

Re-naturing cities through water-centric development: evaluating a canal restoration project in Narayanganj City, Bangladesh

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ABSTRACT

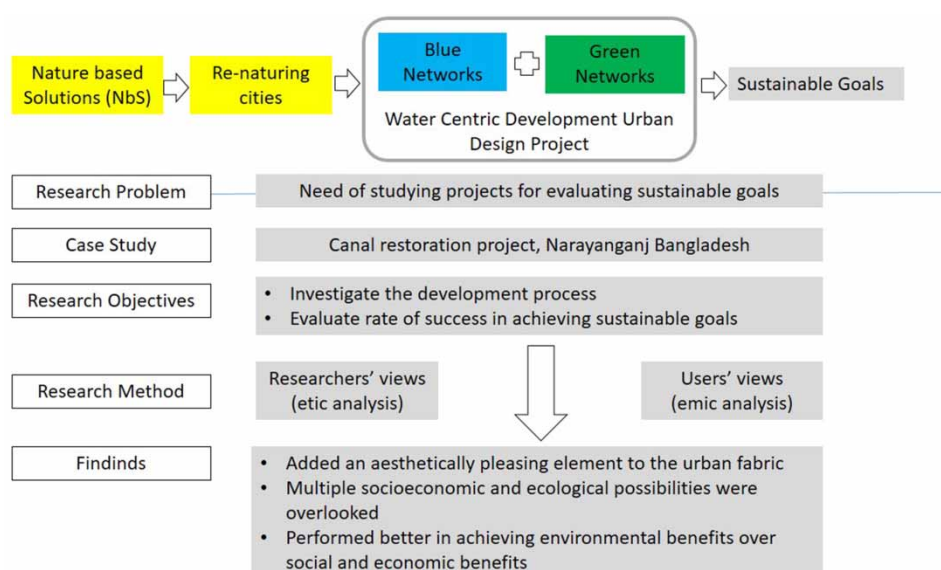
The concept of 're-naturing cities' promotes nature-based solutions for sustainable urban design; one of those being water-centric development with networks of blue (water bodies) and green (vegetation areas) aims to generate urban areas that support economic growth, strengthen social cohesion, and restore degraded ecosystems. Projects get implemented for revitalizing urban water bodies with multifunctional areas. This context demands to study water-centric development projects for evaluating the success of 're-naturing cities' in terms of achieving sustainable goals. This research analyzes a part of a canal restoration project of Narayanganj City, Bangladesh, for investigating the development process and understanding its effectiveness in achieving sustainable goals. The study employs multiple qualitative tools for capturing users' views (emic analysis) and researchers' views (etic analysis). The combined understanding identifies that the project focuses primarily on adding an aesthetically pleasing element to the urban fabric, overlooking multiple socioeconomic and ecological possibilities of living with water.

Key words: blue-green network, canal restoration, nature based solution, re-naturing cities, sustainable urban design, water-centric development

HIGHLIGHTS

- A research framework for scoring the sustainability features of a BGI urban design project.
- Practical application of 're-naturing cities'.
- A literature review on nature-based solutions, re-naturing cities, and sustainable urban design.

GRAPHICAL ABSTRACT



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1. INTRODUCTION

The practice of nature-based solutions (NBS) is getting global attention to improve the deteriorating environment of urban areas (Armson *et al.* 2012; Hsieh *et al.* 2016; Kabisch *et al.* 2016; Mariani *et al.* 2016; Escobedo *et al.* 2019; Mukherjee *et al.* 2022). The NBS approach particularly focuses on cities and asks us to practice a series of solutions inspired by nature to support the idea of sustainable development (Calfapietra & Cherubini 2018), targeting economic growth, strengthening social cohesion, and restoring degraded ecosystems. It promotes making changes to the physical environment, accompanying alterations that are ‘more natural’ than previously (Rice 2020). These ‘more natural’ approaches for urban areas such as ‘re-naturing cities’ largely target natural areas and features in and around cities for enhancing the performances of essential ecosystem services (European Commission 2015). The natural areas and features are often identified as Blue-Green Infrastructure (BGI) (Ahmed *et al.* 2019), where blue infrastructure includes any kind of permanent or seasonal water bodies: rivers, canals, lakes, streams, stormwater drains, irrigation channels, wetlands, and any spaces that can temporarily accommodate water overflow and green infrastructure include urban forest, parks, play-fields, green-ways, recreation zones, and riparian strips (Mayr *et al.* 2017).

NBSs are getting popularity for achieving sustainability goals by reducing multiple urban risks (Mayr *et al.* 2017) and alleviating a series of critical issues (Kabisch *et al.* 2017). These are promoting the development of multifunctional areas with green infrastructures along with blue networks, applying numerous approaches and concepts (Ahmed *et al.* 2019), such as water-sensitive urban design (Burge *et al.* 2008; Zaman & Chowdhoree 2022), integrated water resource management (Mitchell 2005), sustainable urban water management (Mitchell 2005; Pahl-Wostl 2008), water-sensitive cities (Brown *et al.* 2009; Floyd *et al.* 2014), sustainable urban drainage systems (Fryd *et al.* 2012; Ellis & Lundy 2016), water-sensitive urban design (Bach *et al.* 2015; Wella-Hewage *et al.* 2016), sponge city (Jiang *et al.* 2017; Wang *et al.* 2017; Chan *et al.* 2018), etc.

Water systems and watersheds throughout the world are suffering from anthropogenic pressures like urbanization, industrialization, and population growth (Shukla *et al.* 2013). With intentions of improving the degraded urban environment and enjoying the benefits of blue-green networks in both physical and functional ways (Djukić *et al.* 2020), the attempts, often referred to as waterfront developments (Wang & Lu 2001; Zaman & Chowdhoree 2022), are getting popularity for revitalizing water bodies and adjacent areas within an urban fabric. These types of developments are often referred to as (re)development (Yassin *et al.* 2012) as the existence of water bodies needs to be revived by reclaiming encroached lands, excavating water channels, and rearranging land use in a previously built-up area. The waterfront development does not necessarily focus only on the front of water bodies (Yassin *et al.* 2012) but rather deals with an interactive zone that allows the water-centric urban development to responsively and sensitively interact with the water, considering the water as a unique and irreplaceable resource (Wrenn 1983). In response to this, many city authorities are adopting several urban design strategies, following NBSs to comply with the populist demand and showing interest in development projects that highlight the importance of water bodies. In this context, in-depth studies of such water-centric development projects are required to evaluate the success of ‘re-naturing cities’, in terms of uplifting urban social life, improving natural ecosystem quality, and providing scope for economic progress.

