

Sustainable Urban Design Guidelines for Different Types of Urban Ponds: A Case Study of Sylhet, Bangladesh

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Abstract

Urban ponds are one of the essential natural elements that have supported urban communities with ecological benefits as well as sociocultural and economic activities throughout the ages. These ponds are presently facing existential threats due to increased urbanisation and the lack of available space in the cities. Sylhet, one of the most prominent cities in Bangladesh, is expanding at an unprecedented rate. Migrants are making the city's inner circle more populated, raising more pressure on building density, and ponds and open spaces are being filled up. As a result, urban dwellers' living conditions are worsening due to the lack of natural areas and the growing number of environmental issues. People are losing access to ponds and open spaces and shifting away from their traditional lifestyles. Meanwhile, the municipality is working diligently to address these issues, but a collaborative effort between the community and the municipality is required to resolve the difficulties. This paper aims to analyze the importance and current status of the city's existing ponds and establish development guidelines for the ponds, so they can be designed and protected sustainably. Some findings of a survey conducted among the local communities have been presented. Their opinions about these natural elements and reviews from previous research are discussed and analyzed, leading to the design implications for the sustainability of the urban ponds and a sustainable future city.

Keywords

Urban Ponds, Urbanization, Conservation, Urban Design, Sustainability

1. Introduction

Urbanisation is one of the most pervasive human factors contributing to the increased building density and functional disruption of the natural environment (Turner, 1994). According to (United Nation, 2014), 54% of the world's population resides in urban regions, which is projected to increase to 70% by 2050 (Komeily & Srinivasan, 2015; Shen et al., 2011). Urbanisation rates in developing countries are five times faster than in developed countries (López et al., 2001). The rigorous process is causing environmental challenges, one of which is severe ramifications for several water sources involving hydrological and ecological changes (Ahmed et al., 2019; Donofrio et al., 2009). The rapid expansion of city areas faces enormous pressure of population density and backlogs in shelter and infrastructure, resulting in land use change and additional demand for natural resources (López et al., 2001; Mohan et al., 2020). These factors lead to a significant decrease in the area of water bodies, cultivable lands, and open spaces (Dewan & Yamaguchi, 2020).

Although in the past, urban planners and architects believed that a contemporary, rational decision-making process was the driving force behind a successful city, recent research has cast doubt on this assumption. In today's world, decision-makers are contemplating ways to promote sustainable development (Porta et al., 2005). (Basiago, 1998) also ascribes modern development patterns as the root cause of environmental degeneration, directly induced by economic pressures and social disparities, and suggests urban sustainability as a potential solution to be incorporated into the local and regional planning frameworks to combat the social, economic, and environmental issues altogether. The demand for sustainability developed from inequitable development patterns, and the transformation towards environmental sustainability became crucial due to the decline of natural resources (Goodland, 1995). However, it may be challenging to define the indicators of sustainable development within the framework of urban planning policies and decision-making (Puchol-Salort et al., 2021). In the case of designing water bodies and open spaces, developing compact knowledge is the key to integrating various components (i.e., social, economic, and ecological collaboration) of sustainable development (Ameen et al., 2015; Oral et al., 2020; Russo & Cirella, 2020), rationalising design sustainability for diverse stakeholders (Oktay, 2004; Pandit et al., 2015), and exploiting the countless benefits of the natural resources via ecosystem services (Andersson et al., 2019; Brown & Mijic, 2019).

Water bodies (i.e., ponds, lakes, canals, rivers) are essential parts of the urban ecosystem. Water bodies in urban areas are critical to the well-being of public health, environmental protection, and the livability of cities (Fletcher et al., 2013). Cities are developing with buildings, roads, and other grey infrastructures while losing many open space and water bodies. That is where the phenomena of urban heat island (UHI) effects are becoming more prevalent. This effect has garnered significant attention from higher temperatures in the cities than in nearby rural

areas, indicating a grave threat to public health (Amani-Beni et al., 2018). Urban waters positively impact their local microclimate and contribute to the evaporative cooling effect, one of the most efficient passive cooling methods for built environments and urban areas (Ampatzidis & Kershaw, 2020; Gómez-Baggethun et al., 2013; Manteghi et al., 2015; Sun & Chen, 2012). City planners should consider water bodies as nature-based tools for improving microclimatic conditions in outdoor places (Robitu et al., 2006). Water has been the lifeline of urban areas. Sustainable urban water management is crucial for protecting the water resources, utilising their benefits for the present users, future generations, and a resilient city (Novotny, 2008), especially in developing countries because they prioritise infrastructural development, economic gain, leaving environmental issues as the minor concern (Bulte & Van Soest, 2001).

