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Evaluating the activities of urban blues and their correlation with spatial structure

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Abstract: Water has played an essential role in developing human communities since antiquity. It has permitted the growth of diverse social and cultural spheres, establishing social links between small-scale communities through daily household activities, recreation, religious practices, and traditional celebrations. Blue spaces, such as ponds and Dighis (large ponds), are the principal sources of fresh water and focal points for water-based activities in small-scale communities. Blue spaces in cities are important in climate management and drainage and give residents social, cultural, and recreational advantages. Rapid urbanisation challenges water bodies by diminishing their associated activities and capacity for sustainable life. This study explores how the water-related activities correlate frequency with the surrounding spatial features of the urban pond. In a mixed-method process that combined observation survey and spatial assessment of nine urban and less urban ponds selected through purposive sampling. The result shows that the frequency and variety of activities are significantly different in the two contexts. From the regression, it is apparent that access route and activity frontage strongly influence the activity rates, while some factors display a moderate association. The study contributes to the urban design literature by highlighting how micro-scale spatial configurations affect blue space engagement and by offering context-specific planning recommendations to safeguard such aquatic environments. Methodological limitations, including perceptual subjectivity and seasonal variability, are acknowledged. This research contributes to the global discourse on urban blue infrastructure and provides planning insights for climate-adaptive and socially inclusive cities.

Keywords: blue space, urbanisation, spatial structure, activity rate, activity frequency

INTRODUCTION

Access to water resources has had an impact on people's settlement patterns through the ages (Xie, et al., 2017). Water system has driven social, cultural, and behavioural change and determined the layout and form of the towns. In their study, Xu et al. (2016) successfully proved the correlation between water and the scattering of archaeological sites from different ancient civilisations. Ponds provide a gathering area for individuals to participate in water-related activities such as household chores, celebrations, and religious rituals. In addition, ponds foster a wide array of biodiversity, offering inherent advantages for humans (Ngiam, et al., 2017).

The phrase "Urban Blue" encompasses a range of aquatic environments, including rivers, lakes, pools, ponds, and other similar bodies of water (Sunita, et al., 2023). Ponds are often varied with sizes ranging from 1 square metre to approximately 5 hectares (De Meester, et al., 2005), and Dighi refers to a water reservoir exceeding 750 square metres (Huq, 2017). They can be either artificially constructed or naturally occurring shallow bodies of water that serve as storage for water, either on a permanent or temporary basis (household ponds are a prevalent form of freshwater habitat in South Asian nations such as Bangladesh). Historically, these ponds were constructed to supply homestead soil during the rainy monsoon season or occurred naturally near houses, forming miniature freshwater ecosystems (Huq, 2017).

Illegal encroachments pose a significant hazard to water bodies due to growing urbanisation and limited availability of land for human settlement. Due to the phenomenon of urbanisation, it is projected that by 2030, over half of the global population will live in urban regions, making up around 60% of the world's population (Haub, 2007). During the past two decades, urban expansion has encroached upon the city of Sylhet's pond, located in north-eastern Bangladesh. Inadequate water management policies, subpar development methods, and limited public knowledge have resulted in uncontrolled expansion, adversely affecting water-related activities near the ponds.

Research on blue landscapes mainly examines biological and environmental aspects. However, there is a notable lack of research on how physical development affects water activities in cities. Scholars like Céréghino et al. (2014) and Sunita et al. (2023) have identified the incorporation of human behavioural patterns and place context into blue space science. Moreover, scholars working on urban design and planning stress the role of built environment factor such as frontage, access, and land use in contributing to public involvement or restriction (Bentley et al., 2013; Heffernan et al., 2014). This research adds to the understanding of blue space activities in Sylhet's rapidly developing urban environment and by correlating spatial data with activity mapping. It also highlights the issues of governance, such as private ownership of land and top-down planning that hinder equal access to water bodies.

This study aims to investigate water-related social, recreational, environmental, and cultural activities. Second, a hypothesis on the potential influence of the city's spatial structure on water-based activities will be explored. The study observed nine separate ponds spread over the city's municipal area in order to gather data. The activity rates, frequency, and spatial organisation of the pondside area were documented by the study. To collect data, researchers used field surveys and observations, which were then statistically analysed.

This research joins the discussion in architecture and urbanism by considering ponds as ecological and socio-spatial assets and, thereby, as essential drivers of change, expanding the scope of blue infrastructure. It advances previous studies by integrating behavioural components, thus providing a regionally sensitive evaluation of the urban value of water bodies in South Asia. In this paper, a refined, while very regionally focused, proposition is formulated that aims at other cities in the world that have the same problem of unofficial blue infrastructures, which are often overlooked but are pivotal in the development processes.

LITERATURE REVIEW

Benefits of urban blue spaces

Urban blue spaces are vital to the city's ecosystem and substantially contribute to its sustainability. The design of urban environments is influenced by the demands of humans, though these surroundings, despite being close to each other, display a range of different features. To effectively promote sustainable urban development in the context of expanding urbanisation and diminishing natural systems, it is crucial to have a thorough understanding of the benefits offered by urban ponds (Hassall, 2014). Ponds in rural and urban regions have substantial ecological, social, and cultural im-portance (Ngiam, et al., 2017). Urban blue spaces are viewed as critical elements of ecological and social health as well as a climate-responsive urban infrastructure (Völker and Kistemann, 2013; Anguelovski, et al., 2020). There is ample evidence of their multifunctional role as an aesthetic value, mental health contributions, moderation of urban heat, biodiversity, and stormwater management (Kabisch, et al., 2016; Krivtsov, et al., 2022).

Social and recreation

Urban green areas greatly appreciate water bodies' visual attractiveness, recreational possibilities, and capacity to offer education and foster a connection be-tween people and the natural environment (Manuel, 2003). They provide many advantages, such as social and recreational benefits, by encouraging physical exercise like walking along the pedestrian path next to the pond, improving mental well-being, and fostering community involvement (Sunita, et al., 2023). Additionally, these sources serve as exceptional water supplies for neighbouring communities to engage in washing and bathing activities.

Ecology

Ponds and the surrounding green areas are crucial components of urban Blue-Green Infrastructure (BGI) and provide various ecosystem services. These services include reducing the risk of flooding, improving the local climate, enhancing runoff water quality by filtering out pollutants, retaining nutrients, sequestering carbon, and dissipating heat through evapotranspiration (Boyer and Polasky, 2004; Céréghino, et al., 2014; Krivtsov, et al., 2022). Furthermore, urban ponds serve as communal areas in highly populated metropolitan areas. Frequent and localised aquatic, avian, and terrestrial life thrives in the limited areas of plant development along the shores of these ponds. Ponds serve as crucial habitats for aquatic biodiversity, and collectively, they function as interconnected pathways that enable the movement of species (Céréghino, et al., 2014).

