water pollution and water scarcity, and inadequate wastewater treatment. Relational values such as social relationships, spirituality, and identity, and intrinsic values such as existence value were also associated with these challenges.

4.4. Association between socio-economic characteristics and the importance of values

Socio-economic characteristics and plural values were associated in the RDA analysis (Figure 6). Overall, the model was significant (Supplementary Table A8) and so were the explanatory variables (Supplementary Table A9). Nine percent of the variation in the significance of value was determined by the explanatory variables. Axes 1 and 2 together explained 87.6% of the variation in the response data attributed to the explanatory data (Supplementary Table A10). The

eigenvalue of the first unrestricted axis (PC1) (6.6) was much higher than the total eigenvalues of all constrained axes (2.0), pointing to well-structured data. The first and second axes of the RDA explained 71.9% and 15.7% of the variance, respectively.

The age of the respondents and duration of residence in Kolkata and Mumbai had a strong association with food and economic value, suggesting older people and people who have lived near the waterscapes for a longer time perceived greater importance of food and economic value of the waterscapes than younger people. Biodiversity, as well as aesthetic and health values in Hyderabad, were strongly associated with the respondents' level of education and average annual income, suggesting that residents with higher education and income place more importance on biodiversity value than those of lower education and income. Waterscape visits in Hyderabad showed a strong correlation with usefulness, health, aesthetic, environmental, and inherent values.

5. Discussion

This study aimed to elicit how plural values of waterscapes could support transformations toward a sustainable urban future. In the following, we discuss our findings along three major points: the importance of plural values of waterscapes, their

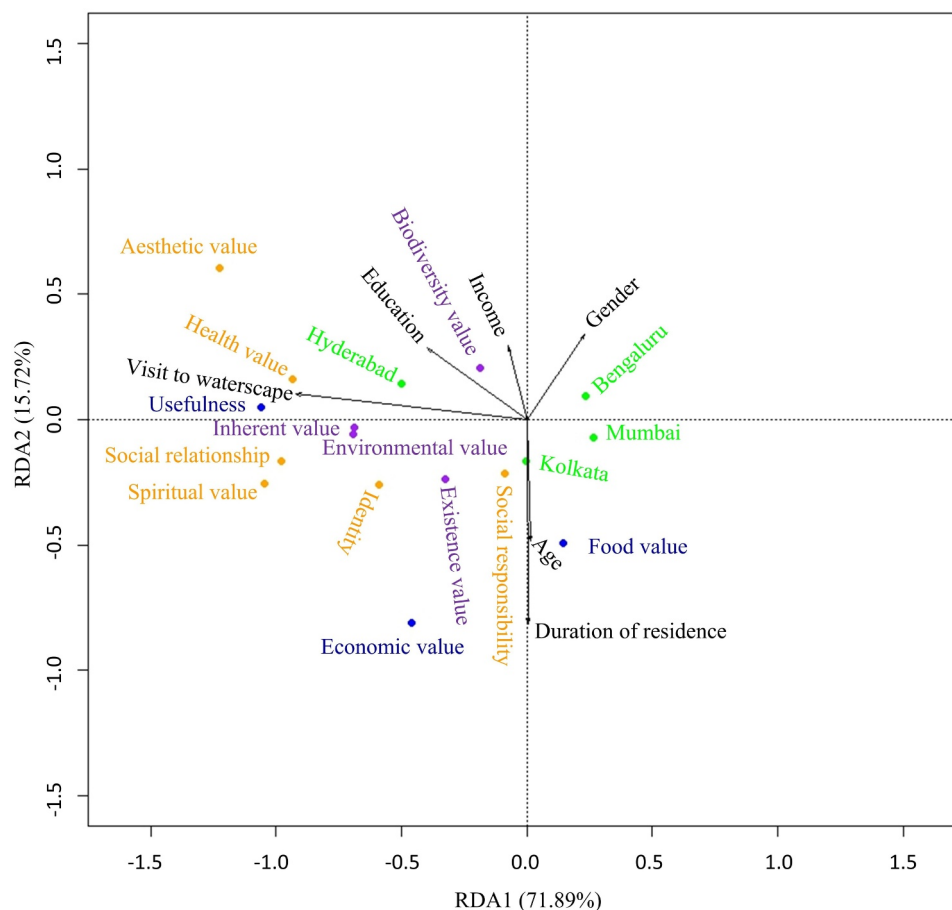


Figure 6. Association between the importance of plural values of waterscapes; cities (green), instrumental (blue), intrinsic (purple), relational (orange) values with socioeconomic characteristics of respondents (black).

relevance for future urban sustainability when applying the Nature Futures Framework, and the differences in plural values across diverse socio-economic groups.