This research analyzes the Nimtola Lake part of the ongoing Baburail Canal Restoration Project of Narayanganj City, Bangladesh, for investigating the development process, evaluating the rate of success, and understanding its impacts on the vicinity and broadly on the city. The study employs multiple qualitative tools, i.e., document review, image comparison, systematic observation, mapping, and semistructured interviews, for capturing emic analysis as users’ views and etic analysis as researchers’ views. The collective expression of both views is expressed in quantitative values for evaluating the success of the project in terms of achieving sustainability goals.

2. LITERATURE REVIEW

2.1. Re-naturing cities and blue-green network

The concept of NBS proposes to apply solutions to limit the negative impacts of increasing population influx, consequences of changed climatic variables, and deteriorating environmental quality and social lives (European Commission 2015; Kabisch *et al.* 2017). The solutions are like ‘re-naturing cities’ that address multiple issues,

i.e., increased pollution levels, increased heat islands, decreased biodiversity, increased number of extreme events (flooding, waterlogging, drought, heat waves, etc.) (Mukherjee *et al.* 2022), increased number of crimes and social inequality (European Commission 2015; Kabisch *et al.* 2017), and increased mental and physical health of the urban population (Carrus *et al.* 2015, 2017; Dadvand *et al.* 2015).

Mayr & colleagues (2017) find that a growing number of cities are practicing NBSs for maximizing ecosystem services by expanding their green infrastructures and investing in clean technologies, occasionally along with conventional engineering solutions. There are strategies for regenerating urban forests (Livesley *et al.* 2016; Pearlmutter *et al.* 2017), introducing green technologies, low carbon, and climate-resilient infrastructure, blue water-based elements, and green vegetation-based elements. These kinds of strategies or approaches are identified as BGI; the term was first used in the case of Sao Paulo, Brazil, while planning strategies were prepared for establishing a healthy network of 'green and blue' for mitigating urban flood risks (Frischenbruder & Pellegrino 2006; Ahmed *et al.* 2019). Mayr & colleagues (2017) find its similarity to the 'century-old' garden city concept that asks to conserve the natural environmental features of the urban landscape. BGI is an umbrella term that is closely related to the concept of 'Green Infrastructure' (Ghofrani *et al.* 2017), and since 2000, it has been practiced to protect urban green spaces and waterbodies as coherent elements of environmental planning systems (Thomas & Littlewood 2010). Scholars (Faggian & Sposito 2009; Faggian *et al.* 2012) posit that without continuity among blue and green networks, many benefits of BGI cannot be achieved. Any kind of waterbody or wetland has notable direct or indirect useable or nonuseable values (Permana *et al.* 2017), and the approaches to BGI in recent times are putting emphasis on rivers and other water bodies as the 'blue' elements (Everett *et al.* 2015; Ahmed *et al.* 2019). Though there are proven and foreseeable advantages of 're-naturing cities' by revitalizing BGI networks, there are cases where the desired performance of BGI networks get hampered due to multiple reasons, i.e., unexpected hydrological performances, negative perceptions by residents about BGI (Williams *et al.* 2019), service delivery, and lack of confidence by decision-makers (Thorne *et al.* 2018). Especially in the third-world urban context, there are not enough studies on revitalizing BGI networks (Ahmed *et al.* 2019) for re-introducing nature within the urban fabric. This research gap justifies the importance of the current research that aims to evaluate a 're-naturing cities' approach where the development is centered around a 'blue' element.

2.2. Water-centric development for sustainable urbanization

The core idea of sustainability demands allowing pollution to an acceptable limit while maximizing the economic opportunity for the citizens and stimulating citizens' well-being (Permana *et al.* 2017). NBSs promise to achieve these sustainability goals in future development by 're-naturing cities' with connected BGI networks (Mayr *et al.* 2017). Researchers (Brown *et al.* 2009; Fryd *et al.* 2012; Floyd *et al.* 2014; Bach *et al.* 2015; Ellis & Lundy 2016; Wella-Hewage *et al.* 2016; Jiang *et al.* 2017; Wang *et al.* 2017; Chan *et al.* 2018) have suggested numerous approaches for future developments, targeting water resources and water systems. Integrated water resources management as an approach highlights the importance of vital ecosystems and maximizes the resultant economic and social benefits by coordinately developing and managing water, land, and related resources (Mitchell 2005). The concept of sustainable urban water management (Gleick 2003; Mitchell 2005; Pahl-Wostl 2008) aims to preserve or mimic nature by developing a landscape with microscale green spaces, linked with macroscale watershed management, and stormwater and wastewater infrastructures (Novotny 2008). The concept of water-sensitive cities aims to enhance livability, sustainability, urban resilience, and productivity and to improve degraded ecosystems and aging infrastructure by introducing more sensitive urban water services and systems (Brown *et al.* 2009; Floyd *et al.* 2014; Rogers *et al.* 2020). These different types of approaches have allowed the implementation of many mega-projects with water bodies across the world and these became a trend of modern urban development (Wang & Lu 2001; Djukić *et al.* 2020). Across the world, primarily municipalities are investing and involving different types of stakeholders, i.e., professionals, scientists, industry, NGOs, and communities to implement effective solutions for regenerating several urban areas (Raymond *et al.* 2017). Water-centric development always has positive multiplier effects. According to Permana & colleagues (2017), water-centric developments have three environmental values: direct, indirect, and bequest. The use of water for maintaining urban life is the direct value. Enjoying the scenic beauty is the indirect value (Tietenberg & Lewis 2012). The bequest values can be realized with increased economic and development opportunities and high demand in land-markets (Permana *et al.* 2017; Zhang *et al.* 2017; Political Economy 2022). It also may provide a linkage to the outside world for social and economic benefits (Al-Shams *et al.* 2013). Yassin & colleagues (2012) posit to develop the waterfront area and enhance its specific features or image, targeting the long-term economic

growth. Therefore, water-centric development projects need to be studied to understand their contributions to meeting the core goals of sustainability.