Culture

Ponds are a central gathering place for residents during various cultural events. These bodies of water may have clubs and temples located nearby. Often, idols are submerged, and festivals are conducted in the fields adjoining these bodies of water. Finally, these bodies of water supply water for extinguishing fires in densely populated and continuously expanding metropolitan areas (Ray and Majumdar, 2005). Furthermore, ponds can provide specific hazards if enough upkeep is not provided. They turn into landfills when garbage is put there, owing to the careless activities of adjacent residents and communities, which threaten the health and well-being of the surrounding community (Deshwara, 2023).

Approaches in blue space research

In recent years, studies have utilised mixed approaches to examine how individuals interact with urban blue infrastructure. For example, Harris et al. (2022) and Chen et al. (2025) used observational processes, geospatial data, spatial mapping, and user interviews to connect blue infrastructure with social activity and interaction. These methodological antecedents validate the observational and spatial analysis methodology utilised in this research. Although the biological roles of ponds are extensively documented (De Meester, et al., 2005; Hassall, 2014), their socio-spatial dynamics in fast urbanising areas are still inadequately investigated. Scholars alike Céréghino et al. (2014) and Sunita et al. (2023) have detect-ed the incorporation of human behavioural factor and spatial context into blue space research.

Moreover, researchers in urban design and planning underline the role of built environment features such as frontage, access, and land use in enabling or constraining public engagement (Bentley, et al., 2013; Heffernan, et al., 2014). This research contributes by contextualising blue space activities within Sylhet's rapidly changing urban fabric and by integrating spatial data with activity mapping. It further highlights the governance challenges, such as private ownership and top-down planning that hinder inclusive access to water bodies. Finally, the literature attests to the urban blue space's ecological, cultural, and recreational significance. However, it emphasises that studies examining the spatial correlates of activities using systematic field observation have been lacking. This study bridges that gap by an empirical approach based on both environmental design theory and socioecological practice.

Water bodies in the context of Sylhet

Bangladesh has abundant rivers, canals, ponds, and bills (shallow wetlands) (Islam and Chowdhury, 2013). Sylhet City is located in the north-eastern region of Bangladesh. It is extended along the Surma River and has a diverse landscape consisting of ponds, canals, hills, and brooks. This urban area was formerly called "Dighirsohor," meaning "city of ponds." Interestingly, numerous other sites in the city bear names derived from important ponds. For instance, the area named Shagor Dighir par means the locality beside the Shagor Dighi; thus, the community that develops around these ponds indicates the significance or reliance on the water body for their way of existence (Chowdhury, 2017). Moreover, the ownership of those ponds and their surroundings significantly influences the activity level. In less urbanised areas with private ownership, ponds are often utilised for social activities. At the same time, those maintained by the government or city corporate authority are more commonly used for cultural and recreational purposes. However, both types of ponds contribute to the overall environmental well-being.

The city is experiencing rapid expansion and urbanisation. Based on the 2001 population census, Sylhet City is Bangladesh's sixth most urbanised city. An increasing population signifies a greater need for water, exerting significant strain on water supplies. In 1988, Sylhet district's total area of water bodies was 81,535.2 hectares. By 2006, this had decreased to 28,435.6 hectares. Unplanned urbanisation and the acquisition of low-lying lands by real estate limited businesses are the primary factors contributing to the depletion of water bodies (Rahman, 2011). The city's notable Dighis included Chara Dighi, Ramer Dighi, Lala Dighi, Sagar Dighi, Majumdar Dighi, and Dhopa Dighi. Except for Lala Dighi, all other bodies of water have been filled in or no longer exist for various reasons, including uncontrolled urbanisation. A section of the Machu Dighi was filled in a few years ago (Haque, 2023). The rapid expansion has primarily been driven by the migration of impoverished individuals from rural areas, notably to major urban centres (Islam and Chowdhury, 2009).

METHODOLOGY

This study utilised a qualitative approach to justify the hypotheses. Data was primarily collected through observation and field surveys of the case study area. The research consisted of several significant steps, from selecting the case to collecting the data.

Selection of case study area

This research aims to determine the number of activities currently taking place in specific urban ponds and examine the correlation between the activity rate and the surrounding environment's physical structure. The northern part of the Sylhet city corporation area, divided by the Surma River, was taken as the study area, shown in Fig. 1. Nine distinct ponds were chosen as examples within the northern city corporation's jurisdiction. A stratified purposive sampling strategy was applied to select nine ponds that collectively represent both urbanised and less urbanised conditions. The criteria for selection included geographic distribution, diversity in ownership (public, private, or semi-public), cultural relevance, observed frequency of use, and accessibility of spatial data. The selected ponds were Botpara Pond, Dostidar Dighi, Membe Pond, Lala Dighi, Machu Dighi, Kajal Shah Dighi, Kazi Dighi, Shonatulla Pond, and Ram Krishna Mission Pond as shown in Tab. 1.

Identification of water-based activity

Urban ponds offer various services that result in tangible and intangible activities in and around the pond area. Numerous studies have identified various water-based activities contributing to social, environmental, cultural, recreational, and economic benefits. Tab. 2 demonstrates the diverse uses and activities associated with urban ponds that have taken place to determine the hypothesis.

