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ERASMUS MUNDUS JOINT MASTER DEGREE

**MASTER DEGREE IN SUSTAINABLE DESIGN, CONSTRUCTION
AND MANAGEMENT OF THE BUILT ENVIRONMENT**

MBUILD

A Critical Analysis of the Integration of Nature-based Solutions into Urban Design Practices in Bangladesh

MD IMTIAZ AHMAD

Supervision:

Prof. Jorge Rodriguez-Hernandez, UC
Prof. Esther González-González, UC

Santander, July 2024



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Dedicated to
My beloved Parents

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ABSTRACT

The rapid urbanization of the 21st century has led to increased environmental degradation, climate change, and social inequalities, posing complex challenges for cities worldwide. Urban areas are confronted with pollution, waste management issues, food security concerns, social segregation, and poverty, alongside traffic congestion, air pollution, flooding, and urban heat island effects. Several developing countries are facing higher vulnerabilities to these repercussions and Bangladesh is one of them placing on top of the list. To bolster urban sustainability and resilience against these challenges, it becomes imperative to integrate green solutions into urban planning. In this context, Nature-based Solutions (NbS) are increasingly recognized as a viable approach to address these multifaceted challenges by promoting environmental, social, and economic resilience and sustainability. This research critically examines the integration of NbS into urban design practices in Bangladesh, identifying key barriers and enablers for effective implementation. Despite Bangladesh's high vulnerability to climate change, there is a notable absence of specific policies that integrate Urban NbS. This study employs a mixed-methods approach, including case studies analysis and interviews to analyze six key projects and provide a comprehensive understanding of NbS from both professional and user perspectives. Key barriers identified include financial constraints, spatial limitations, and insufficient stakeholder engagement. Recommendations for future NbS-driven urban projects are outlined, considering socioeconomic and ecological factors to enhance urban sustainability and resilience. The study emphasizes the need for developing a national framework, prioritizing expanding research, enhancing coordination and collaboration among stakeholders, and securing sustainable financing to overcome these challenges. This research contributes to the growing body of knowledge on NbS by offering valuable insights and practical recommendations for urban planners, policymakers, and practitioners, not only in Bangladesh but also in similar contexts. By integrating NbS into urban planning, cities can achieve significant ecological, economic, and social co-benefits, ultimately fostering more sustainable and resilient urban environments.

Keywords: Nature-based Solutions, Urban Planning, Resilience, Sustainability, Green Cities, Green and Blue Infrastructure

ABSTRACT IN THE AUTHOR'S MOTHER LANGUAGE

একবিংশ শতাব্দীর দ্রুত নগরায়নের ফলে পরিবেশগত অবনতি, জলবায়ু পরিবর্তন এবং সামাজিক বৈষম্য বৃদ্ধি পেয়েছে, যা বিশ্বব্যাপী শহরগুলোর জন্য জটিল চ্যালেঞ্জ তৈরি করেছে। নগর এলাকাগুলো দূষণ, বর্জ্য ব্যবস্থাপনা সমস্যা, খাদ্য নিরাপত্তা উদ্বেগ, সামাজিক বিচ্ছিন্নতা এবং দারিদ্র্যের সম্মুখীন হচ্ছে, পাশাপাশি ট্রাফিক জ্যাম, বায়ু দূষণ, বন্যা এবং নগর তাপ দ্বীপ (UHI) প্রভাবও অনুভব করছে। বেশ কয়েকটি উন্নয়নশীল দেশ এই প্রতিক্রিয়াগুলোর জন্য উচ্চ ঝুঁকির সম্মুখীন হচ্ছে এবং বাংলাদেশ এই তালিকার শীর্ষে রয়েছে। এই চ্যালেঞ্জগুলি মোকাবেলার জন্য নগর স্থিতিশীলতা এবং স্থিতিস্থাপকতা বাড়ানোর উদ্দেশ্যে নগর পরিকল্পনায় সবুজ সমাধানগুলি একীভূত করা অপরিহার্য হয়ে পড়ে। এই প্রসঙ্গে, প্রকৃতিভিত্তিক সমাধান (NbS) একটি কার্যকর পদ্ধতি হিসেবে স্বীকৃত হচ্ছে যা পরিবেশগত, অর্থনৈতিক এবং সামাজিক সমস্যাগুলি একসাথে সমাধান করার সময় স্থিতিস্থাপকতা প্রচার করে এবং স্থায়িত্ব নিশ্চিত করে। এই গবেষণাটি বাংলাদেশের নগর নকশা অনুশীলনে প্রকৃতিভিত্তিক সমাধান এর একীকরণের সমালোচনামূলক বিশ্লেষণ করে, কার্যকর বাস্তবায়নের জন্য প্রধান বাধা এবং সক্ষমতাগুলি চিহ্নিত করে। বিশ্বব্যাপী সবচেয়ে জলবায়ু-ঝুঁকিপূর্ণ অঞ্চলগুলোর মধ্যে একটি হওয়া সত্ত্বেও, বাংলাদেশে নগর সম্পর্কিত প্রকৃতিভিত্তিক সমাধান (Urban NbS) একীভূত করার জন্য নির্দিষ্ট নীতির একটি উল্লেখযোগ্য অভাব রয়েছে। এই গবেষণাটি একটি মিশ্র পদ্ধতি ব্যবহার করে, যার মধ্যে রয়েছে কেস স্টাডি, সাক্ষাৎকার এবং প্রম্নাবলী, ছয়টি প্রধান প্রকল্প বিশ্লেষণ করে এবং পেশাদার এবং ব্যবহারকারী উভয়ের দৃষ্টিকোণ থেকে প্রকৃতিভিত্তিক সমাধান এর একটি বিস্তৃত বোঝাপড়া প্রদান করে। চিহ্নিত প্রধান বাধাগুলির মধ্যে আর্থিক সীমাবদ্ধতা, স্থানীয় সীমাবদ্ধতা এবং অপর্যাপ্ত অংশীদারিত্ব অন্তর্ভুক্ত রয়েছে। ভবিষ্যতের প্রকৃতিভিত্তিক সমাধান-চালিত নগর প্রকল্পগুলির জন্য সুপারিশগুলোর রূপরেখা প্রদান করা হয়েছে, যা নগর স্থায়িত্ব এবং স্থিতিস্থাপকতা বাড়ানোর জন্য সামাজিক-অর্থনৈতিক এবং পরিবেশগত কারণগুলি বিবেচনা করে। এই গবেষণা একটি জাতীয় কাঠামো বিকাশের প্রয়োজনীয়তা, গবেষণার সম্প্রসারণকে অগ্রাধিকার দেওয়া, অংশীদারদের মধ্যে সমন্বয় এবং সহযোগিতা বৃদ্ধি করা এবং এই চ্যালেঞ্জগুলি অতিক্রম করার জন্য টেকসই অর্থায়ন সুরক্ষার উপর জোর দেয়। এই গবেষণাটি প্রকৃতিভিত্তিক সমাধান এর উপর ক্রমবর্ধমান গুণমানভিত্তিক অবদান রাখে, যা বাংলাদেশের এবং অনুরূপ প্রেক্ষাপটের জন্য নগর পরিকল্পনাবিদ, নীতিনির্ধারক এবং অনুশীলনকারীদের জন্য মূল্যবান অন্তর্দৃষ্টি এবং ব্যবহারিক সুপারিশ প্রস্তাব করে। নগর পরিকল্পনায় প্রকৃতিভিত্তিক সমাধান একীভূত করার মাধ্যমে, শহরগুলি উল্লেখযোগ্য পরিবেশগত, অর্থনৈতিক এবং সামাজিক সহ-উপকার অর্জন করতে পারে, যা শেষ পর্যন্ত আরও স্বাস্থ্য এবং স্থিতিস্থাপক নগর পরিবেশকে উৎসাহিত করে।

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SYMBOLS, ACRONYMS AND ABBREVIATIONS

BREEAM	–	Building Research Establishment Environmental Assessment Methodology
CC	–	Climate Change
EC	–	European Commission
ES	–	Ecosystem Services
GBI	–	Green and Blue Infrastructure
GI	–	Green Infrastructure
GS	–	Green Space(s)
IUCN	–	International Union for Conservation of Nature
LEED	–	Leadership in Energy and Environmental Design
NbS	–	Nature-based Solution(s)
NGO	–	Non-Governmental Organization
SDG	–	Sustainable Development Goal(s)
SUDS	–	Sustainable Urban Drainage System(s)
UHI	–	Urban Heat Island
UNEA	–	United Nations Environment Assembly



Boats gathering in a lake, Sylhet
Photo from WESTEND61

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

The escalating global population and rapid urbanization present significant challenges for cities worldwide, as more individuals converge in urban areas (European Commission, 2015), straining resources, infrastructure, and communal spaces. At present, more than 50% of the world's population lives in urban areas, and it is expected that this number will rise to 75% by 2050 (Ritchie et al., 2024; World Economic Forum, 2022). and over 70% of greenhouse gas emissions globally (UNDP, 2016), exacerbating issues like traffic congestion, air pollution, water scarcity, and inadequate waste management. Furthermore, the effects of climate change, such as increasing temperatures, rising sea levels, extreme weather events, and loss of biodiversity, present further risks to urban infrastructure and its inhabitants (Gehrels et al., 2016).

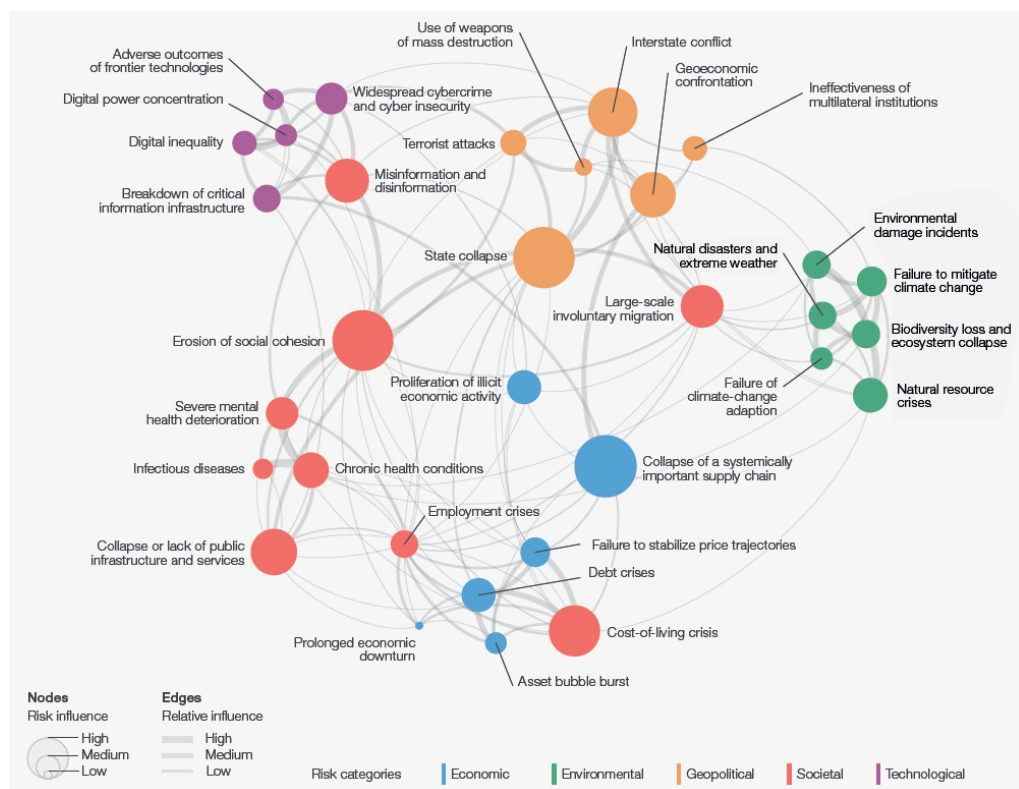


Figure 1 Global Risks Landscape; Source: World Economic Forum, (2023)

Addressing these challenges is paramount to enhancing urban sustainability and resilience, necessitating the integration of green solutions into urban planning strategies (Boros & Mahmoud, 2021; Liu et al., 2021; Sarabi et al., 2019a). Nature-based solutions (NbS) are gaining recognition as effective methods for tackling urban issues (Kolokotsa et al., 2020a; Rojas-Rueda, 2021), including climate change mitigation and adaptation, resilience enhancement, and environmental quality improvement (European Commission, 2015a; Maes & Jacobs, 2017).