3. RESEARCH METHODOLOGY AND FRAMEWORK

This single-case study-based research conducts detailed landscape analysis (consisting of direct observation, physical survey, image comparison, semistructured interviews, and document review) to get information on the physical and functional data of the studied area. Along with the landscape analysis, the epistemological position of this research allows for examining the case by conducting a detailed physical survey and interacting with people who use the space and live in the vicinity (Heath 2001). In this case, adult users (who have experience of using the project site before the project was implemented) of the adjacent buildings within approximately 25 m from the project site line were randomly approached for participating as research participants. In total, 68 people participated in the semistructured group interview sessions. Along with the local research participants, three representatives from the city authority participated in the semistructured interview sessions and gave their opinion about the process of conceptualization, planning, and implementation of the project and its impacts as well as its advantages and disadvantages to the vicinity. The researchers play the role of ‘outsiders’, while the local people, as well as representatives from the city authority, are the ‘insiders’ (Smith 1999; Chowdhoree & Das 2021). The insiders’ interpretation as the emic analysis provides users’ perspectives (Pavrides & Hesser 1989), and the outsiders’ interpretation as the etic analysis allows the cross-cultural analysis of objective and neutral views for unpacking the impacts (Smith 1999). In the case of evaluating the performance of the built environment for resisting natural hazards, Chowdhoree & Das (2021) employed this method for allowing researchers to understand the experiences of users who are accustomed to the environment and at the same time for allowing us to have the outsiders’ neutral view, which is often overlooked by the insiders. Similarly, the current research intends to capture both emic and etic analysis for evaluating the success of different features of the project. Here, a research framework is prepared based on available literature for evaluating the impacts of the case study project on the vicinity and broadly on the city. The triangulated understanding of emic and etic analysis is reflected on a Likert chart for finding out quantitative values from qualitative views. The details of collecting these data are further explained in Section 5.3.3.

3.1. Research framework

Scholars (Burgers 2000; Madanipour 2005; Bruttomesso 2006; Ercan 2007; Bertsch 2008; Varna 2009; Yassin *et al.* 2012; Al-Shams *et al.* 2013; Zaman & Chowdhoree 2022) identify several features that help to evaluate the success of water-centric development. Among them, Bruttomesso (2006) suggests achieving a total of 10 qualities to make a water-centric development successful. These qualities are as follows:

1. Securing the natural quality of water bodies and adjacent environment;
2. Integrating the waterfronts with the existing urban fabric;
3. Reviving the historic identity for giving it an identifiable character;
4. Allowing mixed-use development for ensuring diversity and vibrancy;
5. Allowing public access;
6. Allowing public–private partnerships for developing the site;
7. Ensuring public participation;
8. Developing as long-term projects;
9. Implementing as an ongoing revitalization process;
10. Allowing to make profits from international networking.

Along with these, Bertsch (2008) suggests developing the project in multiple phases, and the vision of each phase should be clear to the stakeholders as well as to the general public. Along with the general people, government agencies, developers, community organizations, and environmental groups will have active participation in the decision-making and implementation process. There should be a balanced sharing of benefits between the public and developer and a profitable public–private partnership may help to make the project sustainable. The new development should be integrated with sociocultural history and existing architectural heritage, and the waterfront should allow public access and should not be isolated (Yassin *et al.* 2012).

Al-Shams & colleagues (2013) suggest involving architects, urban designers, and planners to achieve several essential qualities of a redevelopment project. First, the urban areas should be developed as attractive (Tibbalds

1992) as well as interactive spaces so that these can have an identity and physical design that allows various types of street activities, i.e., outdoor recreation, outdoor eating, street vending, shopping, socializing, meeting people, walking, swimming, cycling, etc. (Burgers 2000; Ercan 2007). It may promote the idea of pedestrianization that requires the creation of more scopes and facilities for pedestrians, like introducing pedestrian malls. Tourists as well as conventioners might be attracted to visit the place (Loukaitou-Sideris 1993). In this way, the urban public spaces may play a role in changing the city's image and marking it as an internationally recognized and desirable destination to visit.

Scholars (Bruttomesso 2006; Bertsch 2008; Varna 2009; Al-Shams *et al.* 2013) focus mainly on the social and economic benefits of water-centric developments. But the environmental benefits, considering the restoration of natural systems and ecological services, are important factors for introducing or reviving a BGI network as an NBS. Other groups of scholars (Benedict & McMahon 2006; Mell 2008; Pickett & Cadenasso 2008; Kazmierczak & Carter 2010; Koomen *et al.* 2012; Wong 2015) argue for a series of environmental features that are considered important for making a water-centric development successful:

- integrated management of the three urban water systems: stormwater, wastewater, and potable water;
- integrated management of water at different scales: from individual houses to urban precincts or regions;
- integrated management of water in the built form, incorporating building architecture, landscape architecture, and public art;
- storing stormwater for various use;
- regulating water stream system, particularly for preventing floods during extreme rainfall events;
- creating habitat for plants, native species, and animal wildlife (nature conservation) and areas for growing wetland crops and second-generation biofuel production;
- improving ecological services by allowing an alternative approach with new or altered vegetation, along with existing urban vegetation (Grimm *et al.* 2000; Pataki *et al.* 2006; Troy *et al.* 2007);
- increasing permeability of urban surfaces by restoring urban waterbodies and wetlands (Goffman *et al.* 2003);
- improving microclimate by restoring waterbodies and green spaces (Nowak *et al.* 2002);
- a cleaning system of polluted water and reducing particulate pollution by introducing mature tree canopies (McPherson *et al.* 1997).

Different features, suggested by different scholars, can be grouped into three categories based on the agreed goals of sustainability: environmental benefit, social benefit, and economic benefit. These features are not mutually exclusive as several features may provide multiple benefits. Table 1 presents all possible features, grouped into three categories, and this table can be used as the checklist to evaluate the case study example.

The semistructured interviews, direct observation, and physical survey of the study area provide data for conducting both emic and etic analyses. In this case, interpretations of insiders and outsiders are collected to evaluate every feature identified in Table 1. The qualitative opinion of both insiders and outsiders is triangulated to get a quantitative value for each feature, based on a Likert scale of 5 scores, where 1 denotes the most unsuccessful performance and 5 denotes the highly successful performance. The average score of each category helps to compare with each other and evaluate the success level of each category.