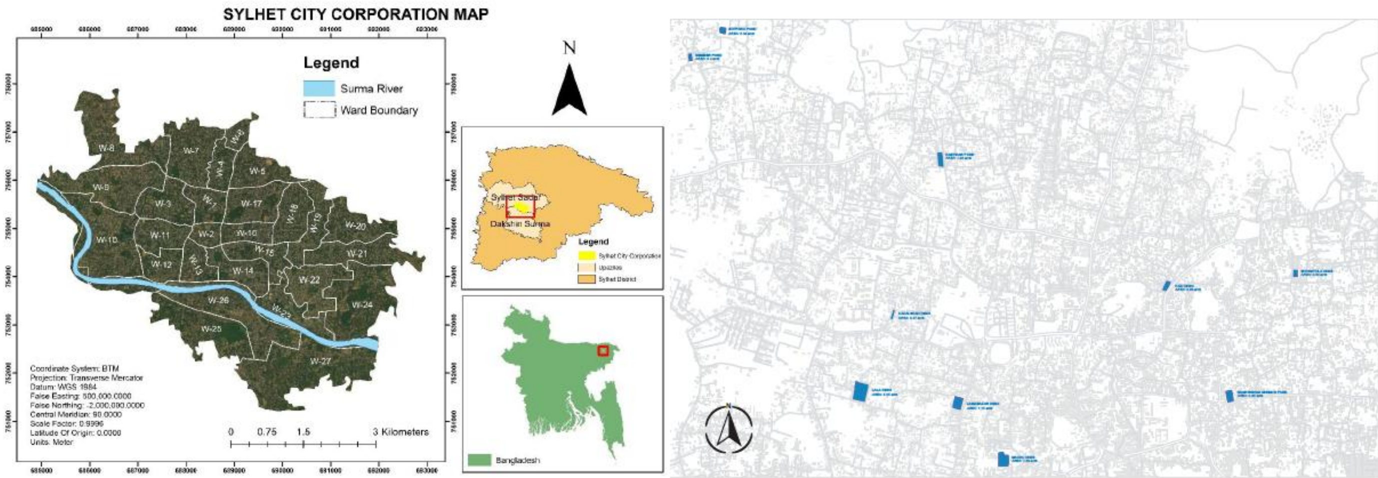

Fig. 1. Location of the study area selected from northern part of the Sylhet city. (Source: Islam and Rahman, 2022; modified by author)

Tab. 1. Inventory of selected ponds. (Source: Authors, 2024)

Name of urban ponds	Geo-Location	Size in acres	Management authority	Surrounding landscape
Botpara Pond	24.918647, 91.844317	0.54	Public	Less urban
Dostidar Pond	24.910615, 91.859369	1.33	Public	Less urban

Shonatulla Pond	24.903016, 91.884005	0.63	Private	Less urban
Member Pond	24.917099, 91.842180	0.4	Private	Less urban
Lala Dighi	24.895937, 91.853630	3.05	Public	Urban
Machu Dighi	24.891322, 91.863521	1.69	Public	Urban
Kajal Shah Dighi	24.900742, 91.855954	0.37	Private	Urban
Kazi Dighi	24.902329, 91.875075	0.85	Private	Urban
Ram Krishna Mission Pond	24.895130, 91.879308	0.85	Private	Urban

Tab. 2. Water-based activity around the urban pond. (Source: Ray and Majumdar, 2005; Huq, 2017; Céréghino, et al., 2014; Ngiam, et al., 2017; Kaur and Prashar, 2019; Suchana, et al., 2012)

Water resources	Bathing	A large number of people from lower economic background use them for bathing.
	Washing	Washing of clothes, utensils and other domestic requirements.
Environment	Climate control	Ponds affect local microclimate, making it cooler and soothing.
	Open space	Ponds provide an open space providing room for air movement. Space for recreational use.
	Trees	Generally, the pond banks have tree plantations, preserving urban nature.
	Aquatic ecology	Ponds support many aquatic and other species, a receptacle of biodiversity in urban context.
	Flood control and drainage	Ponds help to act as water retention tanks during flood and overflow of surface water due to heavy rainfall.
Economy	Fish cultivation	Source for local employment and good protein.
Social and recreational	Community gathering	People spend time sitting around these ponds. Many ponds have seats around them and are an important place for local community gathering.
	Clubs	Because of open space, there often exist many clubs by the pond side. These clubs also manage the ponds.
	Walking, sitting, and meeting	The pond offers spaces to walk, sitting and place for social gathering.
Culture	Temples	Many ponds have temples by their sides. Temple authorities also manage some ponds.
	Holy ponds	Some ponds have a history associated with them and/or are related to some shrines and are considered as holy ones.
	Fair	Due to the presence of temples, fairs are organised in the open spaces in front of many ponds.
	Immersion	The immersion of idols is an important event in Hindu festivals. A number of ponds are specifically used for this purpose.

Observation survey and reliability measures

A survey was done to measure the activity rate and frequency of the chosen urban ponds. The activity rate measures the number of activities carried out in each urban pond, as indicated by the activity chart in Tab. 3. The survey was conducted five days a week over six weeks, covering three daily time slots (10 A.M. to 1.00 P.M., 3 P.M. to 7 P.M., and 8 P.M. to 11 P.M.). The activities were categorised as performative and perceptual to aid the measurement process. Perceptual tasks such as aquatic ecology and climate control were assessed by the research team based on the perceived quality of the current condition. Five scores were possible: one for "abysmal," two for "poor," three for "average," four for "good," and five for "very good." One of the measures of performative acts was the length of use. Tab. 3 presents the average frequency of all activities from 1 to 5, with 1 indicating "never," 2 indicating "rarely," 3 indicating "sometimes," 4 indicating "often," and 5 indicating "always."

Due to the lack of restrictive availability, a specific interview and observation were undertaken to detect occasional religious or communal congregations, which take place once a year or twice a year. The six research assistants assessed the perceptual exercises and undertook an observation survey across different ponds. To certify reliability, observers joined in pilot sessions commonly on two ponds and under-went a systematic two-day training. A cross-evaluation method comprised 20% of observations, and Cohen's kappa (0.78) highlighted substantial inter-rater consistency. Observers replaced among locations to minimise familiarity-based bias, and data forms were anonymised prior to investigation. Nonetheless, perceptual tasks involve subjective judgment, and this limitation is duly acknowledged.

Spatial structure around the case study pond

The physical survey was conducted within a 500-meter radius of the pond's centre to collect spatial structure data. Online maps and information provided by local authorities were analysed. The following variables were assessed and transformed into an ordinal dataset: land use, accessibility, building height, pond size, perimeter roads, and active frontage. These markers are presumed to distinguish between urbanised and less urbanised areas. Land use pertains to the various forms of use within a given area, where a value of 4 signifies the existence of four distinct types of use. The study did not include any differences or variations in these use forms. The access or route is vital in defining the diversity of place and activity (Bentley, et al., 2013). Here, the access count represents the total number of roads linked to the pond, for instance, with a value of 3 indicating that there are three connected roads.