5.1. Importance of plural values from urban waterscapes

Respondents living around waterscapes perceived relational and intrinsic values more strongly than instrumental values. The strong emphasis on social responsibility, identity, social relations, and spiritual values reflects their ethical and moral motivations to address sustainability challenges. Urban waterscapes act as spaces for social interactions, community gatherings, and religious rituals and may thus promote place-based identities and bolster social responsibility toward these ecosystems. This finding aligns with previous studies that highlights relational values as a critical determinant of sustainable development and pro-environmental behaviors (Chan et al. 2016; Pascual et al. 2017), as well as of responsibility toward future generations (Bieling et al. 2020). Such relational values are deeply embedded in Indian society and have historically been reflected in relationships between waterscapes and society. Waterscapes are not

only considered as ecological infrastructure but also as sacred and community spaces (Chowdhury and Behera 2021). Immersion of devotional idols (e.g. Durga Puja in Kolkata), ritual bathing (e.g. Chhath Puja), and community-led tank management (e.g. the Kudimaramathu system of collective labor in South India) illustrate the continued relevance of relational values.

The high importance accorded to existence and biodiversity values indicates respondents recognize nature's inherent worth beyond utilitarian functions (Pascual et al. 2017). In contrast, the low importance given to instrumental values such as food value and uses indicates the diminished utilitarian role of waterscapes in modern urban food consumption patterns (Kenter et al. 2019; Basu et al. 2024). Similarly, the high importance assigned to economic, intrinsic, aesthetic, and health values reveals complex interlinkages between urban waterscape values. For example, the aesthetic value of a waterscape generates recreation opportunities, which may create an informal economy and support physical well-being among urban dwellers. Overall, different values appear to be interlinked, making a cumulative impact on urban society (Chan et al. 2018; Mansur et al. 2022).

5.2. Comparison of the importance of plural values between neglected and well-maintained waterscapes

We observed clear differences between neglected and well-maintained waterscapes. Well-maintained waterscapes were associated with high relational and intrinsic values such as *aesthetics, health, rich biodiversity, artistry, and cultural significance*, fostering place-based attachments and human-nature connections (Himes and Muraca 2018). In contrast, neglected waterscapes characterized by degraded ecological conditions provided limited aesthetic benefits, but respondents valued social responsibility and identity. This suggests that cultural attachment and social cohesion continue to exist despite the ecological degradation of waterscapes (Van Zanten et al. 2016; Mansur et al. 2022). The consistent importance of spiritual values across both types indicates a long-lasting cultural connection with waterscapes that persists despite visible deterioration (Ives et al. 2018).

Instrumental values, including *usefulness, food, and economic benefits*, were more prominent in neglected waterscapes, reflecting their greater utilitarian function (Andersson et al. 2015; Palomo et al. 2021). In contrast, their lower importance in well-maintained waterscapes could be due to a shift in perception toward increased valuing of recreational and aesthetic functions (O'Connor and Kenter 2019). Health value was perceived slightly higher in well-maintained waterscapes, perhaps because of better water quality and greater accessibility. This aligns with studies that linked well-maintained waterscapes with green-blue spaces (Gascon et al. 2017; White et al. 2020) and a clean environment (Raymond et al. 2019) with improved health outcomes. Overall, our findings highlight that the quality of waterscapes mediates plural values and underscores the importance of landscape quality for future urban sustainability (Arias-Arévalo et al. 2017).

5.3. Association between plural values and urban sustainability challenges

5.3.1. Nature for society: instrumental values and future urban sustainability

Our findings revealed that respondents who considered instrumental values important perceived unemployment, water pollution, water scarcity, and inadequate wastewater treatment as sustainability challenges for their local waterscapes. These relationships indicate the importance of waterscapes for urban sustainability by supporting local economic activities, creating self-employment opportunities, and providing local foods (Kabisch 2015; Jones et al.

2016; Beck and Ferasso 2023). For example, parks around a waterscape generate an informal economy, such as street restaurants, toy shops, and paid recreational facilities. Such patterns were mainly found in Kolkata, where a lower average annual income means that residents may rely on such livelihood activities.

However, our findings indicate that the benefits of instrumental values depend on how urban waterscapes are managed (Kachler et al. 2024; Riechers et al. 2024). Poorly managed waterscapes exacerbate pollution and scarcity, but when managed effectively, waterscapes can enhance ecosystem productivity and support ecological resilience (Pascual et al. 2017; Hakkarainen et al. 2020; IPBES, I.S.-P.P. on B. and E.S. 2022). This aligned with the IPBES value assessment (Raymond et al. 2023), which emphasises the need for balancing multiple sustainability goals through the complementary consideration of instrumental and non-instrumental values (IPBES, I.S.-P.P. on B. and E. S. 2022).

5.3.2. Nature for nature: intrinsic values and future urban sustainability

In cities, the intrinsic value of waterscapes promotes a closer connection to nature and improved ecological health and sustainability (Rana et al. 2020). As sustaining intrinsic value can be costly, cost-effective strategies are required. Fostering bottom-up stewardship of the intrinsic values of waterscapes may be one such strategy (Dubo et al. 2023). Intrinsic values often overlap with instrumental values. For example, residents perceived that the biodiversity values of waterscapes can help mitigate heat waves, air and noise pollution in Bengaluru and Mumbai. Waterscapes have been shown to reduce temperature through the heat absorption capacity of water and to absorb air pollutants (Kabisch 2015; Mansur et al. 2022; Pereira et al. 2023). Similarly, waterscapes maintain urban biodiversity and enhance human well-being by providing spaces for recreation and citizen engagement (Kabisch 2015; Thapa et al. 2024).