Numerous lower-income nations face heightened vulnerability to natural disasters and climate change repercussions, largely stemming from their geographical positioning and elevated poverty rates (Eckstein et al., 2019). In response to that, many of these countries are formulating National Adaptation Plans (NAPs) and Nationally Appropriate Mitigation Actions (NAMAs). These initiatives seek to address the impacts of climate change, reduce disaster risks, and lower greenhouse gas emissions, all while promoting the broader range of sustainable development goals (SDGs) (A. C. Smith et al., 2021).

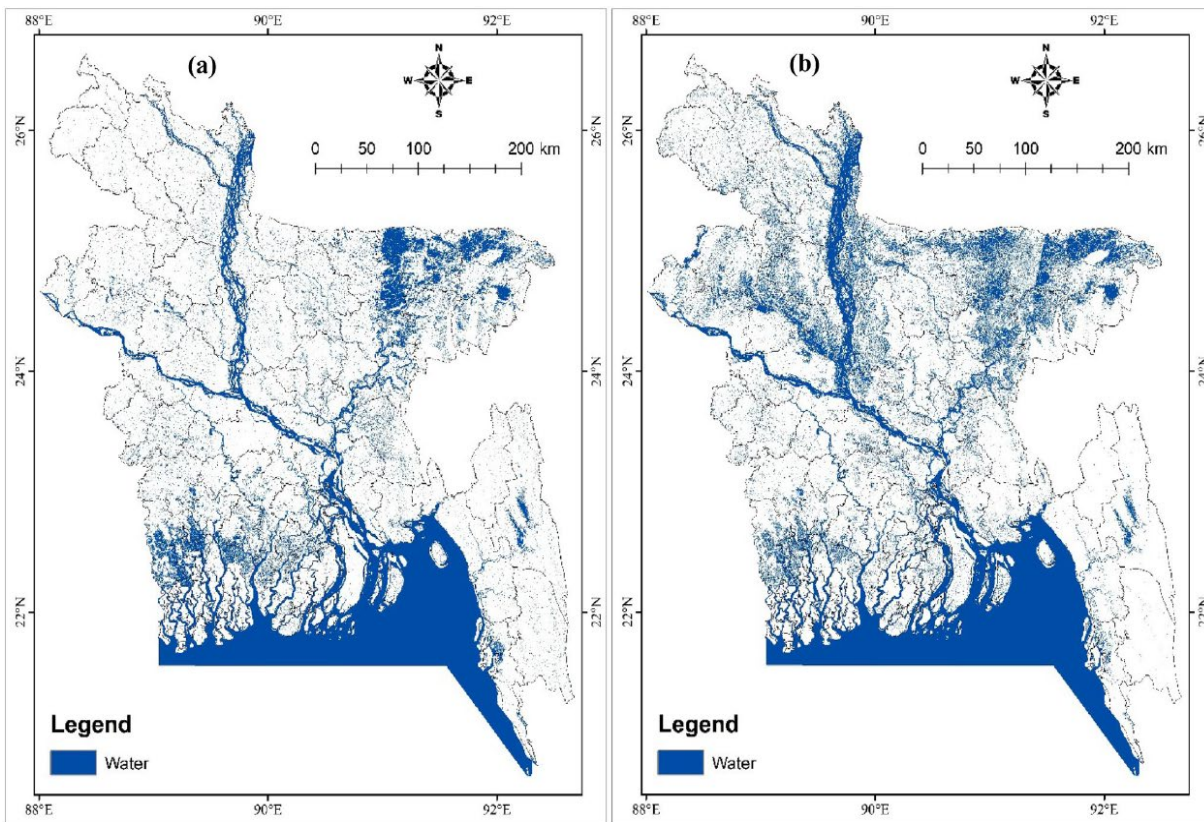


Figure 2 Flood map of Bangladesh (2020); (a) before flood scenario and (b) during flood scenario
Source: Aziz et al., (2022)

Bangladesh, located in South Asia, is widely acknowledged as one of the most climate-vulnerable areas owing to its distinctive geographic location and socio-economic circumstances (Eckstein et al., 2019). As per the 2023 World Risk Report, Bangladesh is ranked ninth among the most severely impacted countries by extreme weather events (Bündnis Entwicklung Hilft & IFHV, 2023). The country's agricultural sectors, freshwater sources, and coastal infrastructure are especially susceptible to the negative effects of climate change, such as changing temperatures, precipitation patterns, and rising sea levels, which intensify the overall impact (USAID, 2013; Shahjahan Mondal et al., 2019). As an example, Figure 2 illustrates the severity of flash floods during the monsoon season, while Figure 3 highlights that the urban heat island intensity effect is concentrated in the urban core of five major cities in Bangladesh. Given this heightened vulnerability, Bangladesh has placed significant emphasis on climate adaptation efforts. Its Nationally

Determined Contribution (NDC) notably includes a comprehensive strategy to integrate adaptation and mitigation measures for long-term resilience (MoEFCC, 2021).

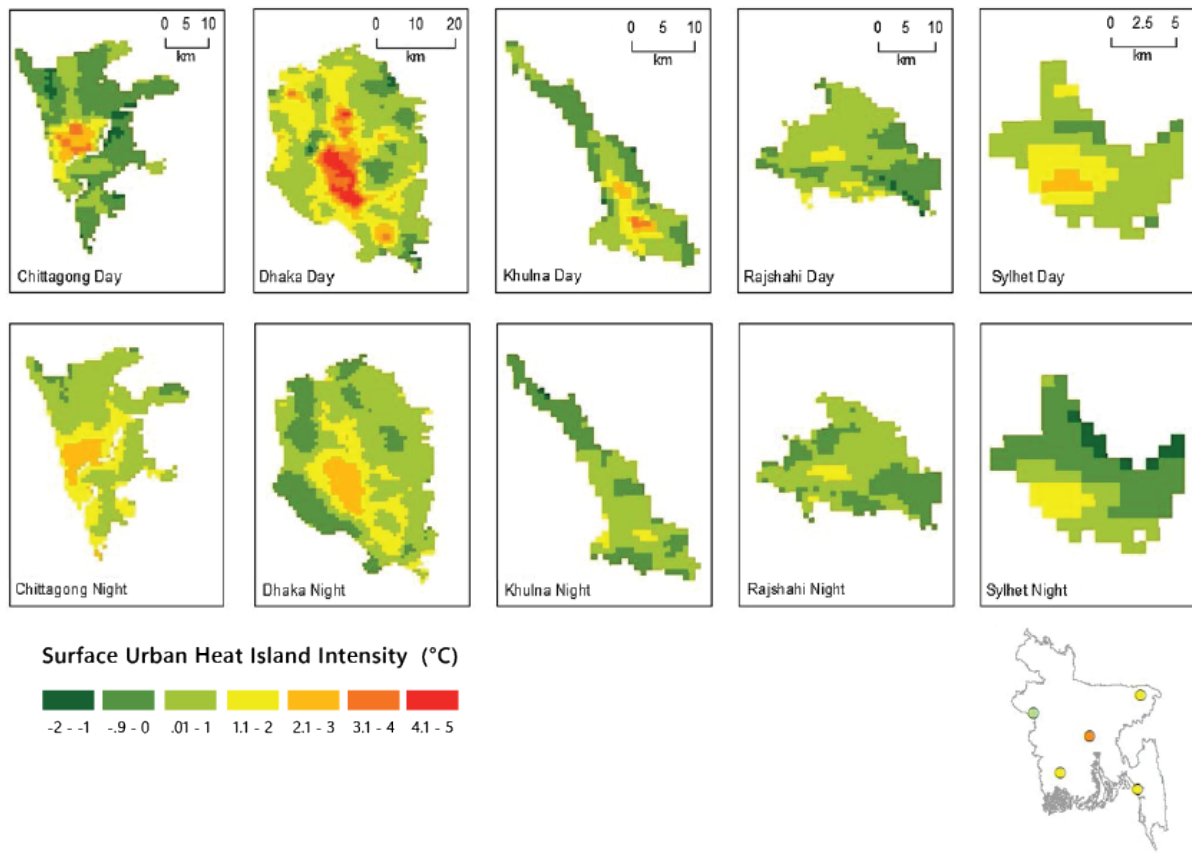


Figure 3 Spatial pattern of surface urban heat island intensity (SUHII) in five cities in Bangladesh, averaged over 2000–2019; (a) day; (b) night. Source: Dewan et al., (2021)

As a developing nation heavily reliant on its natural resources for sustenance, Bangladesh has traditionally employed NbS as an informal adaptation strategy to cope with its challenging climate conditions (Islam et al., 2021). For instance, local farmers use indigenous knowledge to create "floating gardens" from locally available materials, allowing for crop cultivation and reducing food shortages during flood seasons (Alam & Chowdhury, 2018). Additionally, the country has undertaken large-scale coastal afforestation initiatives aimed at mitigating the impacts of storm surges and rising sea levels (Rezaie et al., 2020). Despite the recognition of natural ecosystems' significance in disaster management and climate resilience within national policies, there remains a lack of specific provisions for the implementation and monitoring of NbS initiatives (Tasnim et al., 2020).

1.2 PROBLEM STATEMENT

Nature-based Solutions (NbS) have the potential to empower local people, enable sustainable development, and increase climate resilience (Anjum et al., 2024), though they are not fully integrated into the national policies of Bangladesh. When assessing the state of knowledge of NbS in Bangladesh, it is evident that there is a low level of understanding. Practices, interventions, and case studies are often inadequately documented. According to a study by Islam et al. (2021), nineteen of the twenty national policies of Bangladesh, do not specifically use NbS terminology. Instead, the policies encompass a variety

of approaches and terminology related to NbS, such as ecosystem services, ecosystem-based adaptation, and green and eco-building. Similar challenges are faced by several Southeast Asian nations, including Cambodia, India, Indonesia, Malaysia, Myanmar, Nepal, Singapore, Sri Lanka, and Thailand (Fernandes et al., 2022; Suratno et al., 2023). While each country has an extensive set of national policies, guidelines, and laws that could support the mainstreaming of NbS, specific frameworks for their implementation are lacking. Also, unlike other regions, there is relatively little research on NBS and ecosystem services, particularly in Southeast Asia (Lechner et al., 2020).

In Bangladesh, where urbanization is steadily rising, efficient resource use and sustainable development are essential. Incorporating NbS into urban design is crucial for boosting sustainability and resilience, while also promoting human well-being. Studies like the one by Boros and Mahmoud (2021) emphasize the importance of incorporating an urban ecology perspective throughout the design process to successfully integrate NbS into urban planning practices. This approach ensures a balance between human needs and nature-based elements, leading to more sustainable and nature-friendly urban environments. Although several NbS initiatives have been undertaken in Bangladesh at the practice level, policy level, and knowledge generation, these efforts have often been scattered and uncoordinated.

Research by Sikder et al. (2016) highlights the significance of energy-optimized urban planning in cities like Dhaka to promote efficient resource utilization. Additionally, studies such as the ones by Arifeen et al. (2021) and Hassan and Nazem (2016) shed light on land-use changes, urban expansion dynamics, and environmental sustainability in cities like Gazipur and Chittagong, respectively. Moreover, the development of urban green infrastructure plays a vital role in promoting sustainability and enhancing urban living conditions. Islam et al. (2020) explore urban households' perceptions and contributions to urban greenery development in Chittagong, providing insights into community engagement in enhancing urban green spaces. The potential benefits of this element have also been proved in other countries, such as in the study by Orsini et al. (2014) emphasizing the contributions of rooftop gardens and urban agriculture in improving food security, biodiversity, and ecosystem services in cities.