3.2. Narayanganj City and the study area

Narayanganj (Figure 1), an important and historic town very close to Dhaka, acquired the status of a city corporation in 2011. The city is growing fast and is facing difficulties in addressing various problems like garbage disposal, drainage, and intra-town road network. It lacks open public spaces, children's areas, green parks, and recreation facilities for city dwellers. Due to the increasing demand of Narayanganj city dwellers, the city mayor has promised to revitalize all old waterways (canals) with fully navigable quality and create scope for conserving biodiversity and improving the physical and social environment by introducing recreational facilities and enhanced livelihood opportunities.

The study area of this research is a part of the project of water-centric development. It is titled the restoration of Baburail Canal with landscaping, beautification, and lighting features. The layout plan was prepared by an architectural firm for the city corporation. Locally some parts of the Baburail Canal are known by different names, i.e., Nimtola Lake, Jimkhana Lake, and Sardar Bari Canal. This article presents the study of the Nimtola Lake part that is bordered by the river Shitalakkhaya on the east and Bangabandhu Road on the west (Figures 2 and 3). The fund was arranged from the Municipal Government and Services Project (MGSP) of the Local Government

Table 1 | The list of features based sustainable development categories (Source: The authors)

Category	Features
Environmental benefit	Management of potable water Management of stormwater Management of wastewater Integration of urban water management from adjacent buildings to the precinct Storing stormwater for various uses Regulating stream system, particularly for preventing rainfall-induced waterlogging Creating habitat for native plants and wild lives Allowing new or altered vegetation for improving ecological services Increasing permeable surfaces Improving micro-climate with vegetation Allowing systems for controlling water and other types of pollutions Reviving the historic nature of the water body Developing a connected blue-green network
Social benefit	Allowing public access to the waterfront area Allowing visual permeability Ensuring participation of different stakeholders (government agencies, developers, community organizations, environmental groups, and the public) in the development and management process Allowing the public to know the vision of different phases of development and what types of benefits the public will enjoy Allowing scopes for street activities (such as street vending), active and passive recreation (such as outdoor eating, walking, cycling, swimming, fishing, etc.), and socialization (such as shopping, enjoying views, socializing with friends, meeting with colleagues, etc.) Developing public spaces as an image of the city Increasing the transportation opportunities Increasing pedestrianization through introducing multiple access, connecting important functions, operating pedestrian malls, etc.
Economic benefit	Allowing diverse and vibrant mixed-use development for ensuring diversity and vibrancy with different functions like shopping, outdoor eating, recreational facilities, touristic facilities, etc. Allowing public-private partnerships for developing the site Allowing to avoid losses due to urban risks like waterlogging Allowing to make profits by using it as a naval transportation route

Engineering Department (LGED) that receive finances from the International Development Association (IDA) of the World Bank Group (WBG).

4. WATER-CENTRIC DEVELOPMENT PROJECT: BACKGROUND

4.1. The condition of Baburail Canal (including Nimtola Lake) before the project

From the local oral history and planning document, it became known that the Baburail Canal was a connecting natural channel between two major rivers: the river Dhaleshwari on the west and the river Shitalakkya on the east. The canal was one of the crucial waterways used for carrying goods and passengers through the city. Due to unplanned urbanization and illegal encroachment, the water flow got disconnected, and at various locations, it was difficult to even trace its channel. Especially the eastern part of the canal that connects the river Shitalakkhya was totally encroached. The channel could be traced on the western side just like a narrow drain, carrying the wastewater to the river Dhaleshwari. The local people indiscriminately used this canal for solid and liquid waste dumping and sewerage disposal. The canal lost its usual form and flow and was encroached on by neighboring residents and squatters as well as government organizations, including the city corporation. Any part of this canal was no longer navigable. The city corporation encroached on some parts of it and used it for commercial purposes, building markets, and office spaces. It also built multiple community structures on the naturally and artificially filled-up land of the canal. The area used to suffer from waterlogging, air pollution, water pollution, and the loss of the natural ecosystem. The local people were deprived of enjoying any kind of benefit from the waterbody, other than using it as a location for disposing of all kinds of liquid and solid waste and using the land for developing some illegal infrastructures.