5.3.3. Nature for culture: relational values and future urban sustainability

Our study found that residents in Kolkata perceived sustainability challenges such as un- and under-employment, water pollution and water scarcity, while also placing importance on relational values for waterscapes, including social relations, spirituality, social responsibility, and identity. Spiritual practices and community engagement with waterscapes in Kolkata create opportunities for self-employment, generate income, and empower urban residents. For example, neighbourhood/club-based *puja* (worship) committees manage the

immersion of devotional idols, which reflects collective responsibility and connects cultural identity with waterscapes. Aesthetic values of waterscapes can increase citizen engagement by fostering human–nature connections and inspire people to participate in conservation efforts (Mansur et al. 2022; Raymond et al. 2023). This indicates that relational values operate through different formal and informal institutions, shaped by local practices of urban water governance.

5.4. Association between plural values and socio-economic factors of the respondents

Our results revealed a significant association between plural values and the socio-economic characteristics of respondents living around urban waterscapes, which is typically an expression of the different roles that respondents assume in their daily lives (Arias-Arévalo et al. 2017; Masao et al. 2022; Peter et al. 2022; Kachler et al. 2024). In this study, we focused on respondents in proximity to urban waterscapes, who frequently engage with and observe the waterscape.

The duration of residence was closely associated with food value, economic value, social responsibility, and relational values. This supports the idea that long-term residents have a deeper understanding of the material benefits of waterscapes (Arias-Arévalo et al. 2017), which may help to foster stewardship. Older respondents stated a stronger importance for social responsibility and for food value. This may be because older residents have longer-term experience with the multiple uses of waterscapes. In contrast, younger respondents may have less direct interaction with waterscapes in their everyday lives. Therefore, older residents feel more responsible for maintaining the waterscape for future generations (Britto Dos Santos and Gould 2018; Riechers et al. 2024).

Similarly, frequency of visits to the waterscape was also associated with perceived usefulness, aesthetic value, and health value of waterscapes. This might be because cities in the Global South are congested and have less open space for dog walking, outdoor exercise, jogging, and walking. Waterscapes provide the space for such activities and contribute other health benefits such as cool breezes, improved air quality, and scenic beauty (Lamond and Everett 2019). The frequency of visits was also associated with the inherent and environmental value of the waterscape; this highlights how respondents value nature itself. This may be related to self-identification, as frequent visitors often expressed a stronger sense of attachment towards the waterscape. We found a substantial relation between

biodiversity value and respondents' education level (Arias-Arévalo et al. 2017; Kachler et al. 2024). This could be explained by the fact that educated respondents have a better understanding of biodiversity concepts and their importance to urban sustainability.

5.5. Interplay among the values: insights from the analysis

We found that the relational, instrumental, and intrinsic values of waterscape are interrelated. For example, collecting food materials from the waterscape (instrumental values) creates a relationship with the waterscape (relational value), and finally, these make the respondents accountable for managing the waterscape for existence (intrinsic value). Similar findings have been found in other studies as a result of livelihood practices (Ortiz-Przychodzka et al. 2023), in cultural landscapes (Riechers et al. 2024) and agricultural landscapes (Topp et al. 2022). Our findings indicated that respondents saw in particular relational and intrinsic values as inextricably linked (Arias-Arévalo et al. 2017; Schmitt et al. 2022; Riechers et al. 2024).

Our findings encourage policymakers to see waterscapes as a socially constructed system, suggesting that rethinking human-waterscape relationships can redefine the contributions of freshwater ecosystems to cities. This calls for moving beyond purely utilitarian perspectives and for adopting inclusive, value-based decision-making approaches that recognise the local cultural, spiritual, and identity-based connections to urban waterscapes. This integration of relational and intrinsic values into policy can be operationalised by involving local institutions in decision-making and allocating funds for community-led conservation efforts.

We acknowledge some limitations of our study. We have used binary responses for sustainability challenges, but the intensity of challenges faced by each respondent may differ. Another limitation is that the study covered a higher proportion of male respondents compared to female respondents, which may introduce gendered bias in the perceptions of values.

6. Conclusions

Our study explored the role of local perceptions of residents for the future of urban waterscapes by applying the Nature Futures Framework approach. It revealed the importance of relational and intrinsic values of these waterscapes for residents overall, while highlighting value differences among residents of different ages and education levels. People valued cultural identity, community bonding, and spiritual

connection more from well-maintained waterscapes than from neglected ones, and the importance of these relational values was greater for people who visit waterscapes regularly. The association between biodiversity values and environmental challenges such as air and noise pollution and heat waves suggest that residents view urban waterscapes as ecological spaces that can reduce environmental stresses in cities. Our findings highlight waterscapes as social-ecological infrastructure that supports biodiversity and improves overall urban environmental conditions, as well as providing cultural and recreational places. These results support incorporating relational and intrinsic values into policymaking alongside instrumental values for conserving these vital waterscapes in the Global South.

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