The integration of NbS into urban design in Bangladesh faces several barriers that hinder its effective implementation. Financial constraints, lack of coordination, and the inadequate integration of NbS benefits into valuation methods pose significant challenges (Duffaut et al., 2022). Additionally, there is a lack of proper Private-Public Partnerships, community participation that includes gender and social inclusiveness, a stable political economy, and awareness among policymakers about the benefits of NbS. These challenges hinder the scaling up of NbS to a nationwide level. Moreover, spatial constraints in urban areas limit the suitable locations for implementing NbS projects, further complicating their integration (Perrault, 2022).

Unplanned and grey infrastructures, knowledge gaps among stakeholders, coupled with narrowly focused projects targeting specific species, often result in the destruction of natural ecosystems and the biodiversity they support. In Bangladesh, issues with data accessibility and availability have long been a challenge. Problems include low-quality data, biased information, and poorly maintained datasets, compounded by a lack of incentives or recognition for experts to publish their findings (Tasnim et al., 2020). These factors collectively hinder the effective planning and implementation of NbS projects.

There is also a lack of effective Private-Public Partnerships, inclusive community participation that considers gender and social aspects, a stable political economy, and awareness among policymakers about the benefits of NbS. The absence of a comprehensive set of indicators to guide the network of stakeholders and incorporate lessons from previous projects makes it difficult to assess the effectiveness of NbS. These factors hinder the nationwide scaling up of NbS (Tasnim et al., 2020).

To overcome these barriers and facilitate the successful integration of NbS into urban design, it is essential to address key enablers and barriers. These include the need for rigorous assessment of the potential benefits of NbS (Seddon et al., 2020), the importance of stakeholder engagement throughout the design and implementation phases (Scrieciu et al., 2021), and the necessity of incorporating an urban ecology perspective into the entire design process to ensure human-centeredness and nature-basedness (Boros & Mahmoud, 2021). Additionally, the establishment of a comprehensive framework that enhances stakeholders' understanding of NbS at all stages of policymaking, design, construction, and maintenance is crucial (Zhao & Yue, 2023).

Furthermore, incorporating NbS in urban design practices requires a multidimensional approach that integrates socioeconomic and ecological factors, and identifies potential trade-offs and synergies (Kong et al., 2023). Newton et al. (2022) stress the importance of considering NbS at various scales, from bioregions to neighbourhoods, to enhance urban resilience and mitigate climate change impacts.

1.3 RESEARCH QUESTIONS AND OBJECTIVES

In view of the above, the main research question of this dissertation is: *"How to increase the use of Nature-based Solutions (NbS) to contribute to sustainable urban design practices and respond to urban challenges in the context of climate-vulnerable areas such as Bangladesh?"*

This master's thesis aims to analyze the current planning and design practices of Nature-based Solutions (NbS) in urban areas, particularly focusing on the context of Bangladesh and as such the broader global south region. The findings from the analysis are crucial for organizing and comparing NbS impacts over time and across various disciplines. Additionally, the thesis seeks to explore the challenges and opportunities associated with implementing NbS through the analysis of diverse case studies, highlighting their multifaceted environmental, economic, and social benefits. Furthermore, the study aims to enhance understanding of the implementation of NbS in urban design, aiming to bridge the gap between theoretical knowledge and practical application. To this aim, the following detailed research questions arise:

- What does NbS mean? What are the existing classification schemes of NbS?
- What is the relationship between NbS and the benefits they provide?
- Which parameters are relevant when considering NbS in Urban Design?
- What are the urban challenges that Bangladesh is facing?
- What are the barriers limiting NbS implementation in Bangladeshi Cities?
- How can NbS solve those challenges while providing co-benefits?

1.4 THESIS OUTLINE

The structure of this research work is outlined as follows:

Chapter 1, the introduction, offers an overview of the identified problem, study objectives, and research questions. It also defines the scope of the study and identifies the intended audience of the report. It establishes the context and significance of the research, highlighting the need for innovative approaches to address urban sustainability and resilience challenges.

Chapter 2, the literature review, explores existing definitions of Nature-based Solutions (NbS) from the literature. It examines their connections with related concepts like green and blue infrastructure, and ecosystem services. It critically examines the current state of knowledge and identifies gaps in the literature, providing a theoretical foundation for the research.

Chapter 3, the methodology, details the methodology and theoretical framework used for the research work. It explains the research methods utilized for case study selection and analysis, stakeholder interviews, data analysis and evaluation. Additionally, it addresses the limitations of the study, ensuring transparency and acknowledging potential constraints.

Chapter 4, the case studies, examines six key projects, which are introduced and discussed in terms of their objectives, implementation processes, challenges faced and overall impacts. In addition to investigating the objectives for implementing these solutions and this study also tries to identify the stakeholder groups involved in their development. Furthermore, it examines the barriers and facilitators of implementing NbS in urban settings.

Chapter 5, the discussion, addresses the research questions and objectives in light of the case studies presented in Chapter 4. It identifies the drivers and drawbacks of NbS implementation in the studied projects based on stakeholder input and identifies barriers and opportunities to NbS implementation.

Chapter 6, the conclusion, answers the research questions by summarizing key findings. Additionally, it summarizes general conclusions and offers recommendations based on lessons learned, along with suggesting topics for future research.

Overall, this research aims to enrich the existing knowledge on NbS by conducting a thorough analysis of their definitions, implementation processes, stakeholder perspectives, and potential to tackle urban sustainability and resilience challenges. Through a combination of literature review, case study analysis, and stakeholder engagement, this study provides valuable insights and practical recommendations for urban planners, policymakers, and practitioners interested in integrating NbS into their strategies and initiatives.



Largest slum area in Bangladesh
Photo from WESTEND61

2

LITERATURE REVIEW**2.1. NATURE-BASED SOLUTIONS: THE CONCEPT**

The rapid urbanization of the 21st century poses a multifaceted challenge characterized by environmental degradation, increasing climate change impacts, and growing social inequalities. Cities often confront a complex web of interconnected issues such as pollution, waste management, food security, social segregation, and poverty (Potschin et al., 2016). Traditionally, these issues have been approached as distinct infrastructure problems addressed through conventional "grey solutions" - infrastructure designed to tackle specific challenges without necessarily prioritizing environmental or social considerations, sustainability, or resilience. As the discourse on sustainability and urban resilience has progressed, urban planners and policymakers have explored innovative approaches that acknowledge the interconnected nature of social, economic, and environmental aspects (Chaudhary et al., 2015). Nature-based Solutions (NbS) emerge as innovative tools to address these challenges, offering a pathway toward more liveable, resilient, and sustainable cities, though their uptake is still limited (Sarabi, 2022).

The main components of NbS have been used for thousands of years, although it is a novel idea. For thousands of years, people have relied on the natural world and its processes to help them with a variety of problems and to maintain their well-being. Indigenous peoples' traditional knowledge systems and beliefs highlight the value of ecosystems and the services they offer to people (Cohen-Shacham et al., 2016). The term "Nature-based Solutions" (NbS) refers to a broad category of methods for addressing environmental issues, particularly in urban settings (European Commission, 2015; Potschin et al., 2016). NbS, as an umbrella concept, provide a framework for promoting sustainable development and ecosystem protection while addressing a range of critical societal challenges. These include enhancing human health and well-being, ensuring food security, mitigating and adapting to climate change, fostering sustainable urban development, managing disaster risks, and conserving biodiversity. By improving community resilience and sustainability, NbS offer a comprehensive approach to tackling environmental, social, and economic concerns (European Commission, 2015; Kabisch et al., 2017). Importantly, unlike more neutral ideas like Ecosystem Services (ES), which may improve well-being, the framing of nature-based remedies necessitates the solution of a particular problem (Potschin et al., 2016). NbS are more integrative and systemic, encouraging collaboration and interconnectedness within systems to achieve certain aims while minimizing trade-offs (Cohen-Shacham et al., 2019; Seddon et al., 2021).

2.1.1. Evolution of the NbS Concept

The conceptual framing of NbS sometimes fails to clearly differentiate it from other established environmental concepts, such as green infrastructure, ecological engineering, urban green and blue spaces, and ecosystem-based adaptation, which share fundamental elements. To establish a classification of NbS it is important to outline the definition of the term and its origin (Babí Almenar et al., 2021; Sarabi et al., 2019). Figure 4 illustrates a timeline depicting the evolution of the term NbS in the research field and highlights the most significant events over the past two decades. The concept of NbS was initially introduced in 2002, and over the past decade, it has gained recognition in the research field. In recent years, several definitions of NbS have been proposed.

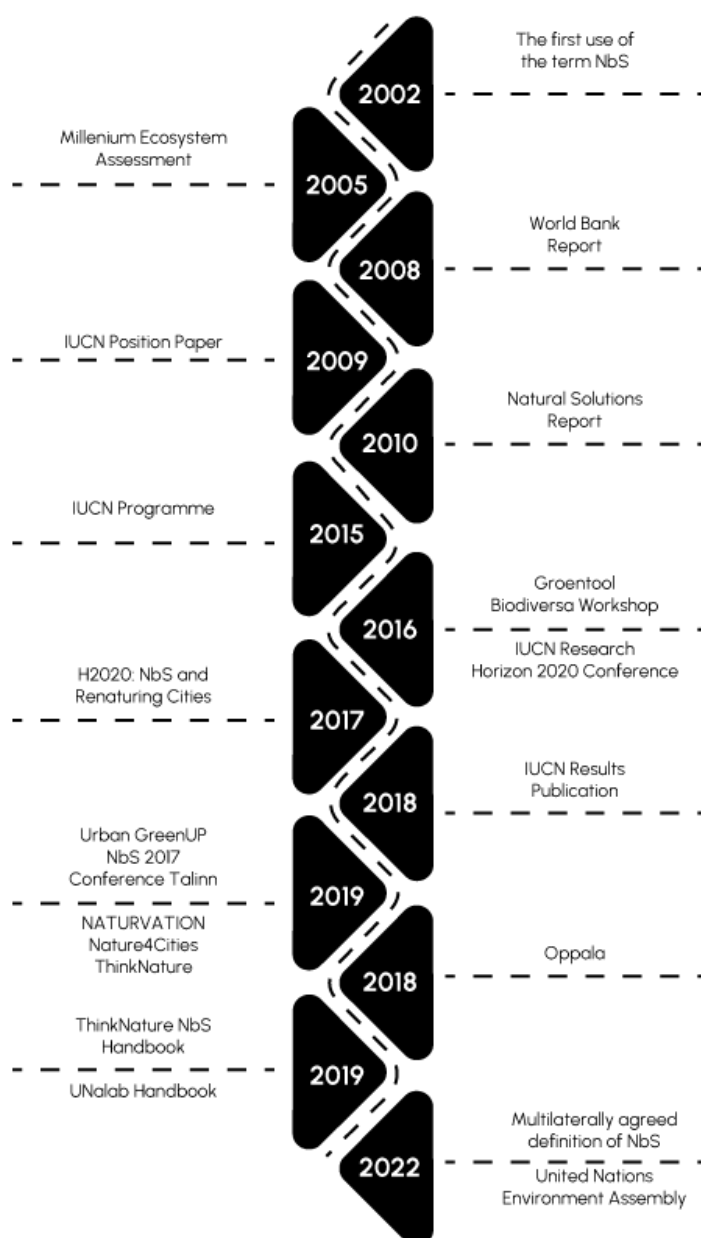


Figure 4 *Timeline and milestones concerning the concept of NbS;
Adaptation from: Somarakis et al., 2019*

Two definitions are frequently used and could therefore be important points of reference. The European Commission (EC) has defined NbS as:

“solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience” (European Commission, 2015).