Bangladesh, like other developing countries, is also dealing with critical environmental issues. People are moving towards urban areas at an unprecedented rate. Cities are expanding without adequate planning. This case particularly applies to the present situation of Sylhet, one of the fastest-growing cities in Bangladesh. Our study area, Sylhet city, is located in the northeastern region of Bangladesh. The rapidly expanding metropolitan city is one of the biggest business centres in the country. Sylhet City Corporation was established in 2001. The city corporation area encompasses 26.50 square kilometres, with a population of nearly 3 million (Population & Housing Census, 2011). Water bodies have always played a significant role in the city's social, economic, and environmental aspects. These natural features served various purposes, including fishing, swimming, washing daily house chores, and passing leisure time. Boating and fish cultivation were some of the economic activities. Urban water bodies in the shape of ponds are scattered around the city and deeply intertwined with its urban fabric and inhabitants (Alam, 2018). These natural features are being filled up, and residents are drifting away from their traditional way of life to accommodate the high population density.

Additionally, the city is triggering various ecological and climatic problems. In the last two decades, most of the city's vital organs are gone. Either building were constructed upon the ponds, or these were converted into small garbage-filled ditches (Chowdhury, 2017). Once which used to be the centre of social, economic, and recreational activities, are now losing their purposes. However, the remaining ponds will experience the same fate if the city continues to expand without proper planning and design guidelines.

This research explores the significance of urban ponds for the well-being of the residents and their surrounding areas. It also addresses peoples' thoughts about the different types of urban ponds and their suggestions for the development process through an online-based survey and physical interviews. The result of the survey is discussed. In the end, the study proposes sustainable design guidelines for conserving the urban ponds and restoring the lost connection to their users for a sustainable city.

2. Methodology

The research criteria were based on gaining practical, grounded knowledge about the existing conditions of the urban ponds and users' perceptions of the future development of these natural features. Both primary and secondary data were analyzed in our research. Primary data have been gathered through a questionnaire survey and physical interviews among the city residents. Secondary data were analyzed through a literature review and desktop research. Respondents were chosen randomly from all over the city, regardless of their gender, age, profession, or duration of residence, to ensure an accurate and unbiased result. The city corporation area is divided into thirty-nine wards, and people from each ward were targeted to cover information about the variety of ponds.

According to recent research, community participation in sharing opinions or direct involvement is considered a successive factor in the sustainable urban planning process (Amado et al., 2009; Münster et al., 2017; Slocombe, 1993). In the city of Sylhet, people come from a variety of cultural backgrounds and have their own distinct identities. Over time, the ponds have also developed their unique characteristics, which help to recognize, value, and classify the areas in which the people reside, both on a communal and regional level. In this case, the opinions of the direct stakeholders are given greater importance for the planning process.

The questionnaire survey was online-based. People were approached through social media (Facebook, Messenger and Whatsapp) and emails and were first notified about the objectives of the survey. Regardless of their age, profession, or place of residence, respondents were chosen randomly from all over the city. Those willing to participate were urged to answer the questions via a google form for participating in the survey. Respondents were requested to give information about their nearest water body so that the answers would reflect the characteristics of a particular area.

The questionnaire form had two response formats: close-ended questions and multiple-choice questions with additional options. Close-ended questions are used to gather the basic demographic information of the users. Multiple-choice questions are designed to ensure that responses are versatile and flexible, and respondents can also provide unique information by selecting the "others" option. Questions were posed to participants about their vision, preferences, and willingness to make proposals and engage in the development of their community. In the physical survey, exploratory interviews with users and residents of the study area were carried out to understand the existing situation better. The study was not intended to predict or forecast anything; instead, it was primarily designed to gather exploratory data. Despite this, the results provide the authors with valuable information regarding how the ponds can be protected in the communities and provide healthy environments for the residents' day-to-day well-being and quality of life.

3. Result and Analysis

Participants are asked for the information needed to assess their social standing and whereabouts, such as gender, age group, and profession. 400 questionnaire forms were distributed over the internet, and a total number of 334 people participated in the survey. The data was gathered over two months. The response rate was relatively high (95.4%) and was frequently accompanied by positive comments and encouragement. **Figure 1** illustrates 66.7% of the participants were male and 33.3% were female participants. The age mainly varied from 18 to 60 years, with young persons who are 18-24 years old making up the majority (42.3%) of the group. Most of the respondents were students by profession (51.5%). People are residing for more than 20 years, indicating that the local residents are the greatest (43.5%) in number among the participants.

3.1. Present Condition of Urban Ponds

Data were collected to analyse the problems and issues regarding the research area's environmental conditions, human safety, physical properties, and spatial quality. People were asked, "What are the main problems with the ponds?". The