Tab. 3. Data collection framework. (Source: Authors, 2024)

Activity types	Activities	Measuring process	Method of data collection	Survey schedule	Rating scale
Perceptual activities	Trees and open space Aquatic ecology Climate control	Based on perceptual quality of existing activities by author.	Observation	6 weeks, 10 hours daily 10 A.M. -1 P.M., 3 P.M. - 7 P.M, 8 P.M. -11 P.M.	values of 1, 2, 3, 4, and 5 represent "very poor," "poor," "average," "good," and "very good," respectively
Performative activities	Bathing, washing Fish cultivation and aquaculture Walking, sitting, and fishing Community gathering, club	Based on duration or frequency of use.	Observation	6 weeks, 10 hours daily 10 A.M. - 1 P.M., 3 P.M. – 7 P.M., 8 P.M. -11 P.M.	values of 1, 2, 3, 4, and 5 represent "never," "rarely," "sometimes," "often," and "always," respectively
	Immersion, holy pond, fair Flood and drainage management	Based on duration or frequency of activities occasionally and yearly.	Observation and interview	6 weeks, 10 hours daily 10 A.M. - 1 P.M., 3 P.M. - 7 P.M., 8 P.M.-11 P.M.	values of 1, 2, 3, 4, and 5 represent “never,” “rarely,” “sometimes,” “often,” and “always,” respectively

The density of an urban pond determines the height of structures within a 500m radius. Typically, the central portions of a city feature more skyscrapers than less developed areas. This study considers the mean height of the buildings in the study region. Active frontage pertains to the portion of the urban pond that is visible and easily accessible from another adjacent area. It encompasses the physical establishment of retail spaces and the ability to enter the building's premises. This study quantified the proportion of the overall area occupied by active frontage. A rating of 50 indicates that half of the area surrounding the pond is accessible and visible to other activities. The distance from the primary thoroughfare indicates proximity, which may influence urban activity (Koohsari, et al., 2015). In addition, urban intervention and density typically align with primary roadways, resulting in less urbanisation in areas remote from these routes. A landmark is a distinctive land use that enhances a place's accessibility and draws people to it (Denis, 1997). Landmarks such as temples, public buildings, open spaces, and mosques significantly impact urbanisation. The study gathered data on the number of landmarks within the designated area.

Interview for data collection and analysis

We did 21 semi-structured interviews with 2 to 3 important users or informants per pond. The purpose of these interviews was to record infrequent occurrences (such as yearly religious ceremonies) and the contextual elements that affect pond activity. Responses were transcribed, translated, and thematically analysed. A preliminary codebook was created, and two researchers independently assigned codes to the transcripts. We talked about the codes to compare and improve them, and we used the results to triangulate and back up the observation data.

Data analysis

The statistical model seeks to illustrate the pattern, trend, and relationship of variables that establish the relevance of the hypothesis. Firstly, descriptive analyses represent the trend and pattern of pond activity. Furthermore, it examines the contrast between a pond in an urban area and a less urban area to ascertain the frequency of activities. The Simple linear regression model is employed to demonstrate the relationship between the activity rate and the spatial parameters of the urban pond in Sylhet. The multiple regression analysis determines which spatial characteristic component is substantially connected with activity creation.

The linear regression model can be represented by an index that incorporates the p-value and t-statistic, indicating the importance of the hypothesis. A high t-statistic suggests a low likelihood of rejecting the null hypothesis, while a decreased p-value indicates more significance of the independent variables. The p-value of the coefficient for the independent variable is statistically significant at a 99% confidence level. The R2 value, also known as the coefficient of determination, is used in linear and multiple regression models to assess the model's goodness of fit. It quantifies the extent to which the independent variables can explain the variation in the dependent variables.

Limitations

Due to time limitations, the survey was conducted for 6 weeks, though there are some essential activities related to religious occasions that occur biannually. Perceptual data was collected by the research team, potentially introducing research bias.

Although these considerations limit generalisability, the methodology offers a solid empirical basis for subsequent urban pond investigations in comparable contexts.

RESULTS

Activity diversity and frequency

The result shows that the number of activities varies across different ponds, with several having a maximum of 9 activities. The average number of activities in a less urban pond is higher than in an urban pond, as shown in Fig. 2. Ponds that were less urbanised had a high-er average number of different activities than ponds that were more urbanised. For instance, ponds like Kalibari and Member Pond had up to nine different activities, but urban ponds like Kazi Dighi and Mission Pond had fewer activities on average. The results, as presented in Tab. 4, demonstrate that all activity frequencies possess a value below the mean of 3, except climate control.

Climate control has the highest mean score among all activity frequency ratings, specifically 3.22, which refers to the perception that the pond's climate control quality is between average and good. The median, mode, and sample variance values are 3, 4, and 1.05, respectively. The urban ponds have an average rating of 3 for their efficacy in flood control, provision of open space, and support of aquatic ecosystems. For community gatherings, clubs have the lowest mean frequency score (2.33). The activities with the highest variability in scores (based on standard deviation) are immersion, holy pond, fair (1.51), and walking, sitting, and fishing (1.33). The perceptual quality of trees and open space has the widest range (4), suggesting more variability in how often this activity is under-taken. The consistency in the median value of 3.00 across all activities suggests a central tendency around this value. The modes vary more significantly, indicating different most common scores for each activity.

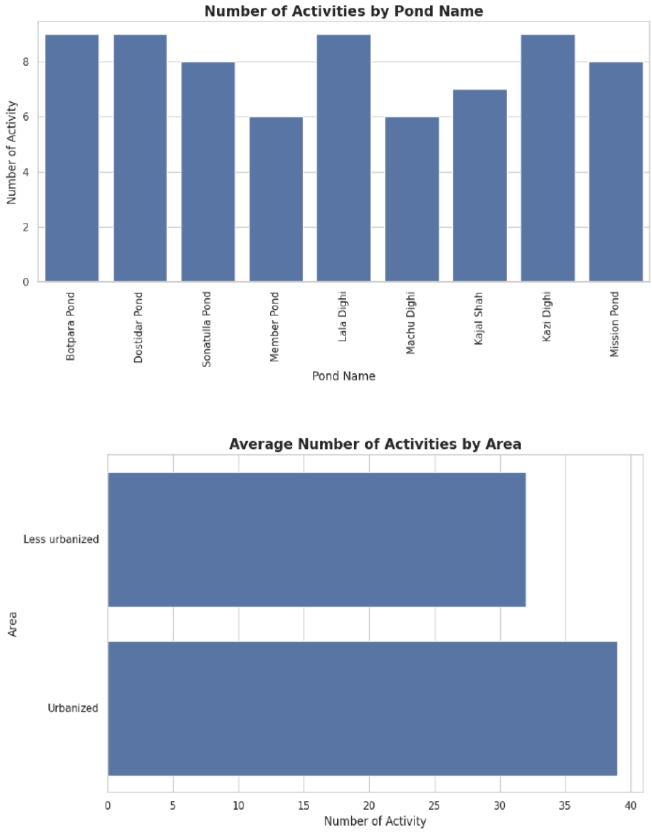

Fig. 2. Number and average activity numbers of urban and less urban pond. (Source: Authors, 2024)

Tab. 4. Descriptive analysis of the activity frequency. (Source: Authors, 2024)