The International Union for Conservation of Nature (IUCN) defined NbS as:

“actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits” (Cohen-Shacham et al., 2016).

While the European Commission's definition (European Commission, 2015) takes a more comprehensive approach and considers the three sustainability pillars at the same time, the IUCN's definition (Cohen-Shacham et al., 2016) places more emphasis on the value of nature conservation and restoration (Albert et al., 2019; Nesshöver et al., 2017). The European Commission's definition of NbS emphasizes urban ecosystems, reflecting the high percentage of the population residing in cities and the need to address issues like human health, climate change, and the decline of natural resources (Raymond et al., 2017). In contrast, the IUCN's definition takes a global view, encompassing all types of ecosystems, but primarily focusing on the protection and management of natural ecosystems (i.e., corresponding to NbS types 1 and 2 in Eggermont et al., 2015). While the IUCN definition recognizes the usefulness and necessity of NbS in specific contexts, it doesn't encompass interventions that are solely inspired by nature (Dudley et al., 2017; Lo, 2016; Vasseur et al., 2017).

Recently, the United Nations Environment Assembly (UNEA) adopted a multilaterally agreed-upon definition similar to the IUCN definition:

“actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems, which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human wellbeing, ecosystem services and resilience and biodiversity benefits.” (UNEA, 2022).

Table 1 presents the definitions of nature-based solutions (NbS) and various approaches that fall under the umbrella of the NbS framework. It illustrates that these definitions vary considerably in both their content and the terminology employed.

Table 1: Definitions of NbS found in literature

NbS are...	References
<i>‘[...] the use of nature in tackling challenges such as climate change, food security, water resources, or disaster risk management, encompassing a wider definition of how to conserve and use biodiversity in a sustainable manner’</i>	(Balian et al., 2014)
<i>‘actions that address environmental, social and economic challenges simultaneously by maximizing the benefits provided by nature (...) inspired by, supported by, or copied from nature’</i>	(European Commission, 2015b)

NbS are...	References
<i>'Nature-based solutions are measures that are supported by nature and jointly benefit the environment, society, and the economy. Because of these multiple benefits, they are more efficient and cost-effective than traditional methods'</i>	(Triest et al., 2016)
<i>'NbS are living solutions inspired by, continuously supported by, and using nature. They are designed to address various environmental challenges in a resource-efficient and adaptable manner and to provide simultaneously economic, social, and environmental benefits'</i>	(Haase et al., 2017)
<i>'multifunctional green interventions delivering upon the social, environmental and economic pillars of suitable development'</i>	(Van der Jagt et al., 2017)
<i>'(...) a pure nature-based solution is a solution (to a certain issue) that is completely based on elements and direct inputs from nature, thus not managed by mankind nor containing any human/industrial element'</i>	(Schaubroeck, 2018)
<i>'conscious use of nature to help urban inhabitants address various environmental, social and economic challenges'</i>	(Małecka et al., 2022)
<i>'soft engineering approaches that are aimed at increasing the resilience of territories and societies affected by meteorological events and therefore reducing the economic, functional, cultural, and social damage disruption that such events cause'</i>	(Short et al., 2019)
<i>'actions that alleviate a well-defined societal challenge employ ecosystem process of spatial, blue and green infrastructure networks, and are embedded within viable governance or business models for implementation'</i>	(Albert et al., 2019)
<i>'Nature-based solutions address these societal challenges through the delivery of ecosystem services'</i>	(Bush & Doyon, 2019)
<i>'Nature-based solutions are being powered by nature and restoring natural flows in cities, creating novel ecosystems that require multi-actor collaborations for their design and sustainability'</i>	(Frantzeskaki, 2019)
<i>'promising means to address a number of societal challenges arising from climate change and urbanization, with multiple social, environmental and economic co-benefits'</i>	(Sarabi et al., 2019b)
<i>'actions to protect, sustainably manage, and restore natural or modified ecosystems, which address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits'</i>	(IUCN, 2020)
<i>'key characteristic of NbS is their capability to be multi-functional, which means the ability to simultaneously perform multiple functions to deliver a set of associated ecosystem services (ES)'</i>	(Gómez Martín et al., 2020)
<i>'Nature-based solutions (NbS) is a concept, defined as actions inspired by, supported by, or copied from nature that: (1) deploy various natural features and processes in a resource-efficient and sustainable manner; (2) are adapted to local systems (...); and (3) face social, environmental, and economic challenges, leading to multiple benefits and supporting sustainable development and resilience.'</i>	(Kolokotsa et al., 2020b)

NbS are...	References
<i>'(...) NbS as a concept stresses the strategic, integrated use of natural ecosystems to support human wellbeing in a cost-effective way'</i>	(Toxopeus et al., 2020)
<i>'NbS can provide a range of ecosystem services beneficial for the urban biosphere such as regulation of micro-climates, flood prevention, water treatment, food provision, and more.'</i>	(Langergraber et al., 2020)
<i>"conscious use of nature to help urban inhabitants address various environmental, social and economic challenges."</i>	(Kronenberg et al, 2017)
<i>'(...) NbS should be cost-effective, resource-efficient, and locally adapted. NbS are systemic interventions that bring more, and more diverse, nature and natural features and processes. They address either a specific problem (i.e., societal challenge) or multiple challenges and simultaneously provide environmental, social, and economic benefits, such as biodiversity, climate change mitigation and adaptation, resilience, human well-being, etc.'</i>	(Nika et al., 2020)
<i>'(...) NbS as a concept stresses the strategic, integrated use of natural ecosystems to support human wellbeing in a cost-effective way'</i>	(Toxopeus et al., 2020)
<i>'Nature-based solutions (NbS) are usually defined as complementary or alternative solutions to "grey infrastructures" (traditionally made with cement) aimed at conserving and regenerating the functionality of natural and semi-natural ecosystems.'</i>	(Turconi et al., 2020)
<i>'Nature-based solutions are innovative solutions, which are inspired from nature, and applied to contemporary societal problems such as climate change, overtourism, poverty alleviation, and so on.'</i>	(Padma et al., 2022)

Although most definitions of Nature-Based Solutions (NbS) are generally consistent, the more complex issue lies in the relationship between NbS and other related concepts. There remains a significant degree of ambiguity, uncertainty, and knowledge gaps regarding the differentiation of these interconnected concepts (Nesshöver et al., 2017). Although different researchers and institutions have presented different definitions (Pauleit et al., 2017), there is a strong consensus regarding NbS's ability to address significant societal concerns. When compared to typical grey infrastructure, NbS is a potential option because of its many benefits (Raymond et al., 2017; Chausson et al., 2020). NbS promotes synergies and minimizes trade-offs between actions to accomplish specific goals since it is more integrative and systemic (Cohen-Shacham et al., 2019; Seddon et al., 2020).

Figure 5 illustrates how NbS function as a comprehensive framework to address various societal challenges. By utilizing and working with natural processes, NbS aim to enhance biodiversity conservation while simultaneously improving human well-being. This approach recognizes the interconnectedness of human society and the environment, highlighting that solutions benefiting one will ultimately benefit the other.



Figure 5 The NbS role as the principal concept for addressing societal challenges;
Adaptation from: Cohen-Shacham et al., (2019)

While many applications of NbS address common themes, such as addressing growing environmental, social, and economic challenges, there is a need for clarity regarding how the concept is defined and applied. A foundational resource is the BiodivERSA workshop report (Balian et al., 2014) which proposed identifying three types of NbS involving:

- **Type 1, low intervention:**
involves little to no human intervention in ecosystems, aiming to preserve or enhance the delivery of various ecosystem services both within and beyond these protected areas.
- **Type 2, medium intervention:**
involves defining and implementing management strategies that cultivate sustainable and versatile ecosystems and landscapes (managed either extensively or intensively). This approach enhances the delivery of specific ecosystem services compared to what would be achieved through more traditional interventions.
- **Type 3, high intervention:**
involves significantly altering existing ecosystems or creating entirely new ones, (e.g., ecological engineering, artificial ecosystems for green roofs and walls to combat urban heat and air pollution, etc.)

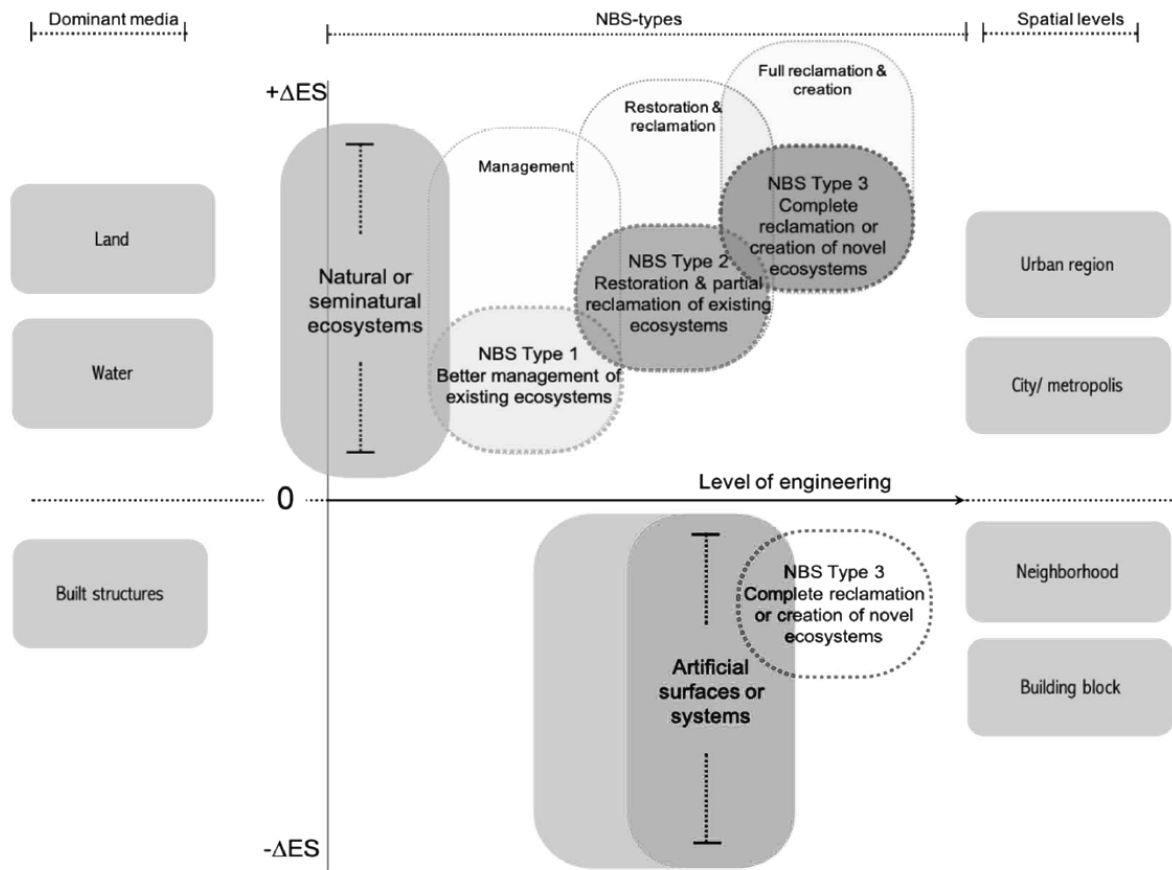


Figure 6 Conceptualisation of NbS types. Elements and their positioning in an X-Y diagram
Adaptation from: Babí Almenar et al., (2021); based on the framework of Cohen-Shacham et al., (2016) and Eggermont et al., (2015).