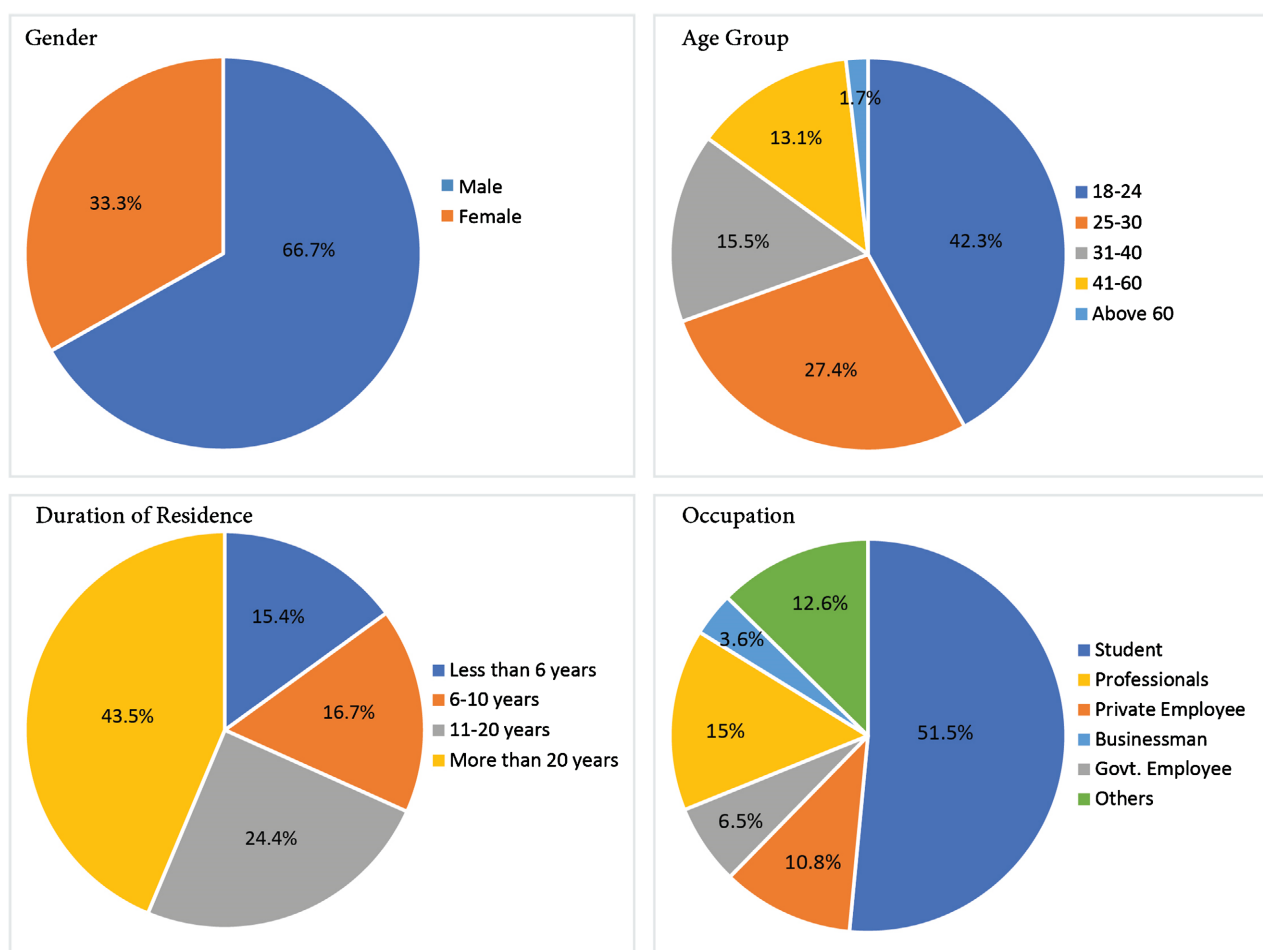


Figure 1. Demographic data of the participants.

attention was drawn to a wide array of responses. 76% of people mentioned “Waste dumping” as the most crucial issue of the present time, which eventually contributed to other problems like water contamination (49%) and awful smell (43%). Public access to the ponds is another unfortunate fact. Either the water banks are disconnected or illegally occupied, and people do not have direct access to the ponds (38%). Other issues include a lack of lighting, ghats, and seating areas. People were asked, “If they feel safe after the evening?”. 89% of them gave negative responses. Improper maintenance and inadequate sociocultural facilities are turning these places into dead spaces.

3.2. Public Preferences Based on the Scale of Urban Ponds

People’s fondness for ponds was revealed via survey. Individuals’ daily usage or visits reflects their demands and what they suggest to develop the quality of the places. This information can be for architects, urban planners and municipalities to make policies and define design approaches that align with the users’ needs and expectations. The same question was posed to ponds of several sizes, namely small, medium, and large, to determine whether or not there are discernible variations in their preferences according to the dimensions of the ponds. People were asked, “what facilities centering the ponds do they suggest?”. The question structure was multiple choice. The following options were provided to select: “walkway”, “park”, “seating”, “ghat”, “tree plantation”, and others. The analysis shows that 62.3% of people suggested tree plantation for the small ponds in **Figure 2**. The result is reasonably expected as there is a close relationship between vegetation cover and ponds available in an urban context.

Integrating trees in the shape of big canopies, shrubs or grass near the water bodies positively influences faster heat reduction (Nuruzzaman, 2015; Zinia & McShane, 2018), less surface runoff (Berland et al., 2017; Mcgrane, 2016; Stovin et al., 2008) and provides a healthy environment for the city dwellers (Coutts et al., 2013). The walkway constitutes another essential facility, as indicated by the users (51.5%). Priority is given to communities’ affordable and easy waterfront access to ensure flexibility, a sense of belonging, and social sustainability (Papatheochari & Coccossis, 2019; Shah & Roy, 2017; Skayannis et al., 2017).