	Bathing, washing	Climate control	Flood and drainage management	Trees and open space	Aquatic ecology	Fish cultivation and aquaculture	Walking, sitting, and fishing	Community gathering, club	Immersion, holy pond, fair
Mean	2.89	3.22	3.00	3.00	3.00	2.89	2.56	2.33	2.56
Median	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Mode	4.00	4.00	3.00	3.00	3.00	4.00	4.00	2.00	1.00
Standard Deviation	1.05	0.83	0.71	1.22	0.87	1.27	1.33	0.87	1.51
Sample Variance	1.11	0.69	0.50	1.50	0.75	1.61	1.78	0.75	2.28
Range	3	2	2	4	2	3	3	3	3
Minimum	1	2	2	1	2	1	1	1	1
Maximum	4	4	4	5	4	4	4	4	4
Sum	26	29	27	27	27	26	23	21	23

Urban vs. less urban pond

The result shows a significant variation in activity frequency between less urban and urban ponds. For in-stance, the benefits due to climate control activities vary, with “good” being more common in less urbanised areas and “average” being common in both, as shown in Fig. 3. Trees and open spaces are commonly perceived as "average" in quality in less urbanised areas. In more urbanised areas, the most common perception is "inferior." Both areas have similar counts for the categories of "very good," "good," and "very poor", as shown in Fig. 4. Fig. 5 shows that the perception of aquatic ecology is "average," with a higher number in less urbanised ponds than in urbanised areas. However, it is "good" in both types of ponds, with urbanised areas showing a slightly higher count. Fish cultivation and aquaculture are more common in urbanised areas than in less urbanised ones. They are rarely or never practised in both. While fish cultivation and aquaculture are sometimes practised in urbanised areas, this practice is not observed in less urbanised areas (Fig. 6).

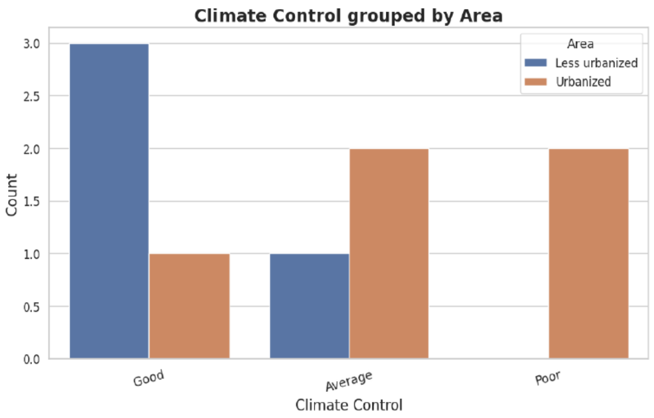

Fig. 3. Activity frequency by area (Climate control). (Source: Authors, 2024)

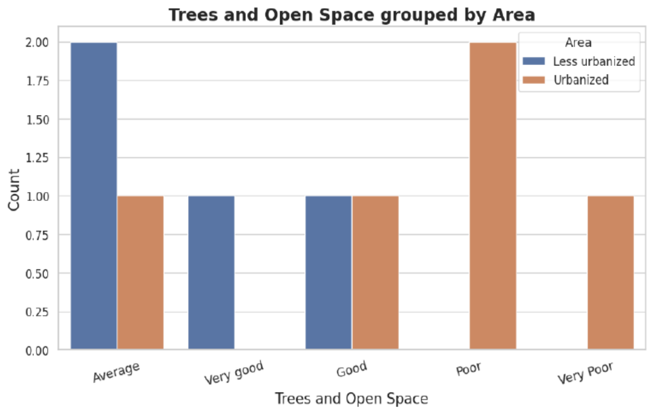

Fig. 4. Activity frequency by area (Trees and open space). (Source: Authors, 2024)

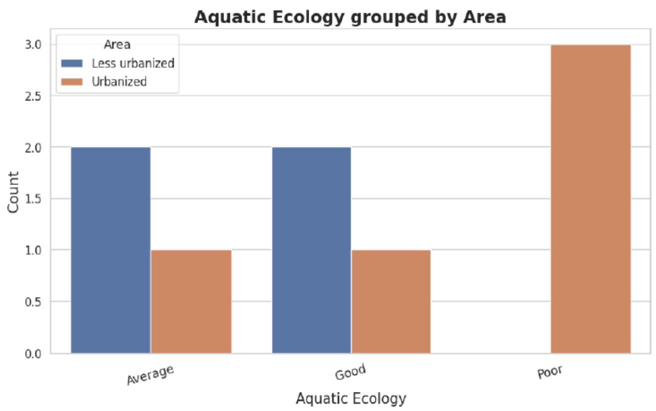

Fig. 5. Activity frequency by area (Aquatic ecology). (Source: Authors, 2024)

The data provided in the figures gives insights into community engagement patterns across different types of areas. For instance, community gatherings or club meetings occur more frequently in the "less urbanised" area, particularly in the "often" category, as shown in Fig. 7. The "Bathing, Washing grouped by Area" graph visually compares bathing habits between more and less urbanised areas. Each set of bars represents the count for each bathing frequency category. The highest count for bathing frequency is observed in the "often" category in both areas. Additionally, the graph shows that the "rarely" or "never" categories are not used in less urbanised areas, as shown in Fig. 8.

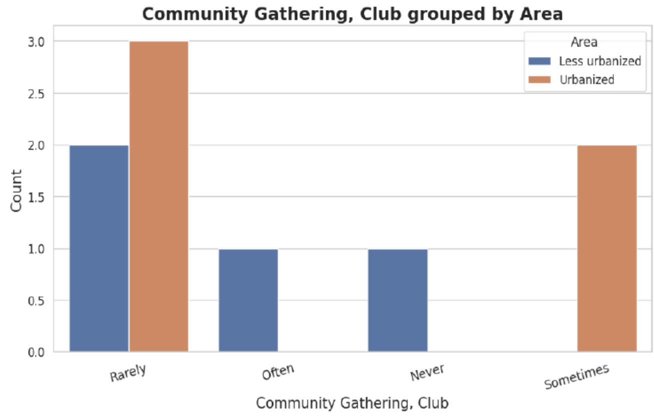

Fig. 7. Activity frequency by area (Community gathering). (Source: Authors, 2024)

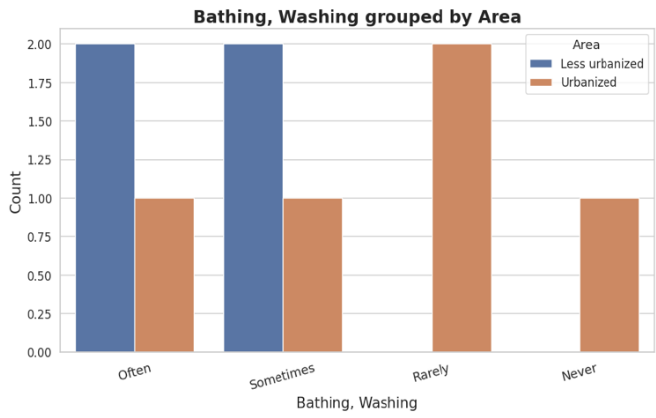

Fig. 8. Activity frequency by area (Bathing, washing). (Source: Authors, 2024)