NbS can provide advantages above traditional technical solutions. In some circumstances, they are more affordable than traditional alternatives (Seddon et al., 2020). NbS offers additional benefits beyond the situation at hand, making it a valuable asset. Though, Kati & Jari (2016), identifies sociocultural benefits such as nature enjoyment, aesthetics, recreation, support for biodiversity, and cultural heritage, which may present challenges in terms of quantification.

On the other hand, NbS are often slower (although not always) than other options. For instance, habitat restoration or development often requires considerable time. While faster-growing plants may expedite the process, they may not offer the same benefits as slower-growing species that develop naturally over time. According to Balian et al., (2014), short-term technological solutions may be more efficient than long-term natural solutions for certain issues.

NbS can also help to achieve the full range of Sustainable Development Goals (SDGs). Specifically, NbS are directly relevant to several SDGs, including SDG 2: Zero Hunger (food security), SDG 3: Good Health and Well-being, SDG 6: Clean Water and Sanitation, SDG 11: Sustainable Cities and Communities, SDG 13: Climate Action, SDG 14: Life Below Water (conservation and sustainable use of oceans, seas, and marine resources), SDG 15: Life on Land (protection, restoration, and sustainable use of terrestrial ecosystems) (Dudley et al., 2017; Lo, 2016; Vasseur et al., 2017).

2.2 URBAN NATURE-BASED SOLUTIONS

Nature-based Solutions (NbS) are being more frequently implemented in urban settings to enhance climate resilience, promote sustainable development, and protect biodiversity (UNEP, 2023). In cities, NbS include the preservation, restoration, and creation of green and blue spaces, which refer to public or private open areas that are predominantly covered by vegetation or water, respectively.

Urban NbS are essential for creating livable and healthy urban environments due to their multiple benefits to urban populations (Cohen-Shacham et al., 2016; Potschin et al., 2016). They can mitigate the effects of extreme heat during summer months by providing shade and cooling the air through transpiration. Additionally, NbS enhance water retention, reducing the risk of stormwater flooding while simultaneously offering spaces for people to reconnect with nature, socialize, and engage in outdoor recreation and activities. These benefits collectively contribute to improved physical and mental well-being, increased social cohesion, and a more sustainable and resilient urban environment (Naturvation, 2020).

Although often smaller in scale than their rural counterparts, urban NbS, like trees and urban forests, contribute to carbon storage and sequestration, even if their impact on climate change mitigation is relatively modest (Koricho et al., 2022). Beyond environmental benefits, these NbS significantly improve the health and well-being of urban residents by providing spaces for physical activity and relaxation (Pataki et al., 2021; Russo et al., 2017). Additionally, they foster social interaction and cohesion among community members. From an economic standpoint, urban NbS offers advantages such as reduced energy consumption in buildings through green roofs, which provide insulation, and shade from trees, which can lower cooling costs (Russo et al., 2017). It is crucial to ensure that urban NbS are inclusive and accessible to all residents, regardless of socioeconomic status, thus promoting equitable access to the benefits they provide (Koricho et al., 2022).

Urban NbS encompasses a diverse range of interventions, varying in scale and scope. These solutions can be implemented at the micro-level, such as green roofs and facades on individual buildings or bioswales along streets, or they can be integrated into macro-level projects, such as the creation of urban forests or the restoration of rivers that span across urban areas, extending into peri-urban zones and the broader landscape (UNEP, 2023). In the context of NbS in urban environments, the Urban Nature Atlas identifies eight main types of NbS (Almassy et al., 2018):

- Building greens, such as green roofs and green walls;
- Urban green areas integrated with grey infrastructure, such as alley and street trees, railroad banks, house gardens, and green playgrounds/school grounds;
- Parks and (semi) natural urban green areas, including urban forests;
- Allotments and community gardens;
- Green indoor areas;
- Blue areas, such as rivers, lakes, seacoasts, and wetlands;
- Green areas designed for water management, such as rain gardens or sustainable urban drainage systems;
- Derelict areas and abandoned spaces with patches of wilderness.



Figure 7 8 types of NbS within the urban environment
Based on: (Almassy et al., 2018)

2.2.1. Principles for Urban Nature-based Solutions

To successfully design and deploy NbS in urban environments, a deliberate and methodical approach is necessary. To address the challenges in the urban environment, Kabisch et al., (2022) have identified five principles for Urban NbS. These principles aim to facilitate the transition to NbS in urban areas by focusing on issues such as spatial translation, participatory planning, and effective governance. The suggested urban principles can provide a fresh approach for choosing and evaluating frameworks for designing, monitoring, and integrating NbS into urban planning. This approach aims to ensure that NbS contribute to the development of resilient and inclusive cities both in the immediate and long-term future. The 5 Principles of Urban NbS are listed below:

1. Systemic understanding
2. Consider benefitting both people and biodiversity
3. Contribute to inclusive solutions for the long term
4. Consider context conditions
5. Foster communication and learning

Principles for Urban Nature-based Solutions

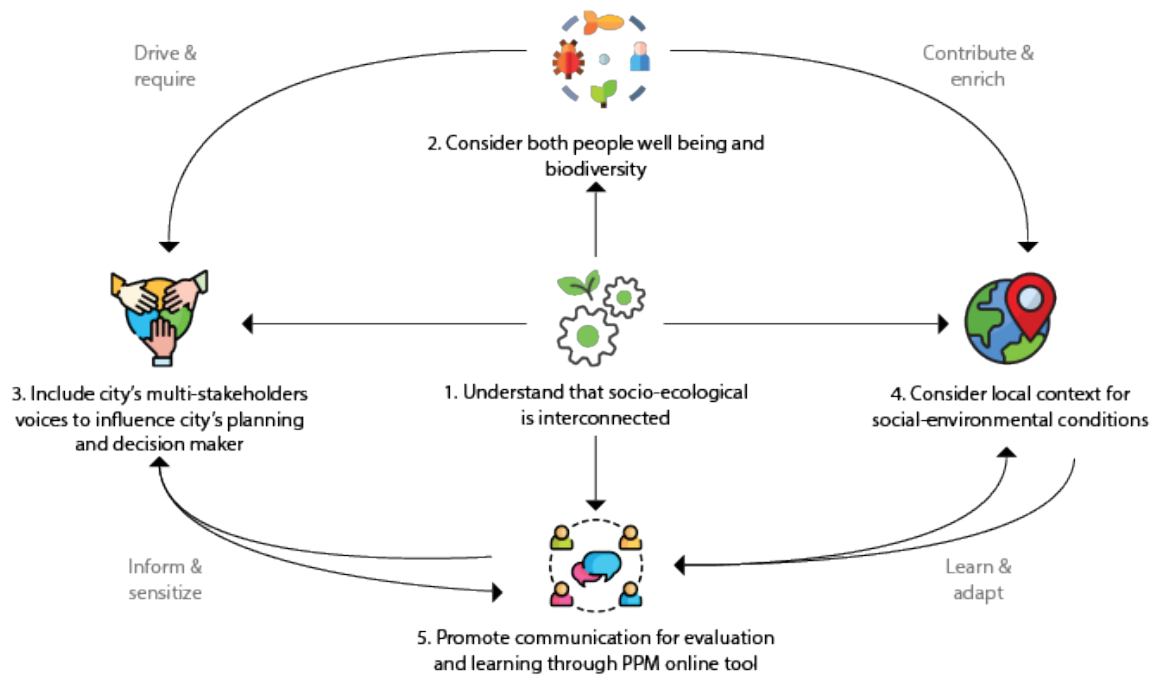


Figure 8 The five principles for Urban NbS; Adaptation from: (Kabisch et al., 2022).

These scientifically grounded concepts concentrate on the particular challenges related to urban NbS, offering a solid conceptual foundation for this research endeavour. The five principles of urban NbS address both social and ecological considerations within the urban environment.

Frantzeskaki, (2019) suggests seven key points for successfully using nature-based solutions in cities:

1. They should look good to the people who live there, especially those directly affected.
2. They should create new green spaces for everyone to enjoy.
3. They need people to trust their local government and be willing to experiment and try new things.
4. They should involve many different people in creating them and learn from how social changes happen.
5. They need everyone to work together, including government, businesses, and community groups.
6. They should have a clear purpose that connects to many different goals for the city.
7. They need a commitment to learning, making changes, and copying what works in the long run.

These lessons show that successful nature-based solutions involve people from different areas of expertise, both local knowledge and scientific knowledge, and the willingness to create new ways of working together as new solutions come up (Raymond, Frantzeskaki, et al., 2017).

2.2.2. Challenges Related to Urban Nature-based Solutions

The global urbanization rate is on a continual rise, underscoring the growing significance of adapting urban areas to effectively contend with the repercussions of Climate Change (CC). In simpler terms, cities must enhance their resilience against CC, given their heightened susceptibility to its impacts and their role in accommodating a substantial portion of the world's population. Attaining urban resilience necessitates the incorporation of strategies that address both mitigation and adaptation. NbS involves enhancing or introducing green infrastructure within urban areas to tackle various environmental issues, encompassing challenges associated with climate change and food security. These solutions are characterized by their inspiration, support, or emulation of strategies derived from nature (Kabisch et al., 2017).

The unprecedented challenges posed by the need for housing, services, workplaces, infrastructure, and institutions for millions of additional people necessitate careful consideration of potential impacts resulting from development decisions. Incorporating NbS into urban design and planning presents a promising approach to tackling these challenges in ever-expanding, densely populated cities (Cardinali et al., 2021; Conti et al., 2021). This approach not only holds promise for improving human health and well-being but also offers ecological and economic co-benefits. Integrating NbS into neighbourhood spaces can promote healthy physical activity and facilitate social connections. This encourages residents to spend time outdoors, enhancing the communal use of public spaces and fostering a greater sense of safety and mobility (Kolokotsa et al., 2020; Rachel J. Standish et al., 2013).

Implementing NbS in cities presents unique problems due to factors such as geography, population density, and social relationships. The challenges listed below are summarized by Kabisch et al., (2022):

1. *"Spatial conflicts with urban system nested Ness"*- Cities are dense, intricate systems. The natural, residential, business, transportation, and infrastructural sectors are all interconnected. This necessitates an awareness of systemic overviews and strategic planning.
2. *"Specific urban biodiversity, fragmentation, and altered environments"*- Biodiversity is fragmented in urban settings due to limited land and ecological interconnectedness. This can prevent ecosystem propagation.
3. *"Value plurality, multi-actor interdependencies, and environmental injustices"*- Unequal access to city areas, services, and benefits affects a varied population. Some people have access to good environmental circumstances, while others are living in threatened locations. Encouraging engagement in environmental rights, particularly for public places in cities, is crucial to prevent harmful effects.
4. *"Path-dependencies with cultural and planning legacies"*- Each city has unique issues based on its historical infrastructure. The areas have distinct features and societal values. One size does not fit all, so consider the local context.
5. *"Misconception of cities as artificial landscapes disconnected from nature"* - Urbanization has led to a perception that cities are technical or industrial areas, disconnected from nature. Strategic communication is essential for developing a shared vision for sustainable transformational cities.

Despite the well-documented advantages of employing NbS to enhance urban resilience to CC (Faivre et al., 2017; Raymond, et al., 2017), their effective implementation remains limited or unsuccessful in many cities (Palla et al., 2024). This is particularly evident in developing countries, where the full potential of NbS for CC mitigation and adaptation is often underutilized. Despite this untapped potential, minimal research has been conducted to identify the obstacles hindering successful implementation, as noted by Matthews et al., (2015). Examining the factors that have influenced the implementation of NbS in the past could contribute to more successful future implementations. Despite the endeavours of policymakers and practitioners (Cohen-Shacham et al., 2016a) to disseminate information about the purpose and application of Nature-Based Solutions (NbS), the concept remains ambiguous or unfamiliar to the general public (Nesshöver et al., 2017). Additionally, there is a paucity of research exploring how the implementation of NbS varies across different regions of the world with different barriers and triggers to success. This gap is significant, considering that variations in city characteristics and priorities may lead to differences in the recommended utilization of NbS.