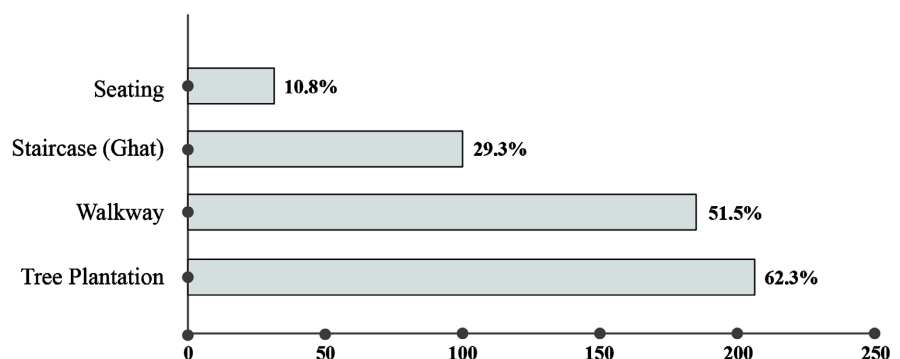


Figure 2. Public preferences for small ponds.

Seating and ghat were also preferred. Ghat is a structure with a couple of stairs which is typically used for entering the pond. People here are traditionally attached to ghats to swim in the ponds, wash daily utensils and pass their leisure time sitting on stairs. Responses were more varied for ponds of medium size than the preceding one. Medium ponds along with some open spaces, were suggested to be facilitated with parks (30.5% and playgrounds (31.7%) in **Figure 3**. The plantation of trees (65.9%) and walkways (49.7%) continued to hold a majority of votes. Large ponds cover an area of more than 5 acres and provide services to dwellers on the city scale. People from all over the city tend to visit these places. In this respect, they suggested many alternative facilities for these ponds. Recreational parks were preferred among many of them (43.1%) in **Figure 4**. Urban parks are the provider of social services such as relaxation, social integration and

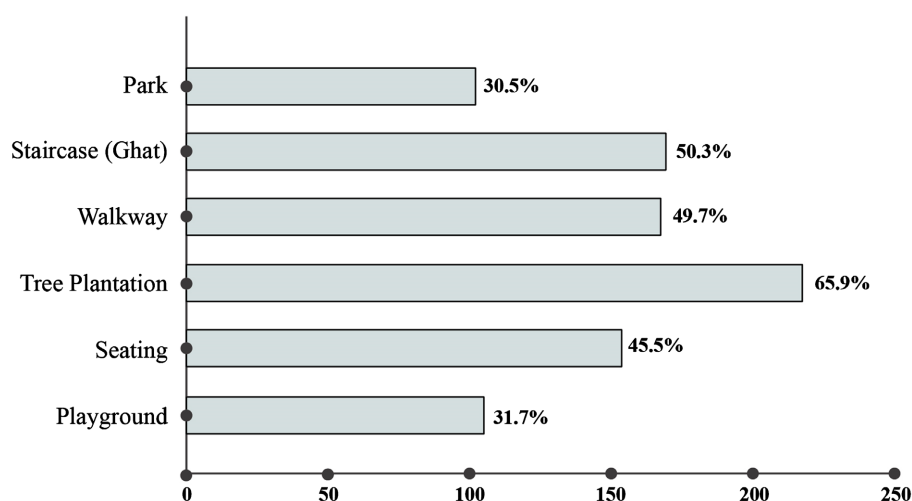


Figure 3. Public preferences for medium ponds.

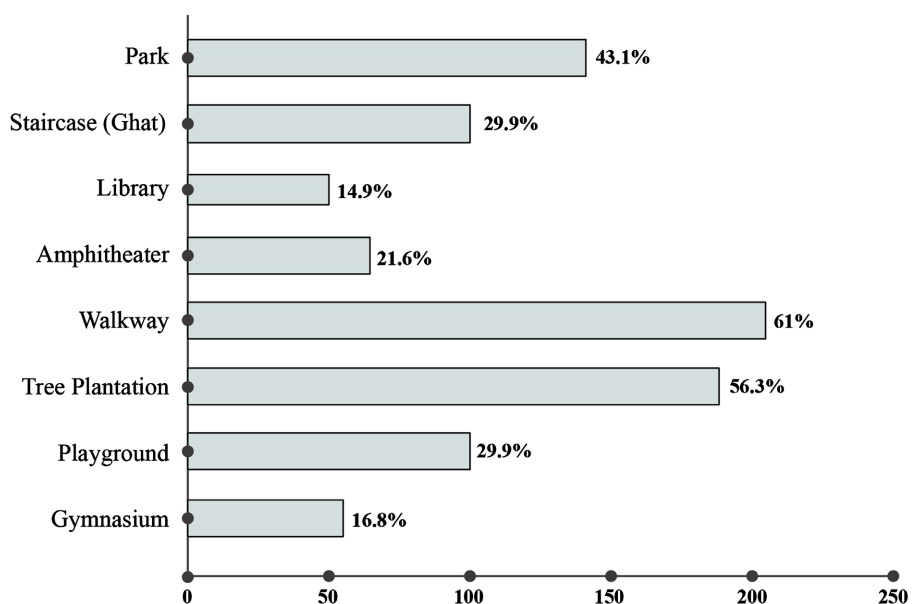


Figure 4. Public preferences for large ponds.