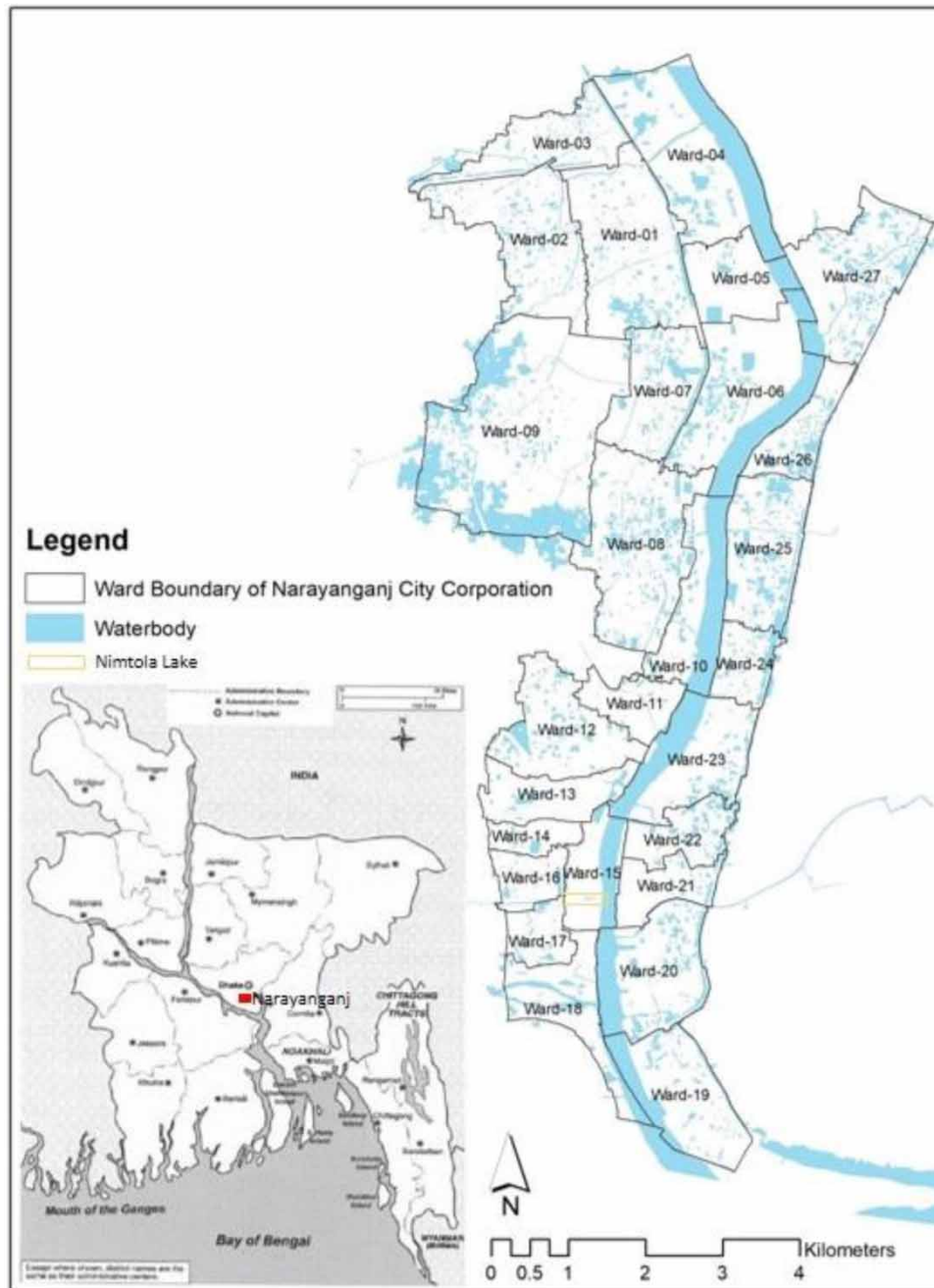


Figure 1 | The map of Bangladesh shows the location of Narayanganj (left) and the map of Narayanganj City Corporation Area (right) (NCC 2022).

4.2. The project interventions

The project implemented different types of physical works including reclaiming the lands from illegal occupiers, demolishing structures from the canal land, re-excavation of the canal, slope protection, construction of walkways on both sides, widening of adjacent roads and lanes, planting trees, reconstruction of bridges at selected locations, adding light fixtures and street furniture, adding decorative items for beautification, and constricting a sluice gate (Figure 4). In the Google Earth image of 2015 (Figure 5), the Nimtola Lake area was totally occupied by informal settlements or structures. All these structures were removed, residents were relocated, and the canal was re-excavated for implementing the project. The representatives from the Narayanganj City Corporation (NCC) mentioned that they have implemented the project within the existing land of NCC or public land and not a single private owner was affected due to this project. The authority preferred to practice only voluntary



Figure 2 | The 3D virtual image of Baburail Canal Project. It shows different parts of this waterbody (NCC 2022).



Figure 3 | The Google Earth image is showing Nimtola Lake with adjacent locations (Google Earth 2022).



Figure 4 | A view of Nimtola Lake from the river (Field Survey 2022).

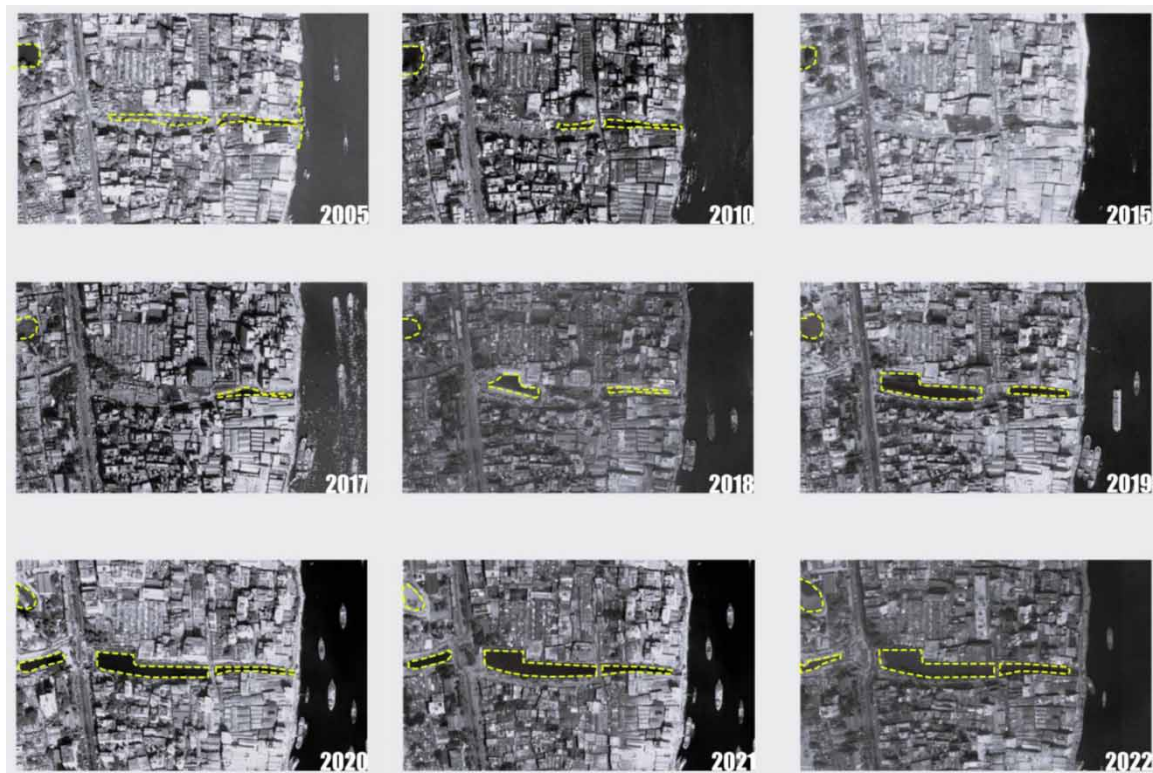


Figure 5 | The Google Images from 2005 to 2022 show the condition of the lake. The waterbody cannot be traced in the image of 2015 (Google Earth 2022).

dispossession of occupiers without providing any compensation to the encroachers and well-off informal settlers. The project was funded by the World Bank. The World Bank also does not prefer to acquire any private land for the project implementation. Moreover, it also prefers not to evict occupiers who are not voluntarily leaving the land. Involuntary removal from the public land and acquisition of the private land were tried to be avoided in most of the locations.