"Walking, Sitting, and Fishing grouped by Area" provides an overview of Dighi's walking, sitting, and fishing activities and their frequency in different types of areas (less urbanised vs. urbanised). Notably, community members in the "Less urbanised" area engage more frequently in these activities, particularly in the "often" category, as shown in Fig. 9. The bar graph titled "Count of Flood and Drainage Management grouped by Area" compares the frequency of flood and drainage management in less urbanised and urbanised areas. Flood and drainage management is higher in the "rarely" category in less urbanised areas. Conversely, flood and drainage management in urbanised areas is significantly higher in the "Sometimes" category than in less urbanised areas, as shown in Fig. 10. Finally, the bar graph "Immersion, Holy pond, Fair grouped by the Area" reveals that Immersion occurs more frequently in urbanised areas, particularly with a significant difference in the "Often" category, as shown in Fig. 11.

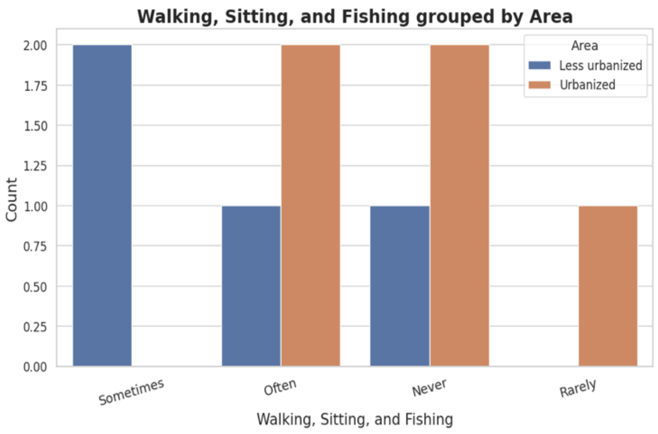

Fig. 9. Activity frequency by area (Walking, sitting, finishing). (Source: Authors, 2024)

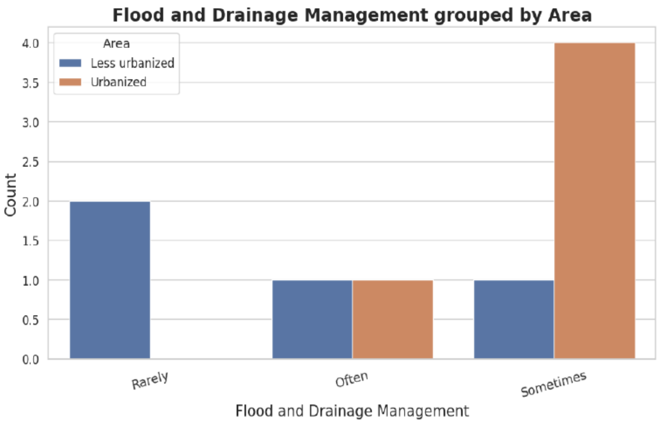

Fig. 10. Activity frequency by area (Flood and drainage). (Source: Authors, 2024)

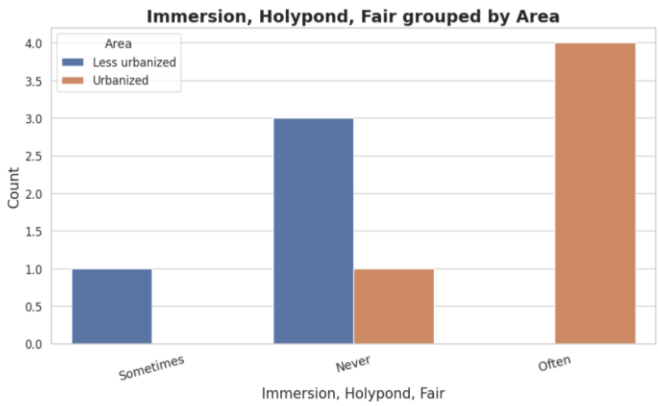

Fig. 11. Activity frequency by area (Immersion, Fair, Holy pond). (Source: Authors, 2024)

Regression results

The study examines the linear correlation between the activity rate and the spatial structure of the urban pond, with the y-axis representing the independent variable (spatial structure) and the x-axis indicating the dependent variable (activity rate). The activity rate is closely linked to the number of accesses, the active frontage, and the size of the water bodies, for instance. It means that when these numbers rise, so does the number of activities, as shown in Fig. 12, 13, and 14. There is a substantial link between the number of accesses and the active frontage, with correlation coefficients of (r = 0.44) and (r = 0.29), respectively. The coefficient for the size of the water body is (r = 0.06), which means that there is a moderate link between the size of the water body and the activity rate.

Conversely, the activity rate exhibits a negative correlation with land use (r =.13) and building density (r =.013), as illustrated in Fig. 15 and 16. It can mean that the activity rate is lower because of the intense competition surrounding urban ponds. The relation between activity rate and presence of the landmark near pond area seems insignificant as shown in Fig. 17. We discovered a substantial multiple correlation be-tween the indicators of spatial configuration and activity rates ($p < 0.05$), despite a low R^2 value. Lower coefficients guarantee that spatial considerations alone do not fully explain the variability in pond usage among individuals and also show how important cultural, institutional, and ecological elements are.

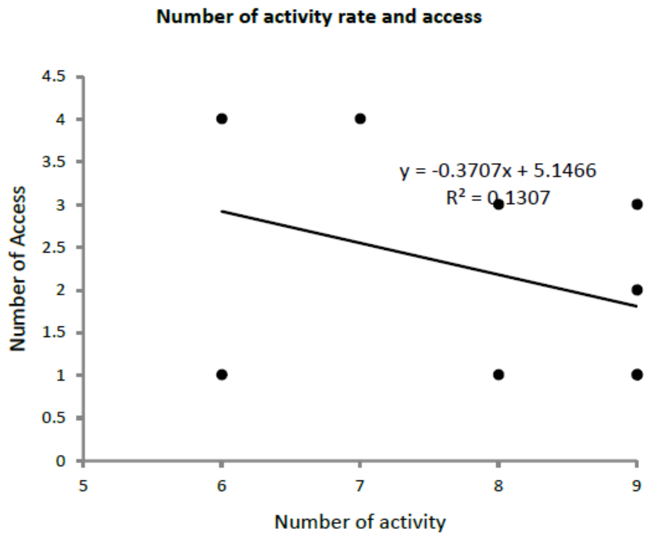

Fig. 12. Correlation between number access and activity rate. (Source: Authors, 2024)