Planning NbS solutions and urban environments sometimes presents a paradox: *"The main actors in urban planning are city inhabitants, but unfortunately, they are not usually included in the planning until the end of the process"* (González-Méndez et al., 2021). Minorities, marginalized individuals, and vulnerable groups in cities often face restricted access to information and opportunities for decision-making. Understanding the urban environment through the perspective of citizens, particularly youth, can inform development processes and influence the creation of cities that meet their aspirations (Smith et al., 2015; Teixeira and Gardner, 2017).

Urban planners play a crucial role in advocating for the adaptability and innovation of spaces and services, necessitating a reassessment of both the natural and built environment, as well as the perspectives of officials and citizens. Professionals involved in creating healthy environments, including public health experts and landscape architects, widely acknowledge urban greening as an asset with significant potential to enhance health and well-being. By exploring locally suitable nature-based solutions, professionals can examine the adaptability and innovation of spaces and services, creating a context that encourages change and development. NbS also resonates with urban populations, highlighting the significance of citizen empowerment and citizen-driven innovation in harnessing the potential benefits of these solutions for urban social regeneration. To fully harness these innovative capabilities, resources, and collaborative efforts, it is essential to explore new forms of stakeholder engagement and citizen participation in urban design and planning.



A roundabout in Dhaka
Photo from WESTEND61

3

METHODOLOGY

3.1 RESEARCH DESIGN

This research is designed as an exploratory study to examine the complex challenges and opportunities involved in integrating Nature-Based Solutions (NbS) into urban design practices to address urban issues in Bangladesh and similar contexts. The methodology adopts a qualitative approach, utilizing multiple methods to gather in-depth insights from a variety of sources. This approach, focusing on qualitative data rather than quantitative measures, which were often unavailable or not generated in many of the projects, was deemed appropriate. As Creswell, (2013) emphasizes, that qualitative research is especially suitable when the subject is new, under-researched, or key variables remain unknown to the researcher.

The strength of qualitative research lies in its ability to generate rich, contextual, and multilayered interpretations, providing valuable insights into specific situations, settings, or processes (Anderson, 2010; Creswell, 2013; Mason, 2002; Walliman, 2010). Additionally, data derived from human experience can capture subtle details and complex issues more effectively than quantitative data (Creswell, 2013). The overall research process can be summarized as follows:

1. **Literature Review:** A comprehensive literature review was conducted to consolidate the current knowledge on NbS, encompassing their definitions, typologies, and applications within urban contexts. Both peer-reviewed publications and grey literature are used for this review. This step helped identify existing knowledge gaps and informed the development of the research questions and theoretical framework (Sproule, 2006).
2. **Case Study Selection and Analysis:** Six urban Nature-based Solutions (NbS) projects in Bangladesh, either recently completed or ongoing, were selected for in-depth case study analysis. These projects represent a range of urban contexts and NbS interventions, offering a rich empirical foundation for the research. Additionally, documents published by architecture firms and other organizations involved in these projects were analyzed, alongside various reports and policy documents released by government agencies. These documents provided supplementary information on project objectives, design specifications, and implementation strategies, enhancing the overall understanding of the NbS interventions under study. These findings were used to develop strengths, weaknesses, opportunities, and threats (S.W.O.T. analysis) related to each of the case studies.

3. **Semi-structured Interviews:** Semi-structured interviews (Flowerdrew & Martin, 2005) were conducted with key stakeholders involved in the selected case studies, including urban planners, researchers, architects, and representatives from local authorities and community organizations. Purposive and snowball sampling strategies were used to select participants, where, in snowball sampling, interviewees suggest others who also meet the established criteria (Merriam, 2010). Rather than emphasizing the sample size, the goal was to select participants who could provide the most valuable and detailed information to address the research questions. Nevertheless, a larger sample might have yielded a more comprehensive and compelling study (Walliman, 2010). These interviews were designed to gather first-hand perspectives, experiences, and insights on the drivers, barriers, and implementation processes of NbS in urban design practices (Döringer, 2021; Kvale & Brinkmann, 2009; Travers, 2014).
4. **Discussion of the Findings:** The data gathered from case study analysis, document analysis, and interviews were examined and analyzed collectively using the qualitative content analysis (QCA) method. This approach is highly valued and encouraged in case study research, as it provides a more comprehensive understanding of the studied case and enhances the validity of the findings (Harrison et al., 2017; Merriam, 2010). This step aimed to identify patterns, themes, and key findings related to the case studies that would help in answering the research questions. The findings derived were synthesized and evaluated against existing theoretical frameworks and best practices in NbS implementation. This step involved assessing the effectiveness, challenges, and lessons learned from the case study projects, as well as identifying potential areas for improvement or further research.
5. **Recommendations and Guidelines:** Based on the research findings and synthesis, recommendations and guidelines were developed to inform the integration of NbS into urban design practices in Bangladesh. These recommendations address various aspects, such as policy frameworks, stakeholder engagement, design considerations, and implementation strategies.

Overall, the methodology combines multiple qualitative methods to triangulate data from various sources, ensuring a comprehensive understanding of the research topic. The case study approach, coupled with document analysis and stakeholder interviews, provides a rich empirical basis for exploring the practical implementation of NbS in urban design practices in Bangladesh.

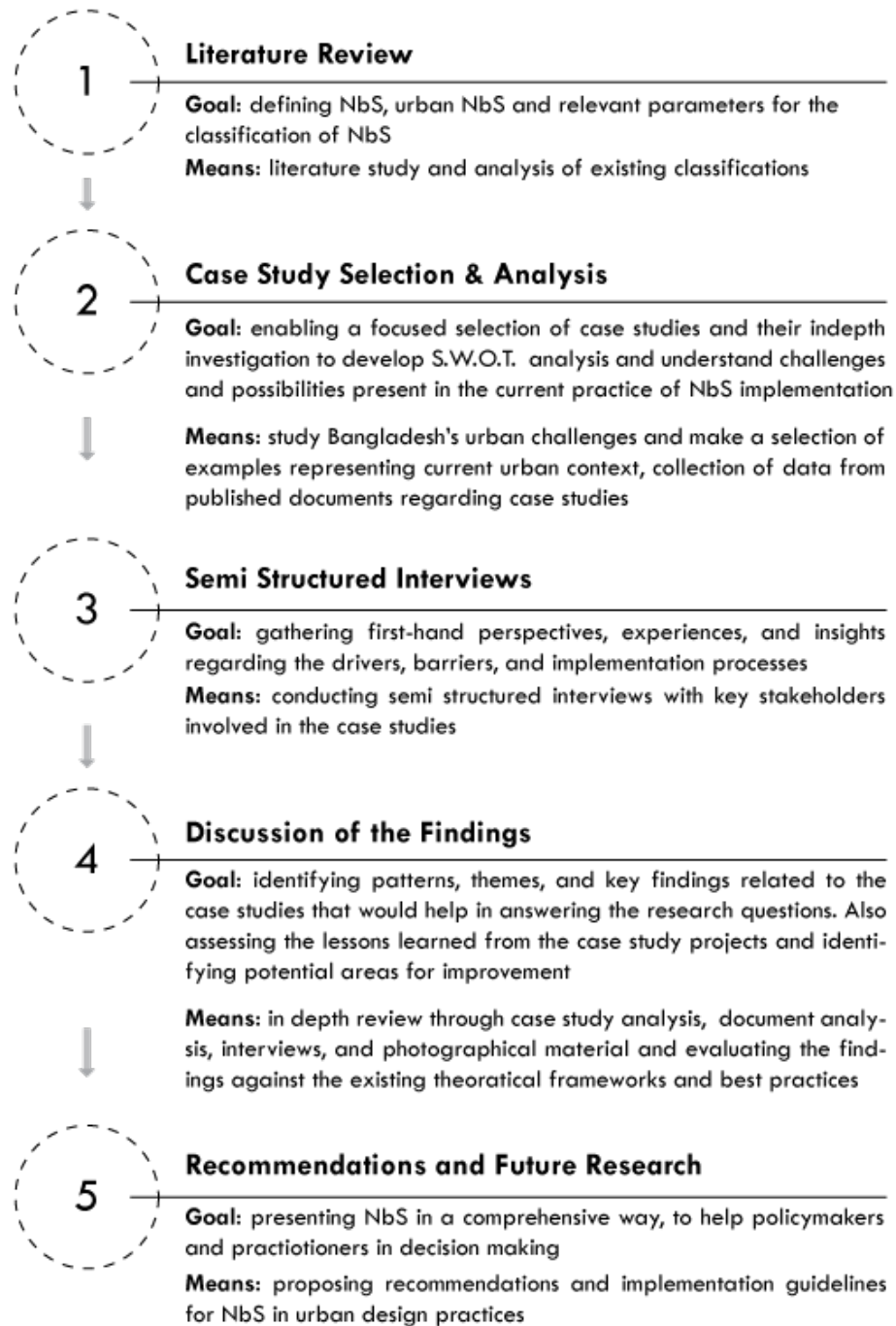


Figure 9 Visual representation of the research methodology

3.2 DOCUMENT ANALYSIS

A theoretical literature review was conducted to establish the understanding of NbS and the issues regarding Urban NbS based on the available knowledge. Peer-reviewed publications were identified through Scopus, Google Scholar and Web of Science Core Collection. The papers were retrieved from the Web of Science using the following search strings: "Nature-based Solutions", "Urban NbS", "Uptake", "Resilience", "Sustainability", "Urban Planning", and "Green Cities".

To gather comprehensive information pertinent to the research questions, approximately 23 written sources, both printed and online, were reviewed. These sources included reports from planning practices, private and public records, websites, and governmental reports. The documents were sourced using the search engine Google and were also requested from relevant stakeholders. Each document was meticulously analyzed to ensure its validity, appropriateness, timeliness, and accuracy. Furthermore, documents concerning the country's policies and institutions were examined to gain essential background information and to enhance the understanding of the national context in which the case studies were situated. Fig. 10 summarises the method based on the PRISMA systematic review approach (Liberati et al., 2009; Moher et al., 2009).

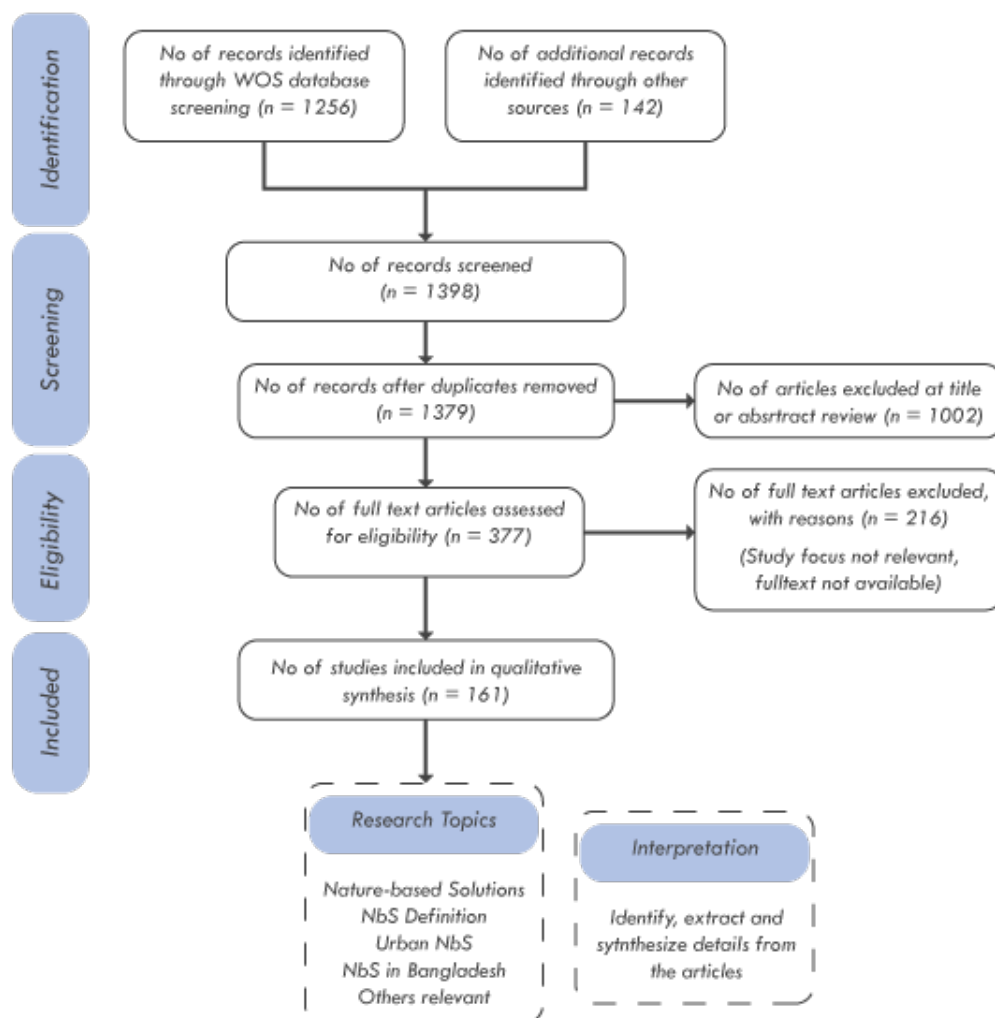


Figure 10 Flow of information through the different phases of the systematic review.