Focus group discussion sessions with local people and a central-level public consultation meeting were arranged by the project planning team for making major decisions about the project. The major decisions were as follows:

- i. Effective compensation should be given to those who will be affected by the project.
- ii. The project will have a positive impact on beautifying the city.
- iii. There should be a better drainage system.
- iv. The project will have a positive impact on increasing economic activities.
- v. Environmental pollution will be reduced.
- vi. The canal will be an entertainment center.
- vii. Naval transportation will be introduced in the future between two major rivers, which is not possible to implement in the project's lifetime.
- viii. The adjacent areas will be developed considering the presence and benefits of water bodies.
- ix. The condition of local shops, markets, and local trade centers will be improved.
- x. The project will contribute to make the city neat and clean.
- xi. Both sides of the lake/kanal will have wide walkways for pedestrians, and at least one side will have a wider road for vehicular traffic movement.

5. CURRENT CONDITION OF THE WATER-CENTRIC DEVELOPMENT OF NIMTOLA LAKE

The Nimtola Lake has been developed as a part of a long canal redevelopment project. The project was implemented with the major intention of creating a beautiful place for the citizen so that they can use the

space mainly for recreational purposes. Though the connections with major rivers are not restored, it was connected with other adjacent waterbodies, i.e., Gymkhana Lake, Baburail Canal, Sardar Bari Canal, and Kashipur River. It helped to revive the historic nature of the connected water body at a significant level. In this way, it can be considered an attempt for developing a connected blue-green network. There are industrial, residential, commercial, and mixed-use buildings on either side of the lake, which are shown in the building-use map of Figure 6. The physical features and current use of this area are further investigated in the following sections, considering the features identified in Table 1.

5.1. Physical features of the Nimtola Lake development project

The Nimtola Lake is now developed as a linear water body, edged by pedestrian and vehicular ways. The eastern side is edged by an arched pedestrian bridge. After that, there is a sluice gate as a connecting barrier (Figure 7) that restricts the polluted water of the river from entering the canal. The wastewater disposal drains (under the pavements) are placed on either side of the lake, and wastewater is discharged into the river.

There is an attempt to control the pollution level of the water of Nimtola Lake by controlling the water flow from the river as the river water became highly polluted due to the liquid and solid waste, disposed of from the adjacent facilities and functions including various types of toxic and nontoxic industries. But the representatives from the city corporation confirmed that the water of the lake cannot be used as potable water and the authority has no plan to treat the water and use it as a water source for installing a piped water-supply system. Even the local people also never think to use it as a source of potable water. The wastewater drains are installed under the pavement on either side of the lake and the wastewater is discharged into the river. In this way, the lake remains free from contamination by the wastewater of the neighborhood. But the local people conveyed the information that in several locations the sewerage lines get connected with the wastewater drain, and finally, it discharges into the river. Though wastewater and untreated sewage are not polluting the lake, the adjacent areas of the river Shitalakkha get polluted due to these. There are no treatment plants in the vicinity for



Figure 6 | Building-use map of the vicinity (Field Survey 2022).



Figure 7 | The sluice gate (Field survey 2022).

treating the sewerage, which is considered a very essential component for any water-sensitive development (Wong 2015).

The open lake as the natural waterway is working as the stormwater drainage system, and the local people found it as effective in eliminating the rainfall-induced waterlogging problems from the vicinity. The lake is acting as a catchment area for the stormwater, which is now used for cultivating fish. Though it has become a landscape feature that acts as at-source detention and retention of stormwater, there is no plan to use this water for any other purpose. Usually, integration is expected in this kind of water-centric development where the urban built form (including individual allotments and buildings) can participate in the water cycle management of three types of water: potable water, wastewater, and stormwater. But the scope of the project did not include the adjacent allotments and buildings, and as a result, there was no consideration of managing the water cycle of individual allotments and buildings through water conservation, rainwater harvesting, pollution control of wastewater and stormwater, controlling the generation of wastewater, recycling of wastewater, etc.

The whole length of the lake (from the river to the Bangabandhu Road) is physically divided into two segments by a secondary road (M A Maleh Road) that crosses the lake as a bridge. Both sides of the lake have pedestrian ways, and half of the southern edge has vehicular access that is known as the R K Mitra Road. The lake was totally inaccessible to the public before the project implementation. Now the lake became accessible, especially at three locations: Bangabandhu Road, which is a primary road, S M Maleh Road (in-between secondary road), and the riverside walkway. Besides these three locations, there are another five narrow allies that can be used to reach the lakeside. There are two other access points that are private and remained locked. From the physical survey, direct observation, and semistructured interviews, it is clear that the opportunities of accessing the lake are not enough, considering the length and potential of the lake. Even the visual permeability is restricted from the adjacent functions in many areas. The visual permeability is restricted by solid walls, walls with small openings, and parked vehicles. Even the functions of adjacent buildings in some areas are such (informal industry, warehouse, and storage) that it is not at all necessary to enjoy a water view from there. Along the periphery of the lake, some areas are totally blocked with solid walls of informal industries, and some areas have continuous facades of informal industries with small windows. Along the R K Mitra Road (the major vehicular road), most of the time, the view also remains blocked because of parked trucks or lorries on the road. The view axis and access points are shown also in the map in Figure 8.

Different types of trees are planted along the lake without considering to create a habitat for native plants and wild lives. The representatives from the NCC and local people believe that the new or altered vegetation may play some roles in improving ecological services. The lake has some fish, and occasionally some birds are seen in the area. Local people believe that the development is helping to improve the micro-climate with vegetation, and they also found the area remains cooler than other adjacent areas on a hot summer day.

The scope for allowing permeable surfaces is not fully utilized. Wide and fully paved pedestrian ways and vehicular roads are built along the edges of the lake. Besides this, semi-permeable concrete blocks are used on the