the well-being of mental and physical health of children to elderly citizens (Barbosa et al., 2007; Byrne & Sipe, 2010; Chiesura, 2004; Konijnendijk et al., 2013; Wang et al., 2013). Culture, in all its manifestations and forms, becomes a significant asset to ensure societal cohesiveness, and culturally diverse social elements help define the local identity (Amado et al., 2009). “Amphitheater”, “Library”, and “Playground” are some other features people have chosen which would boost not only sociocultural values but also promote new economic sources (Shah & Roy, 2017). However, walkways (61%) and tree plantations (56.3%) were mentioned most frequently and reflected a great significance among all the other facilities users have suggested.

4. Recommendation

The survey findings reveal significant opportunities for urban ponds to be transformed into active, usable spaces that can serve people a healthy urban life and ecosystem benefits (Andersson et al., 2019). It also recognizes green open areas or blue spaces as the most prominent provider of ecosystem benefits that can serve both at a large scale (whole city or urban region) and a small scale (neighbourhood area). These natural resources can mitigate urban sustainability challenges (temperature increase, poor environment quality) and community participation needs such as outdoor recreation and social activity (Elmqvist et al., 2018; Haase et al., 2014; Kabisch et al., 2017). Sustainability is deeply intertwined with urban design (Frey, 1999; Jabareen, 2006; Wheeler, 2000), and sustainable urban design is an accumulative term of broader notions to create socially, economically, and environmentally sustainable urban areas (Carmona, 2009; Gasparatos et al., 2008). To enhance the city’s sustainability, urban planners should aim to facilitate the urban ponds with a holistic development strategy.

Social sustainability has become a crucial facet of sustainable development, becoming entangled with the discourse on delivering sustainable communities (Colantonio, 2010). Accessibility seems to be a key component in promoting social sustainability (Chan & Lee, 2008) and has a psychological impact on how people perceive places on the basis of comfort and safety (Sairinen & Kumpulainen, 2006). People who responded mentioned walkways as an essential amenity to improve their connection to local ponds or ponds in distant areas. By incorporating pedestrian routes and bike lanes into streets or vehicular roads, people are prompted to stroll more frequently, where they meet friends and neighbours, and the sense of community is brought to life (Liu et al., 2021; Oktay, 2004). “Seating area”, “Playground”, and “Ghat” are some of the amenities that people have widely expected to include in the pond banks of different urban land uses and spatial qualities. Communal sustainability has five measurable aspects which are social interactions, participation in collective groups, sense of place attachment, community stability and safety-security (Dempsey et al., 2011, 2012) and these are interrelated with the amenities the area has provided.

The survey response has also demonstrated the need for “Space for celebrating

cultural programs”, and “Space for religious festivals”. The responses clearly express the existence of cultural ethnicity. Culture acts as a continual filter that affects how individuals perceive and celebrate various environments while still residing in the same areas (Setten et al., 2012; Stephenson, 2008). One of the aspects of social sustainability is an individual’s level of involvement in cultural and community activities (Kearns & Forrest, 2000). Sustainable urban design needs to provide people with a variety of freedom in case of amenities for how they can interact with their neighbourhood areas and public environment (Beatley & Manning, 1997; Bentley, 1985; Montgomery, 1998; Rodríguez et al., 2014). Economic viability is another crucial aspect of sustainability (Ameen et al., 2015), and economic sustainability thoroughly depends on the local economy with diverse activities and more local employment (Brindley, 2003). It is essential to provide the scopes of local entrepreneurship, economic expansion and direct connectivity with the major economic areas surrounding the pond banks in order to improve economic viability. People also drew great attention to the environmental quality of the pond’s surroundings. To protect the urban ponds, green features impact on a large scale. Incorporating green open spaces, green canopies, small shrubs, and grasses helps in a wide range, from stormwater management, slope protection, and water purification to wastewater management (Larco, 2016). To enhance the city’s livable environment, urban planners should aim to facilitate the urban ponds with convenient access by local communities and adequate amenities for physical activity and recreation along with the economic growth and restorative ecology (Kabisch, 2017).