3.2 CASE STUDY SELECTION

In Bangladesh, while specific frameworks for the implementation of Nature-based Solutions (NbS) are currently absent, there exists a comprehensive collection of national policies, guidelines, and laws that could potentially facilitate NbS integration into mainstream practices. Bangladesh possesses a range of medium-term and short-term plans, in addition to long-term visions, for development planning that address climate change, environmental protection, and biodiversity conservation. These policies collectively provide a framework for the implementation of NbS. A comprehensive overview of how NbS are addressed within various relevant policies and planning instruments can be found in Annex I.

Bangladesh has made significant strides in implementing Nature-based Solutions (NbS) across various sectors, including forestry, agriculture, and coastal management, successfully implementing NbS such as the protection and restoration of forests, mangroves, and wetlands, conservation agriculture, agroforestry, and participatory management of natural resources (see Table 2). However, the experience of urban NbS in the country remains relatively limited, despite the potential benefits these solutions can offer in addressing urban challenges exacerbated by rapid urbanization. This represents a missed opportunity, as urban NbS can play a crucial role in enhancing the resilience and sustainability of the cities in Bangladesh.

Table 2: A List of current NbS practices in Bangladesh; Source: (Tasnim & Anzum, 2019)

Institute/ Organization	Sector	The Practice of NbS in Different Projects
Centre For Natural Resource Studies (CNRS)	Wetlands management	Haor Flood Management & Livelihood Improvement Project by BWDB.
	Forest Management	Forest Co-management Project, DoF
	Mangrove forest	Mangroves for the Future (MFF), IUCN
Caritas Bangladesh	Food Security and Climate Change	Strengthening adaptive farming in Bangladesh, India, and Nepal (SAF-BIN), BRRI, University of Vienna, and Caritas
Local Government Engineering Department (LGED)	Waste Separation and Organic Waste Management	Programmatic CDM Project Using Municipal Organic Waste of Towns in Bangladesh, Waste Concern
	Waste Management and Biogas Plant	Waste Management Programme by Jahangirnagar University
	Produce Organic Compost and Biogas	Poultry Waste Management Projects
Department of Agricultural Extension (DoAE)	Pest Management	Integrated Pest Management (IPM), UNEF, FAO and DoAE
	Less Water Consumptive Irrigation	Alternate Wetting and Drying (AWD), DoAE
	Energy Efficient Irrigation	Solar Powered Irrigation Project
	Resilient Island Development	Char Development and Settlement Project (CDSP)
	Organic Composting	Veri-compost project

Institute/ Organization	Sector	The Practice of NbS in Different Projects
University of Dhaka	Protecting communities from flood and storm surges	Coastal resilience project in Bangladesh, World Bank
University of Dhaka	Biodiversity, climate change and ecosystem	University projects on Biodiversity and Ecosystem
	Hill Tracts Biodiversity Management	Restoration of hilly biodiversity through community-based bio-resource management, Arannayak Foundation
	Livelihood opportunities for forest-dependent people	Livelihood development of forest-dependent communities in and around Chunati Wildlife Sanctuary, Arannayak Foundation
	Forest wildlife and biodiversity	Books on wildlife, biodiversity, and forest management by Arannayak Foundation
Bangladesh Forest Department	Biodiversity of Mangrove	Inventory report on Sundarban reserve forest
	Forest biomass status	Carbon inventory reports
	Forest biodiversity	Bangladesh tropical forests and biodiversity assessment
	Livelihood improvement activities	Sustainable Forests and Livelihoods (SUFAL) project
	Portal for forest information	Bangladesh Forest Information System
	Forestry community management, forest resources, and livelihood opportunities	Reports on Social forestry, Community management, Women empowerment, Alternative livelihood opportunities, Wild plant genetic resources, Wild edible fruits and vegetables

The aforementioned table does not explicitly mention any specific urban projects where NbS are implemented. To address this knowledge gap, several potential urban projects were considered around the country that have been completed in recent years or are still ongoing.

The selection of these projects followed a purposive sampling strategy, aiming to capture a diverse range of urban NbS implementations across Bangladesh. This strategy was crucial to the research process, allowing for an in-depth examination of the drivers, enablers, barriers, and impacts of NbS implementation in various urban contexts. The selection criteria for these case studies were comprehensive and included the following factors:

- **Project Type:** The case studies encompassed a variety of NbS types, such as issue-specific infrastructure projects (e.g., urban forests, green roofs), water management projects (e.g.,

retention basin, rain gardens, sustainable urban drainage systems (SUDS)), ecosystem restoration (e.g., urban parks, playgrounds) and integrated projects that combine multiple NbS approaches. This diversity ensured a comprehensive understanding of the potential applications of NbS in urban settings.

- **Scale:** The selected case studies represented a range of scales from small-scale community-led initiatives to larger-scale projects implemented by government agencies or non-governmental organizations (NGOs). This diversity in scale enabled the assessment of the effectiveness and challenges associated with NbS implementation at different levels, providing insights into how scale influences outcomes and sustainability.
- **Location:** The case studies were geographically dispersed across Bangladesh, representing different urban contexts, including major cities, secondary towns, and peri-urban areas. This geographic diversity facilitated the identification of location-specific factors that influence the implementation and outcomes of NbS projects. It also ensured that the findings are relevant to a broad spectrum of urban environments within the country.
- **Implementation Stage:** The selected projects were at different stages of implementation, including recently completed and ongoing. This allowed for a comparative analysis of the barriers and enablers of NbS implementation throughout various stages of the project lifecycle.
- **Data Availability:** The selection process prioritized projects with readily available data on their design, implementation, outcomes, and impacts. Access to such data is critical for conducting in-depth case study analyses. It ensures that the research is grounded in empirical evidence, allowing for robust conclusions and recommendations.

This initial selection of potential case studies presented 14 unique projects around the country (See Annex II). From this initial pool, six urban projects were chosen as case studies based on five key criteria. These projects were selected to provide a representative sample of NbS implementations, ensuring that the research captures a wide array of experiences and insights. The locations of these selected case studies are illustrated in Figure 10, and their selection criteria are detailed in Table 3.

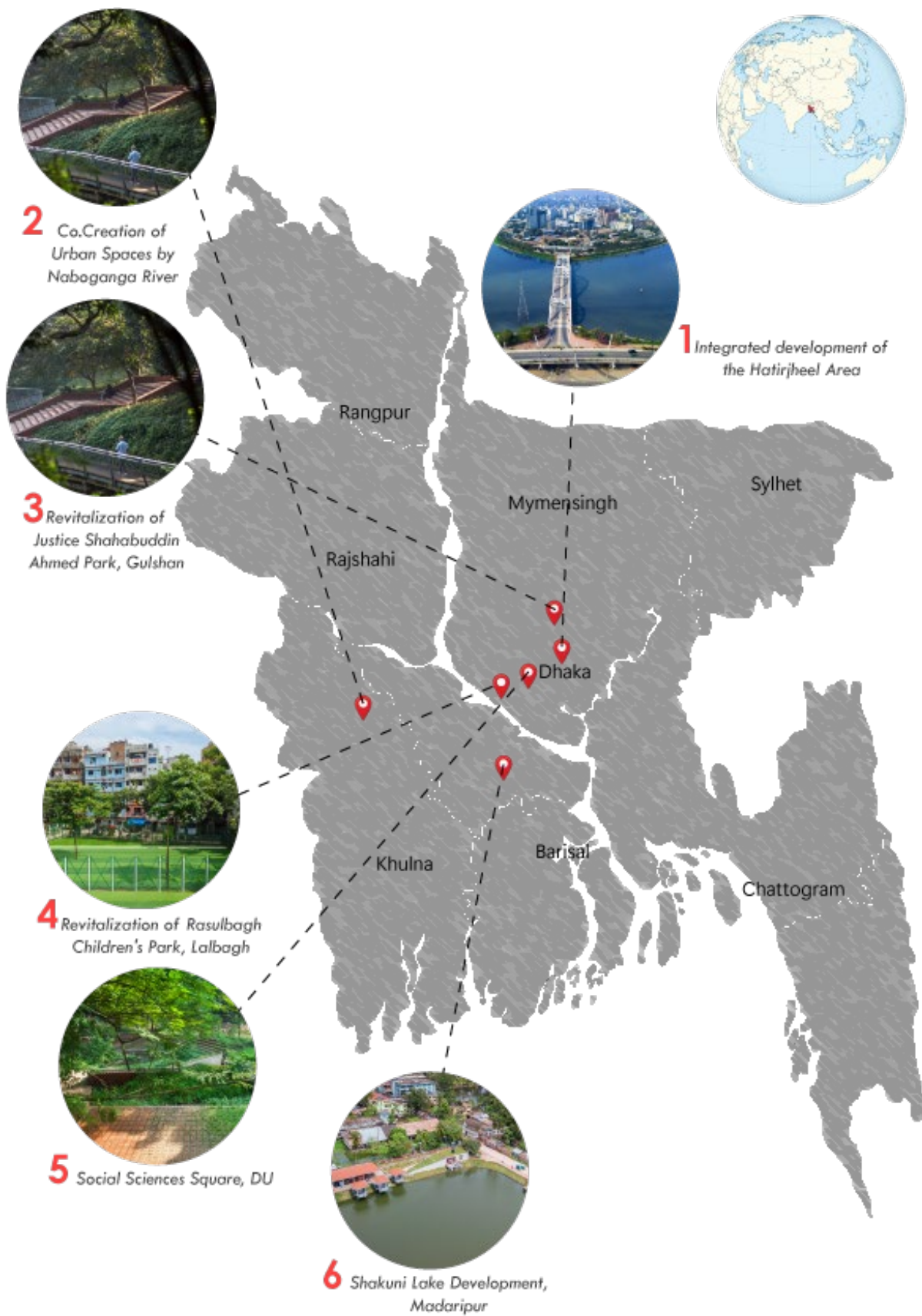


Figure 11 Locations of the Selected Six Case Studies

Table 3: Selected case studies and their selection criteria

Case Study	Case Study 1	Case Study 2	Case Study 3	Case Study 4	Case Study 5	Case Study 6
Selection Criteria	<i>Integrated Development of the Hatirjheel Area</i>	<i>Co.Creation of Urban Spaces by Naboganga River</i>	<i>Revitalization of Justice Shahabuddin Ahmed Park, Gulshan</i>	<i>Revitalization of Rasulbagh Children's Park</i>	<i>Social Sciences Square, DU</i>	<i>Shakuni Lake Development, Madaripur</i>
Addressing Climate Change Effects <i>tackles specific climate challenges in the urban environment</i>	X	X	X	X	-	X
Inclusion of NbS Solutions <i>Implements Nature-based Solutions into the project</i>	X	X	X	X	X	X
Impact on Urban Landscape <i>integrates with and influences the existing urban landscape such as land use, functionality, and aesthetics</i>	X	X	X	X	X	X
Involvement of Different Stakeholders <i>incorporates participation from various stakeholders in the city such as professionals, local authorities, and community</i>	X	X	X	X	-	-
Available Resources <i>Adequate information and data to complete a thorough case study</i>	X	X	X	X	X	-

The inclusion of these case studies aims to gather empirical evidence, derive valuable lessons from the practical experiences and provide a comprehensive understanding of the real-world scenarios and challenges associated with the implementation of NbS in urban settings.