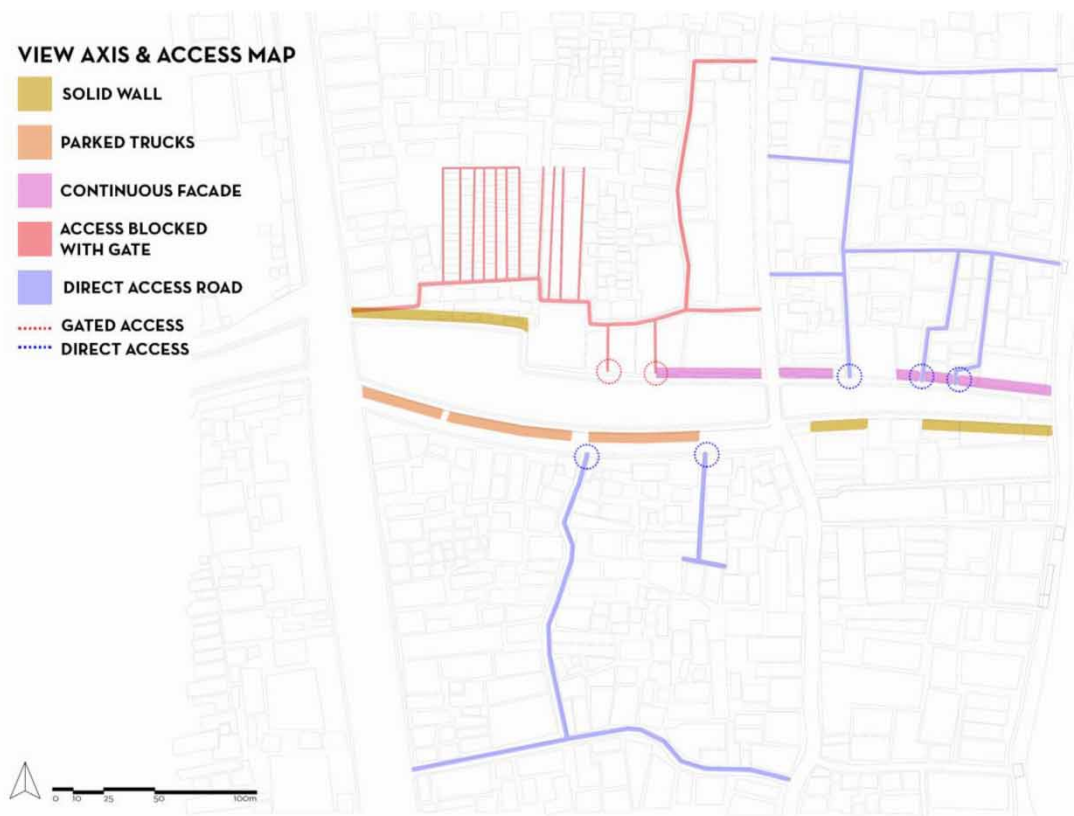


Figure 8 | The view axis and access map of the vicinity (Field Survey 2022).

sloped edges of the lake. Even the local people think that the number of permeable surfaces could be easily increased. According to the representatives from the city corporation, the vegetation types and pavements are chosen based on the landscape design, prepared primarily to make this place visually pleasant.

5.2. Uses of the space

The development project was initiated by the city corporation, and the design consultant firm had some interactions with the local people to know their expectations. But there was no opportunity for engaging different stakeholders, like private developers, community groups, environmental groups, and civil societies in the decision-making and management processes. The local people in the vicinity as well as the bigger urban population did not get to know the vision or purpose of this project. Though the people appreciate the place as a beautiful element added to their neighborhood, they do not get any idea of what kind of benefit they are getting or will get because of this project. They also believe that the major functional opportunity of using it as a naval route for mass transportation is not at all considered. One of the research participants (who is an industry owner) said

‘The space looks nice, but it did not have any economic return. Because of this project I have lost some parts of my factory land and now I am experiencing a financial loss because of this project.’ (Participant 16)

The local people as well as the research team have the observation that a few people practically use the space. Most of the time, the space remains abandoned. However, people use the space mainly for seven types of activities: reaching destinations, sitting or taking rest, playing, using the mosque, meeting friends or colleagues, eating street food, and jogging (morning/ evening walk). Some people use the space to reach the riverside and choose this route as a short and easy way to reach their destinations. Truck drivers mainly use the space for taking rest or spending their leisure time in between their trips. A few kids (whose mothers work in the neighboring industries) occasionally play there. A considerable size of crowd can be observed in front of the mosque on Friday noon time as they come for their *Jumma* (Friday special Muslim) prayer. Occasionally, teenagers and young people visit

the place for spending some time with their friends or colleagues. In total, six street food vendors are observed at the junction points of roads, and some people gather around those vendors for having street food. Those vendors were there even before the development project. A few people are observed who use the place for walking or jogging for physical fitness purposes. Overall the presence of females is very rare in this area. The local research participants as well as representatives from the city authority believe that new development is not contributing much to increasing street activities on a significant scale. The project has created options for pedestrians to avail themselves of a green pathway to reach the riverside. But because of not introducing multiple access and developing social and community functions (like markets, shops, food courts, café, restaurants, etc.), people rarely become interested in visiting the place.

5.3. Scoring of categorized features

All identified features are grouped into three categories: environmental benefits, social benefits, and economic benefits. It was attempted to identify the rate of success of each feature by assigning a quantitative value based on qualitative opinions. During the time of semistructured group interviews, the local people were engaged in active conversation with the research team members. The research team members explained identified features of the research framework based on the etic analysis acquired through systematic observation and understanding of the outcome of the project. At the same time, participants' observation and experiences as emic analysis influenced the etic analysis of the researchers. Participants as well as research team members expressed their understanding on a 5-band Likert scale, where 1 denotes the most unsuccessful performance and 5 denotes the most successful performance. Every response was counted with equal weightage. In this way, the cumulated average number as the expression of triangulated data of emic and etic analysis provided the final value of each feature of the research framework. Table 2 shows the result derived from this process. The individual score was converted into a whole number, and each score was coded with color: 1 = red, 2 = orange, 3 = yellow, 4 = yellow green, and 5 = green. The column of average score shows the average of the individual score for each feature.

The average scores of economic benefit, social benefit, and economic benefits are 2.84, 1.86, and 1.5, respectively. This shows that the project is contributing more environmentally than toward social and economic factors.

6. DISCUSSION

This research has been conducted with the intention of studying a case of water-centric development in a third-world context for understanding the process and evaluating the success of 're-naturing', in terms of uplifting urban social life, improving natural ecosystem quality, and providing scope for economic progress. The project was initiated to revive the lost water body as an attempt to re-introduce the blue infrastructure and to make a beautiful space with some trees, pavement, and lighting fixtures. The attempt can be appreciated as a (re)development project, where the existence of the water body was revived by reclaiming encroached lands, excavating water channels, and rearranging the area in a previously built-up area. The project was initiated as the populist demand of reviving lost waterbodies and developing adjacent areas. But it did not follow any specific concept for preparing its plan, whereas there are multiple approaches internationally practiced as modern trends of sustainable urban design and development (Wang & Lu 2001; Djukić *et al.* 2020; Zaman & Chowdhoree 2022).