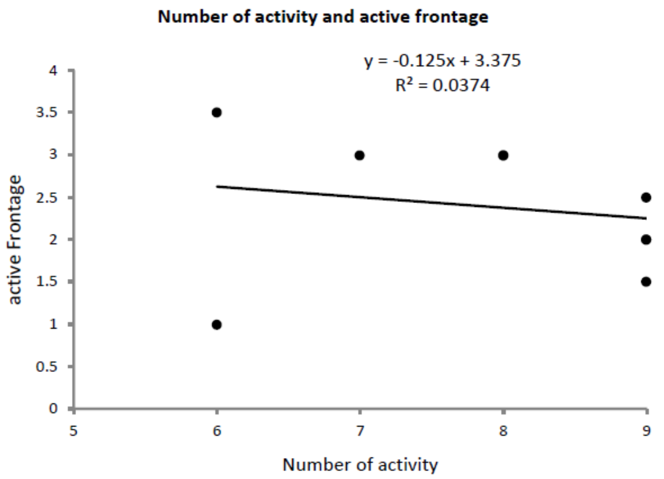

Fig. 13. Correlation between active frontage and activity rate. (Source: Authors, 2024)

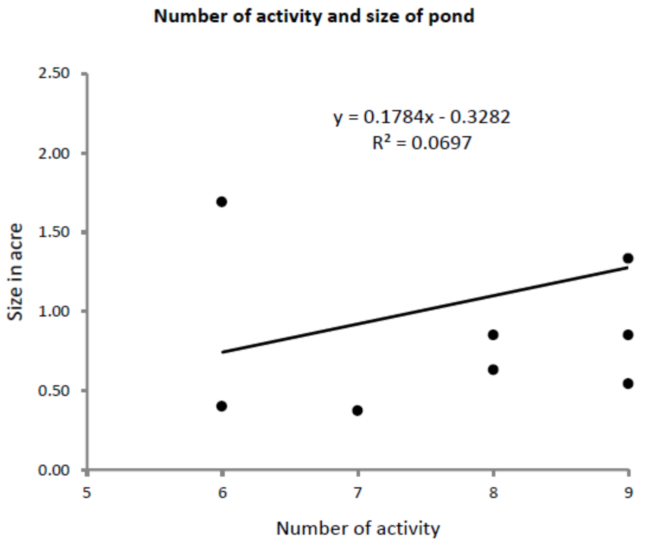

Fig. 14. Correlation between activity rate and pond size. (Source: Authors, 2024)

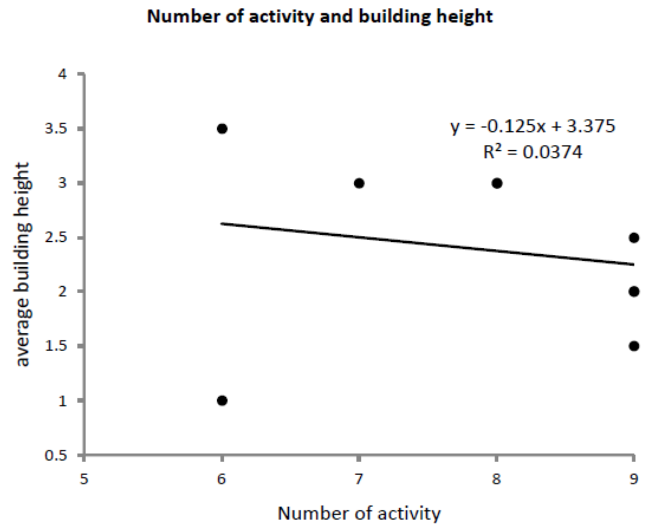

Fig. 15. Correlation between activity rate and building height. (Source: Authors, 2024)

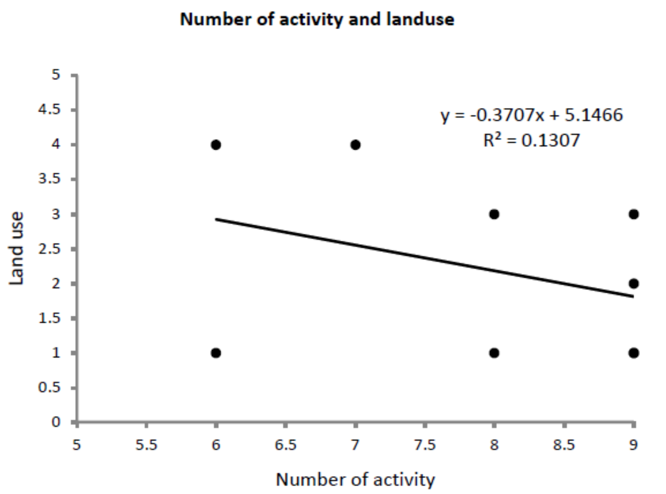

Fig. 16. Correlation between activity rate and land use. (Source: Authors, 2024)

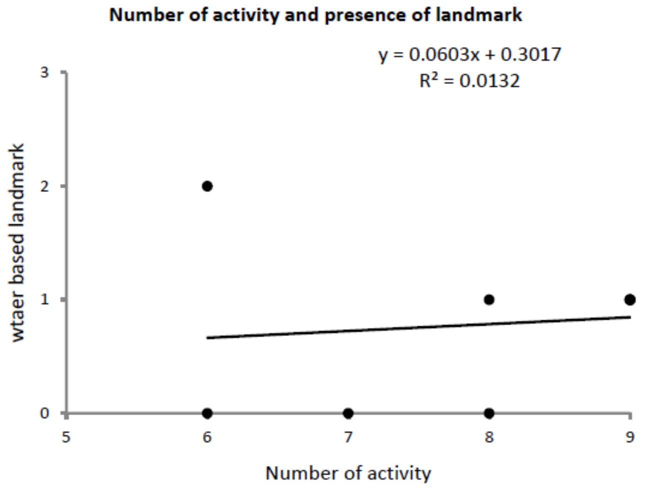

Fig. 17. Correlation between activity rate and landmark. (Source: Authors, 2024)

DISCUSSION

Understanding the water activity patterns

The survey confirms six prevalent activities among the nine specified kinds. Domestic tasks such as bathing and washing were more common in ponds located in less urban areas like Kalibari Ponds, Member Ponds, and Dostider Dighi, as opposed to urban ponds. Residents continue to rely on fewer urban ponds for routine domestic tasks, as the water supply from the local municipality in urban areas does not reach them. The rich natural landscape of ponds (as shown in Fig. 18) makes evaporative cooling a noteworthy feature for reducing warmth, a function that aligns with previous studies on the influence of urban ponds on thermal advantages (Boyer and Polasky, 2004; Céréghino, et al., 2014; Krivtsov, et al., 2022). Conversely, urban ponds exhibited more restricted usage, with activities skewed toward formalised events such as religious ceremonies. This divergence may reflect both infrastructural constraints and socio-political regulation in denser areas. These findings support previous scholarship suggesting that public space usage is strongly conditioned by accessibility, perceived ownership, and the surrounding built environment (Bentley, et al., 2013; Heffernan, et al., 2014). Nevertheless, the survey findings for these activities in the chosen case studies are subpar. The study has highlighted various societal and managerial issues underlying the reasons, such as:

1. The social conflict arises from the presence of different groups residing near the pond.
2. The excessive regulation and strictness in pond utilisation are shown in Fig. 19.
3. The ponds are surrounded by high-speed vehicular lanes to prevent unauthorised occupation, as shown in Fig. 20.
4. Insufficient space and infrastructure to promote recreational and social activities.
5. The planning and design process follows a tradition-al top-down approach.
6. The presence of strong private ownership makes it difficult to intervene.

The analysis indicates that urban ponds such as Mission Ponds, Kazi Dighi, Kajal Shah Pond, and Lalal Dighi were commonly used for public gatherings, including fairs, festivals, and immersion ceremonies.

Fig. 18. Large trees and green space around Member Pond reduce air temperature. (Photo: Authors, 2024)

Fig. 19. Kazi Dighi is surrounded by steel gates that control pond use. (Photo: Authors, 2024)

Fig. 20. Peripheral vehicle road reduces public recreation around urban waterbodies. Expalme of Lala Dighi. (Photo: Authors, 2024)

Spatial structure and use

Multiple access points and pathways surrounding urban ponds facilitate public involvement and connectedness, encouraging participation in various activities, which is consistent with previous studies, as the paths impact the variety and extent of activity in a given location (Bentley, et al., 2013). In the study area, an active frontage, such as retail shops, public buildings, commercial and communal activities, contributes to public security and surveillance. For instance, annual religious program of Hindu community performance is held every year centring on a Hindu temple located just beside the Kajal Shah Pond as shown in Fig. 21. It may explain why ponds with a more active frontage experience increased levels of activity and public involvement aligns with other studies examining the influence of active frontage on individuals' views of public space, specifically concerning safety, comfort, sociability, and liveliness (Heffernan, et al., 2014).

Fig. 21. Religious festival beside Kajal Shah Pond. (Photo: Authors, 2024)

While certain spatial variables like access and active frontage correlate positively with activity diversity, the modest R^2 values indicate that spatial design alone cannot fully predict or stimulate public use, underlining the need for integrated planning approaches that combine spatial openness with social inclusivity and ecological enhancement. The weak negative correlation between building height and activity, for instance, suggests that vertical density can reduce informal engagement, likely due to visual enclosure, noise, or perceived inaccessibility.

Community feedback and governance

Fig. 22. Pond deck development for public use and recreation at Dostidar Dighi. (Photo: Authors, 2024)

Fig. 23. Pond side shaded pedestrian path. (Photo: Authors, 2024)

Interview responses and field observations highlight broader systemic issues such as top-down planning approaches, poor maintenance, limited recreational infrastructure, and a lack of coordination between municipal and private stakeholders. In urban ponds, high vehicular traffic around the perimeter (e.g., Kazi Dighi and Lala Dighi) was often cited as a barrier to engagement. Similarly, heavy regulation and unclear access rights deterred daily use, particularly for marginalised communities. The case of less urbanised ponds—such as Dostidar Dighi and Kalibari Pond—demonstrates how local ownership models and informal stewardship can foster higher levels of everyday use. For instance, people living around Dostidar pond have successfully developed their area by improving pond deck and peripheral pedestrian as shown in Fig. 22 and 23. However, these systems also carry risks of exclusion and environmental degradation without regulatory oversight. Therefore, successful blue space management should balance formal planning with bottom-up governance and community-driven initiatives.

Design and planning implications

The study points to several key considerations for urban designers and planners:

1. Ensure multiple, pedestrian-friendly access points to enhance permeability and encourage spontaneous use.
2. Integrate active frontage through community services and retail to promote passive surveillance and safety.
3. Avoid complex zoning and single-use surroundings that limit activity diversity.
4. Incorporate flexible-use platforms and infrastructure (e.g., steps, seating, shaded areas) that accommodate both routine and ceremonial uses.
5. Employ inclusive governance frameworks that allow co-management between local authorities and community stakeholders.

Overall, this study extends the understanding of how spatial characteristics intersect with sociocultural practices in the context of urban ponds. It underscores the importance of considering physical, social, and ecological dimensions concurrently to protect and revitalise blue infrastructure in developing cities like Sylhet.

CONCLUSION

Incorporating and supporting blue spaces like ponds can help minimise the negative consequences of intense urban strain while enhancing the overall quality of life in an increasingly urbanised culture. The significance of this paper lies in the investigation of the fundamental attributes of urban blue spaces, such as ponds and Dighi, and their interconnection with the surrounding environment. The findings show that spatial features such as access routes, pond size, and active frontage can significantly shape the frequency and type of activities occurring around urban ponds. However, the modest R^2 values in the regression models reinforce the idea that spatial design alone is insufficient. Instead, the success of urban blue spaces depends equally on social inclusivity, policy support, and community stewardship.

From an international perspective, the study aligns with recent global efforts to revitalise blue-green infrastructure as part of sustainable and climate-resilient city planning (Davis, et al., 2020; Kabisch, et al., 2016). In particular, this research underscores the relevance of decentralised, context-sensitive design approaches in tropical cities where formal planning often overlooks community needs and environmental interdependence. Based on the material presented, the following planning strategies are recommended:

1. Implement adaptive co-management models involving local authorities and user communities.
2. Prioritise inclusive access design, especially for marginalised groups.
3. Safeguard pond perimeters from complex infrastructural barriers like highways and high-rise walls.
4. Promote multifunctionality by integrating ecological services, cultural events, and informal uses.

5. Introduce seasonal monitoring frameworks to capture long-term variations and improve water management.

In addition to the strengths of the study, several limitations must be acknowledged. The six-week data collection period restricts generalisation across seasons, and perceptual assessments, despite calibration efforts, carry inherent subjectivity. Future research could extend this work by employing longitudinal designs, incorporating environmental data (e.g., water quality, temperature), and comparing multiple cities across regions. Ultimately, safeguarding urban blue spaces like ponds requires more than environmental concern—it demands a synthesis of design intelligence, participatory governance, and social justice. This study offers a model for understanding and enhancing such spaces in Sylhet and serves as a reference point for other cities navigating similar challenges in the Global South.

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