4.1. Recommendations to Achieve Sustainability

Therefore, sustainable urban design guidelines have been recommended for the urban ponds on the basis of different areas, cultures, people, and their purposes. The recommendations seek to improve the socio cultural-integration, economic viability, and environmental quality of the urban ponds and their surrounding areas. The recommendations are as follows:

4.1.1. Sociocultural Recommendations

- Providing walkways for easy and convenient public access.
- Designing cycle lanes surrounding the ponds.
- Providing ghats and seating areas for community integration.
- Designing amenities such as children’s play zones and small neighbourhood parks centering the medium-sized ponds.
- Designing public recreational parks and playgrounds centering the large ponds.
- Creating lively public spaces for cultural celebrations, such as amphitheatres for public gatherings.
- Providing spaces for religious festivals near the water banks of religious areas.
- Designing adequate lighting and railing for safety and security.

4.1.2. Economic Recommendations

- Connecting the ponds with the city's major roads.
- Incorporating public gathering areas with new scope for local entrepreneurship, such as vendors, tea stalls, and food courts.
- Boating facilities and fish cultivation in the urban ponds.
- Designing floating decks for public attraction.

4.1.3. Environmental Recommendations

- Providing green ecological networks surrounding the ponds.
- Using vetiver grass for natural slope protection and green quay walls in case of a flat embankment.
- Providing Hedges and native shrubs beside the walkways and cycle lanes.
- Providing fauna passages for the safe movement of the reptiles.
- Cultivation of waterlilies for natural beatification and water purification.

4.2. Typological Design Prototypes for Different Scale of Ponds

In this section, the existing issues and future development guidelines for various ponds have been described. In addition, how these ponds can be redesigned and protected by applying the sociocultural, economic, and ecological sustainability recommendations has been discussed here. **Figures 5-7** illustrate the design guideline prototypes to address challenges and develop facilities for particular pond types, surrounding areas, and users.

4.2.1. Typological Design Guideline Prototypes for Small Ponds

In some cases, small ponds have vehicular roads adjacent to their banks. In the

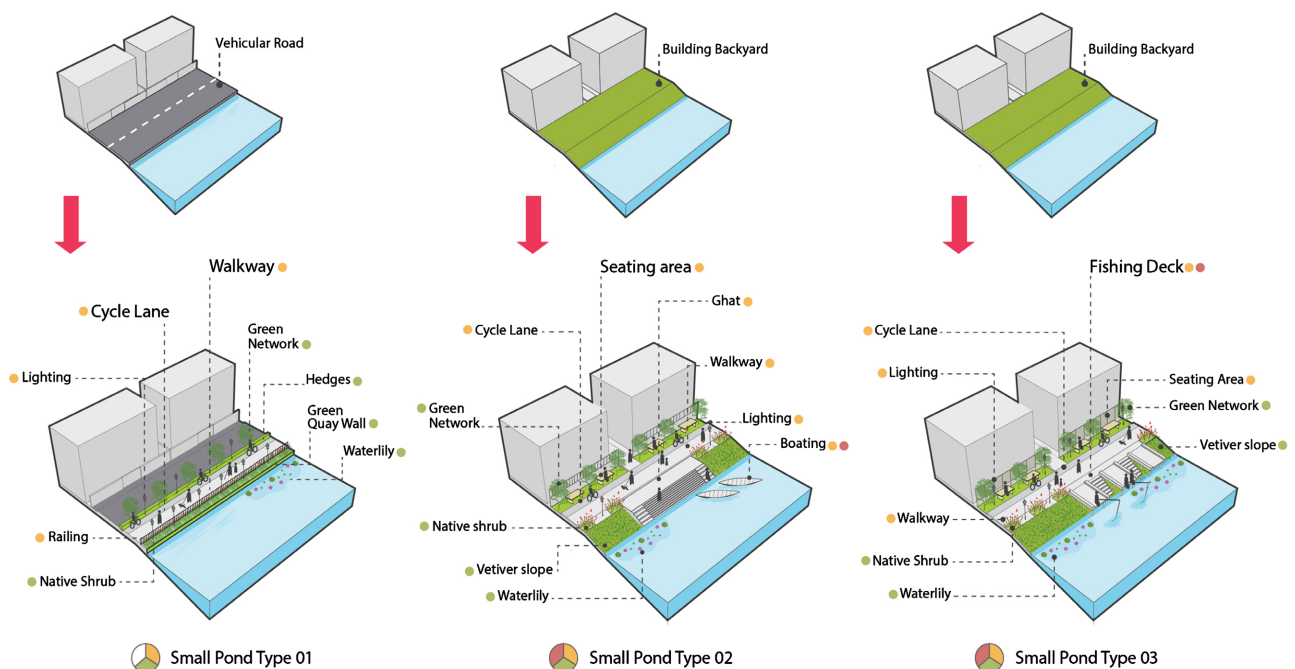


Figure 5. Design Guidelines for small ponds.