The project had the potential to enjoy the benefits of developing a BGI network by 're-naturing' cities for achieving sustainable goals. Developing resilience to any hazard (like urban floods, or waterlogging) and reducing risks are considered required features of urban design practices (Zaman & Chowdhoree 2022) in ensuring the continued sustainability of cities (Mukherjee *et al.* 2022). The scored analysis of the studied project area shows that its performance in enjoying environmental benefits is better than enjoying the other two types of benefits. Its environmental performance is at a moderate level mainly because it performs well in reducing the risk of rainfall-induced waterlogging. The 're-naturing cities' as an NBS promises to reduce urban risks (Mukherjee *et al.* 2022), and the implemented project has proven its success in this area. Managing stormwater, along with improving micro-climate with vegetation, and controlling water and other types of pollution also help to enjoy some environmental benefits. But, its poor performance in multiple areas (like restoring native habitats, and integrating water management from the individual plots to the area level) restricts the enjoyment of various other benefits of this BGI.

In the case of achieving economic benefits, the project has displayed its success in avoiding losses due to urban risks (like waterlogging), as the regulated and renovated stream system with the artificial drainage system is preventing the generation of rainfall-induced floods. But the usual practices of generating diverse and vibrant

Table 2 | The scored values of listed sustainability features (Field Survey 2022)

Category	Features	Score	Color Code	Average Score
Environmental Benefit	Management of potable water	1		2.84
	Management of stormwater	4		
	Management of wastewater	3		
	Integration of urban water management from adjacent buildings to the precinct	1		
	Storing stormwater for various use	3		
	Regulating stream system, particularly for preventing rainfall induced water-logging	5		
	Creating habitat for native plants and wild lives	1		
	Allowing new or altered vegetation for improving ecological services	2		
	Increasing permeable surfaces	3		
	Improving micro-climate with vegetation	4		
	Allowing systems for controlling water and other types of pollution	4		
	Reviving the historic nature of the water body	3		
	Developing a connected blue-green network	3		
Social Benefit	Allowing public access to the waterfront area	3		1.86
	Allowing visual permeability	2		
	Ensuring participation of different stakeholders (government agencies, developers, community organizations, environmental groups, and the public) in the development and management process	1		
	Allowing the public to know the vision of different phases of development and what types of benefits the public will enjoy	1		
	Allowing scopes for street activities (such as street vending), active and passive recreation (such as outdoor eating, walking, cycling, swimming, fishing etc.), and socialization (such as shopping, enjoying views, socializing with friends, and meeting with colleagues, etc.)	2		
	Developing public spaces as an image of the city	3		
	Increasing the transportation opportunities	1		
	Increasing pedestrianization through introducing multiple access, connecting important functions, operating pedestrian malls, etc.	2		
Economic Benefit	Allowing diverse and vibrant mixed-use development for ensuring diversity and vibrancy with different functions, like, shopping, outdoor eating, recreational facilities, touristic facilities, etc.	1		1.5
	Allowing public-private partnerships for developing the site	1		
	Allowing to avoid losses due to urban risks like waterlogging	4		
	Allowing to make profits by using it as a naval transportation route	1		

mixed-use economic and social activities are absolutely missing in the project area, and the participation of the private plot owner was also found absent to develop their site considering the presence of newly developed public space. Even the historic character of using the canal as a route for cargo and passenger transportation is also not re-introduced. The scopes of developing various types of street activities for making the place socially engaging and economically more profit making are not properly utilized. The local people were not actively involved in the process of developing the space, and they also do not have any idea how they can socio-economically benefit from this project. The adjacent informal industries, warehouses, and stores are still operating in the same way, erecting a blank wall toward the waterbody. The landowners of the adjacent plots did not get ideas of altering the land use or designing the building or introducing functions for the new users of the place. The overall

ineffectiveness in developing social spaces, generating social activities, and introducing economic opportunities proves the failure of the project to meet the goals of sustainable urban design. The narrow vision of introducing an aesthetically pleasing element was restricted to work on the adjacent plots and with different stakeholders for increasing accessibility and visual permeability and developing or altering adjacent functions, targeting higher economic return and upgrading the social life of the vicinity.

7. CONCLUSION

It is evident from the study that the Nimtola Lake Development project has failed to make a significant impact on the socioeconomic lives of the city dwellers, whereas the creative application of BGI is one of the most promising approaches of ‘re-naturing cities’ for adapting to rapidly changing human and environmental circumstances by supporting economic growth, strengthening social cohesion, and restoring degraded ecosystems. A growing number of waterfront development and redevelopment projects are available throughout the world, and these are contributing to several factors such as reducing urban risks, developing environmental awareness, preserving the natural ecosystem (Troy *et al.* 2007; Mukherjee *et al.* 2022; Zaman & Chowdhoree 2022), and allowing adaptive uses for socialization and commercialization (Al-Shams *et al.* 2013). This study highlights that to secure the long-term growth of water-centric development, it is important to understand the potential of a waterbody and not to undermine its scope for contributing in multiple ways. Through evaluating its environmental, social, and economic benefits, this research criticizes the intention of the project that has narrowed down the scope and opportunities of living with water. The narrow vision of the studied project failed to explore the multiple opportunities of socioeconomic and ecological possibilities. In this way, this study demands to understand the importance of waterbodies within a blue–green network that requires a conscious decision in terms of designing, developing, and managing any area in the future for enjoying the multidimensional and diversified benefits of sustainable urban design.

This study adopts the method of combining emic and etic analyses, which is ‘dialogic’, ‘communicative’, and ‘participatory’ in nature. This method can be applied to other research works that require an understanding of the feedback of lived experiences and outsiders’ neutral views and interpretations based on global examples. At the same time, this study presents a comprehensive research framework that also can be applied for evaluating similar other cases. The research framework was prepared based on the available literature review for evaluating the sustainability goal of any water-based urban design project, and it also proves how the framework can be applied. It meets the epistemological need of understanding realities of a particular case. In this way, this research contributes to the global research methodology, along with highlighting the need for evaluating the sustainability goal of urban design projects for exploring the scope for making improvements.

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DATA AVAILABILITY STATEMENT

All relevant data are included in the paper or its Supplementary Information.

CONFLICT OF INTEREST

The authors declare there is no conflict.

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