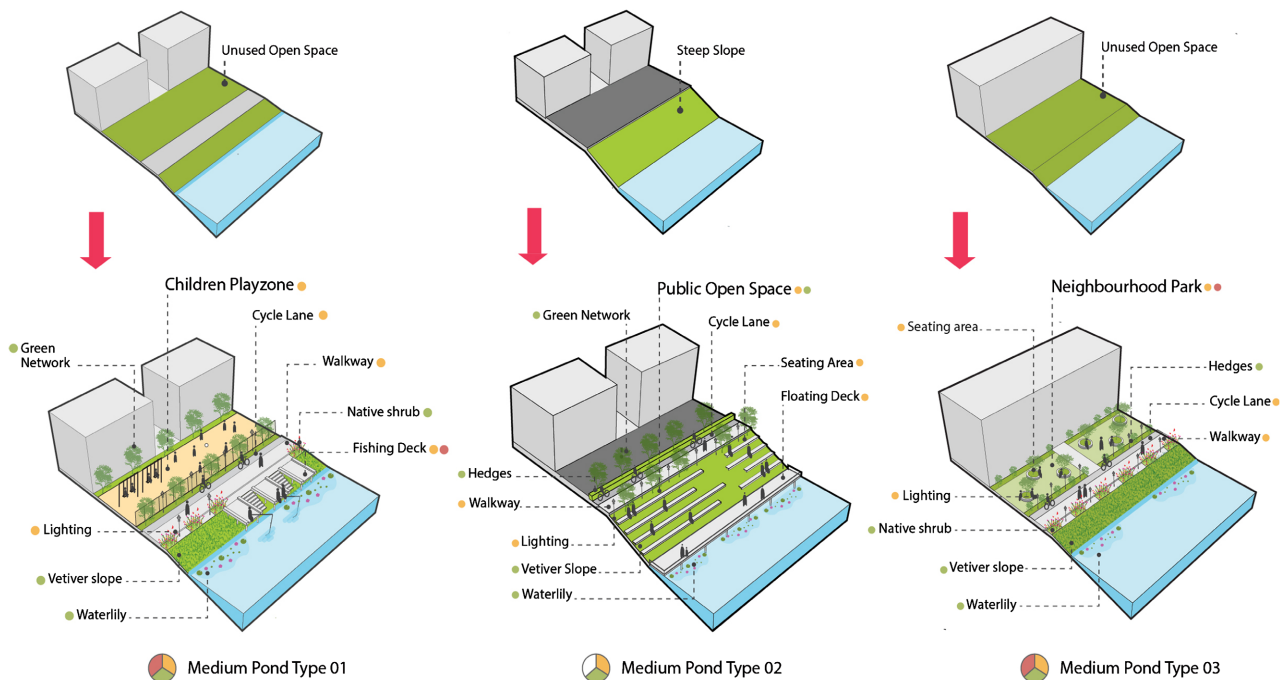


Figure 6. Design Guidelines for medium ponds.

absence of any pedestrian connection, people cannot get access to these water bodies. Moreover, no railing or lighting facilities raise safety issues for the users. **Figure 5** illustrates how walkways and cycle lanes can be designed near the banks to increase walkability and cycling facilities. Eco-friendly green quay walls can be used instead of flat concrete banks. Railing and adequate streetlights can ensure safety and security for users of all ages or genders. Ponds that do not have enough and are mainly used as building backyards can be transformed by adding seating areas, ghats, and fishing decks for serving as small community spaces. Boating facilities and fish cultivation will create new sources of economy. The green networks of big canopies and native shrubs will improve the environmental quality.

4.2.2. Typological Design Guideline Prototypes for Medium Ponds

Medium-sized ponds with unused open spaces can be revitalised by children's play zones, public open areas, and neighbourhood/parks. **Figure 6** describes these ponds can be a great source of mental and physical well-being on a community scale. Children's play zones designed with toys and sliding instruments will be joyful, active spaces for the children in the community area. Neighbourhood parks can be used as exercise areas, picnic spots, BBQ corners, and other outdoor activities for people of all ages. Fishing decks can extend social interaction as well as the local economy. Unused steep slopes can be designed as seating areas where people from neighbourhood areas can spend leisure periods. Vetiver grass will help to protect the pond slopes, and waterlilies will mitigate water pollution.

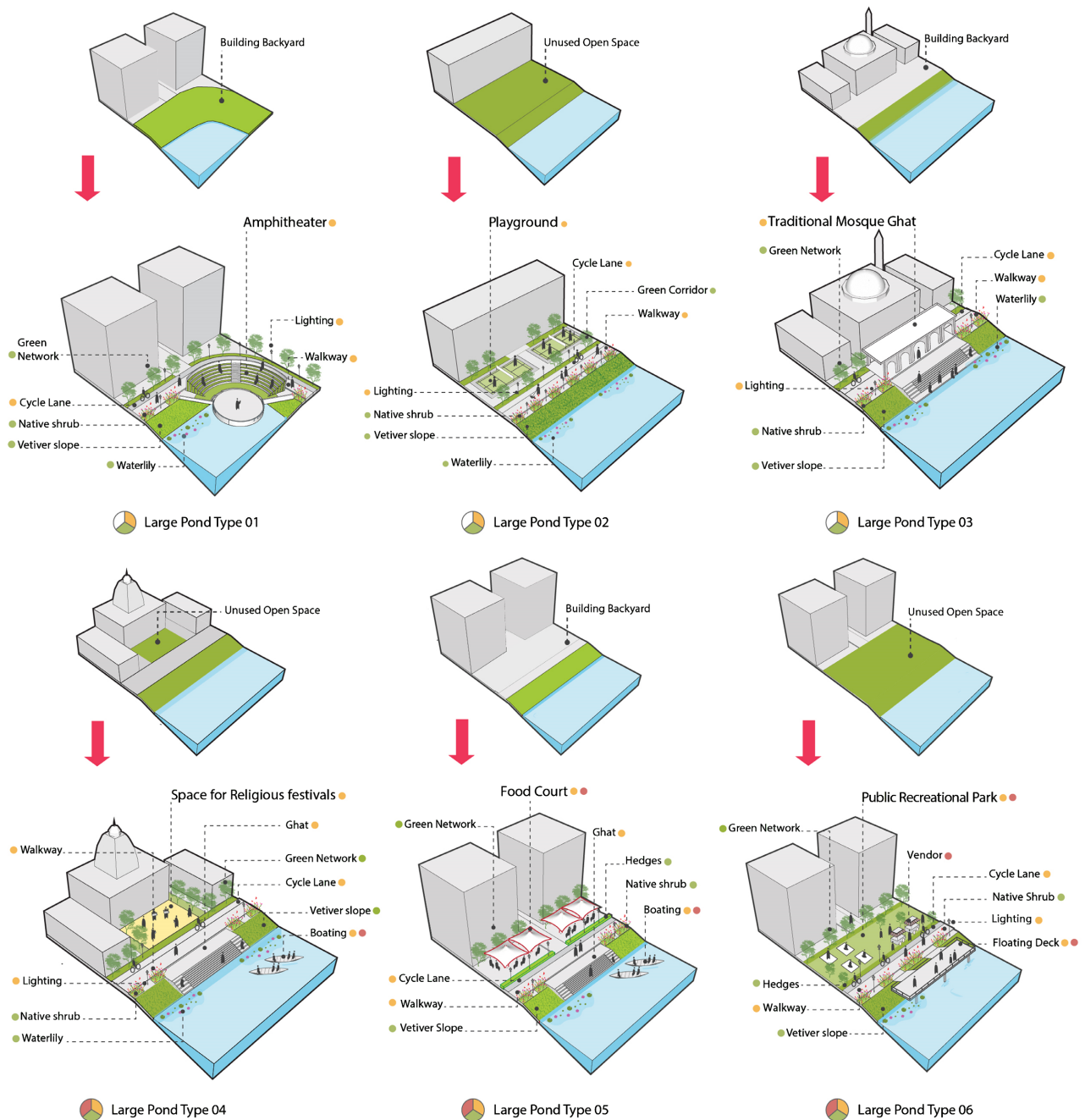


Figure 7. Design Guidelines for large ponds.

4.2.3. Typological Design Guideline Prototypes for Large Ponds

Large ponds can potentially serve as nature-based recreational zones on a regional scale. As for Figure 7, these ponds can be designed with diversely active, public-friendly open spaces and serve people from all over the city. Unused big chunks of open spaces can be developed with food courts, playgrounds for public gatherings, and outdoor gaming facilities to serve the people on the city scale. An amphitheatre near the pond banks can be designed as a multipurpose platform for cultural activities, live performances, and get-togethers. The traditional

mosque or temple ghats associated with pond banks in front of religious facades will bring back the age-old image of cities' cultural ethnicities. Open spaces in religious areas adjacent to the pond banks can be designed for extended prayer areas or outdoor spaces for celebrating religious festivals. Public recreational parks can provide multiple sources of public engagement and recreational activities. Vendors, tea stalls, and food courts can enhance local entrepreneurship and social gatherings. Trees, shrubs, and hedges will increase biodiversity and mitigate environmental degradation. Altogether, these facilities will not only enhance the sociocultural, economic, and ecological viability but also bring back the lost connection between the neglected ponds and the urban users.

5. Conclusion

In this research, the function of urban ponds as providers of ecosystem services, with benefits for the society, economy, environment, and their significance to the sustainability of a city has been addressed. Community participation has been emphasized throughout the ponds' development, design, and management procedure. A varied range of physical and social issues associated with the ponds have been identified through the perceptions of direct stakeholders. Priority has been given to providing convenient access to all, regardless of their gender, age, culture, or socio-economic status, so they can engage with the places differently yet articulate shared values through different opportunities and benefits. The design elements recommended centering the ponds, and their surrounding areas serve to increase users' amenities and enhance the space-user relationship's functionality. The functions also open up new opportunities for entrepreneurship, strengthening the local economy and boosting real estate values. Improvement of the natural environment was another concern, and the planning approach is directed toward creating a balance between the well-being of humans and the ecology. The design guidelines are intended to enhance the social-cultural, economic, and ecological values at the neighbourhood and regional levels. They serve as reference criteria for local planners and designers to protect the ponds through more resilient strategies for a sustainable city.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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