3.3 ANALYSIS AND EVALUATION OF COLLECTED DATA

3.3.1. Analysis of the Case Studies

Each of the selected case studies underwent a structured analysis, organized into three subchapters:

Overview: Initially, a comprehensive overview of each case study was presented, outlining the project's location, primary objectives, features, and the issues it aimed to address.

Overall Impacts: Subsequently, an assessment of the overall impacts of each project was conducted. This involved an analysis of the environmental, economic, and social effects resulting from the project's implementation.

S.W.O.T. Analysis: Finally, a S.W.O.T. (Strengths, Weaknesses, Opportunities, Threats) analysis was performed for each case study to identify its internal strengths and weaknesses, as well as external opportunities and threats. This analysis provided a holistic evaluation of the factors influencing the project's success or failure.

This approach facilitated the extraction of valuable insights concerning the challenges, opportunities, and consequences associated with incorporating nature-based solutions (NbS) within urban contexts. Through a comparative examination of the case studies, this analysis aimed to identify commonalities, variations, and anomalies that could illuminate the complex dynamics of NbS implementation.

3.3.2. Selection of Study Participants

To conduct the study interviewees were purposefully selected who met certain conditions to gain comprehensive insights into the Urban Nature-based Solutions (NbS) projects in Bangladesh. The selection criteria and rationale for including different stakeholder groups were as follows:

- a) Researchers, architects, and planners were selected based on their profiles and involvement with the selected urban NbS case studies in Bangladesh. Their expertise and direct experience with these projects make them valuable sources of information regarding the planning, design, and implementation processes of NbS initiatives.
- b) Stakeholders were also purposefully selected for interviews based on their involvement or connection with the chosen urban NbS projects. This group likely includes representatives from local authorities, community organizations, environmental groups, or other entities that have a stake in the development and outcomes of these NbS projects.

The inclusion of researchers, architects, planners, and stakeholders serves several purposes:

- a) Researchers and Practitioners can provide technical insights into the conceptualization, design, and planning aspects of the NbS projects, including the rationale behind the chosen solutions, the challenges faced, and the strategies employed.
- b) Architects and Planners can offer perspectives on the practical implementation and construction phases of the NbS projects, as well as the integration of these solutions into the urban fabric.

- c) Stakeholders, such as local authorities, community groups, and environmental organizations, can provide valuable information on the societal, cultural, and environmental contexts in which these NbS projects are situated. They can shed light on the community engagement processes, public perceptions, and the potential impacts (both positive and negative) of these initiatives on local communities and the environment.

By including a diverse range of stakeholders, the intention was to capture a comprehensive understanding of the urban NbS projects from multiple angles, including technical, practical, and socio-environmental perspectives. This approach allows for a more holistic analysis of the drivers, barriers, enablers, and outcomes (Young et al., 2018) associated with the implementation of NbS in urban settings.

A total of 32 potential participants were identified based on their expertise and involvement in urban NbS projects in Bangladesh and were initially approached and invited to participate in the study. However, due to scheduling conflicts and other commitments, only 14 individuals ultimately agreed to participate and were interviewed for this research (Annex III). Most respondents were architects related to the design of the projects (43%), followed by local government employees (21,5%) and researchers (14,5%). The final sample of 14 participants, while smaller than initially anticipated, still represents a valuable cross-section of perspectives and experiences related to urban NbS implementation in Bangladesh.

3.3.3. Interview Design

The interviews were semi-structured and thematic, employing open-ended questions to gather narrative data that explores the intricate and intangible aspects of stakeholder relationships within the selected projects (Kvale & Brinkmann, 2009). While most interviews followed a core set of questions outlined in a 4 block interview protocol, additional questions were introduced based on the interviewee's role and emerging themes during the discussion. The first block establishes the definition and value of NbS and explores the interviewee's perspective, the second delves into the interviewee's personal experiences with NbS projects, the third examines the roles of various stakeholders and the dynamics of their participation, and the fourth investigates the factors influencing NbS integration in urban planning.

These interviews were conducted over videoconference, and detailed notes were taken during each session. Typical interviews lasted between 45 to 90 minutes, although durations varied depending on the time availability of the interviewee, the length of their answers to the open-ended questions, and their overall enthusiasm to contribute to the research. All interviews were recorded with the consent of the participants, and significant passages were transcribed, and edited for clarity, and to eliminate redundancy (Hay, 2005; Walter, 2006).

The key objectives of the interviews were:

- **Data collection:** Gathering primary information directly from stakeholders.
- **Data verification:** Ensuring the accuracy and reliability of the collected information.
- **Assessment contribution:** Providing valuable insights and perspectives to inform the evaluation of NbS projects.
- **Addressing data gaps:** Utilizing expert opinions and experiences to supplement missing data and propose design solutions for improved NbS implementation.

Interview Protocol

The characterization of the interviewees is as follows:

Experts	Other Stakeholders
Related to any of the case studies	Related to any of the case studies
Not related to any of the case studies	Not related to any of the case studies

Starting Question:

Could you please introduce yourself and briefly describe your role in your organization?

Block 1. NbS definition and value	1. How would you define NbS? 2. What are the possible benefits/negative effects of NbS? 3. Do you think the NbS brings anything new to sustainability discourse?
Block 2. Experiences	1. How many projects do you know about NbS in your city? 2. Are you involved in any of them? If yes, select one. 3. What is the best and the worst of the selected project?
Block 3. Participation	1. Could you tell me more about the people's involvement in the projects you know? 2. Which stakeholders should be involved in NbS? 3. What is or should be the weight of the different stakeholders?
Block 4. Triggers and barriers	1. Who or what do you see driving the integration of nature-based solutions into sustainable urban planning? 2. What barriers, if any, do you see to incorporating nature-based solutions into urban planning in your city? 3. What are the potential solutions?

Final question:

Do you know of other experts working in this area, or planners, green business representatives, etc. whom I might contact?

Thanks.

By combining theoretical frameworks, stakeholder perspectives, and empirical evidence from case studies, this research endeavours to bridge the gap between conceptual understanding and practical application of NbS, ultimately fostering more widespread adoption of these innovative solutions for enhancing urban sustainability and resilience.

3.4 LIMITATIONS

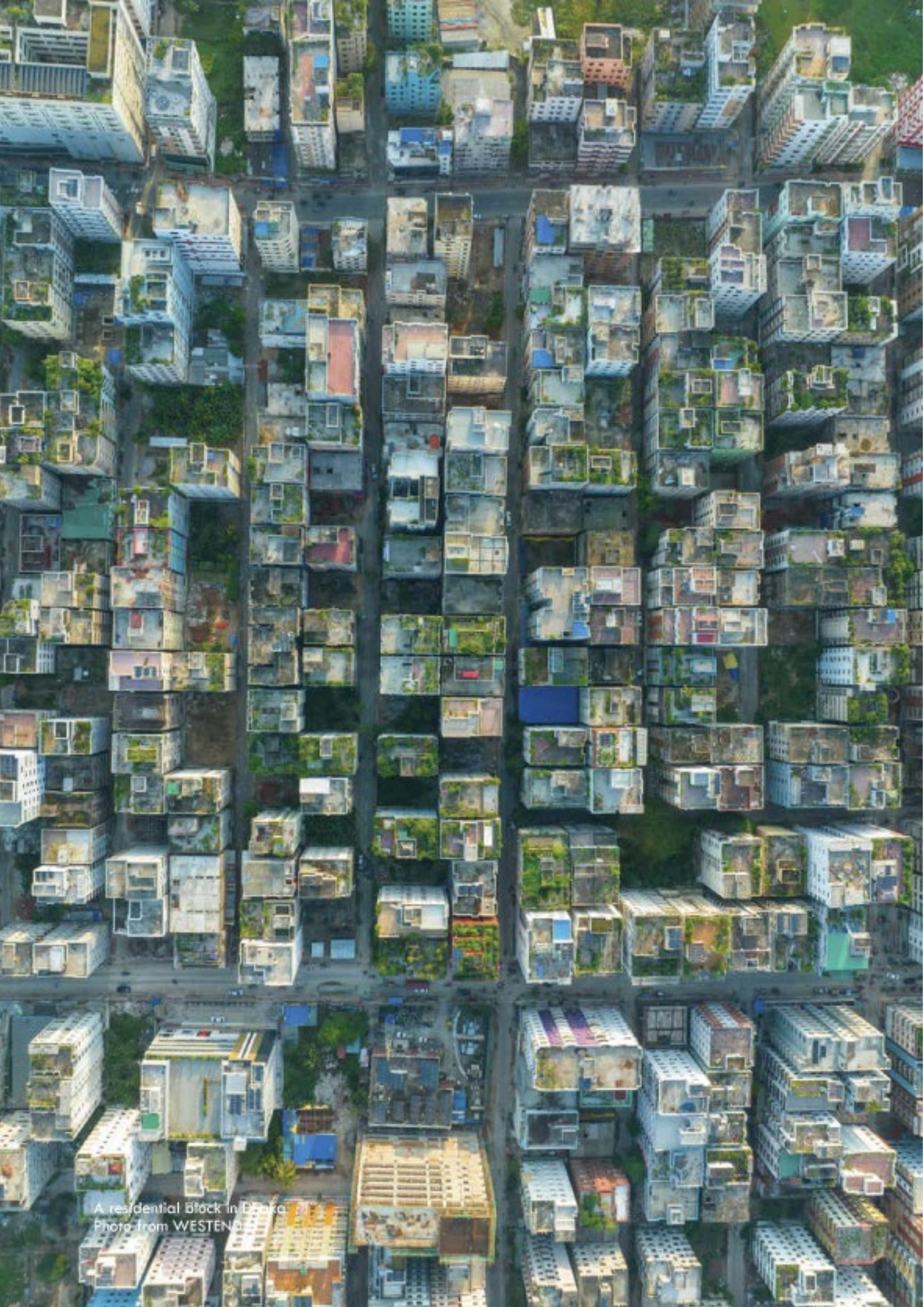
The qualitative, exploratory case study approach employed in this research offers valuable insights into the practical implementation of NbS in urban design practices within the context of Bangladesh. However, it is important to acknowledge the limitations of this methodology to maintain transparency and objectivity in the interpretation of the findings.

One primary limitation is the lack of quantitative data, which could have been obtained through surveys or empirical studies. While the qualitative data gathered through interviews and document analysis provides rich, contextual information, it does not offer the statistical representativeness and generalizability that quantitative methods can offer.

Additionally, the individuals interviewed in this study are knowledgeable and influential stakeholders involved in various aspects of planning or national regulation, although they do not represent a statistically representative sample of larger groups. Their perspectives were valuable regarding the study, but they may not fully capture the diverse range of opinions and priorities held by different stakeholder groups or the general public.

It is also important to note that some of the interview information may be subjective or based on personal opinions, and corroborating documents were not always available to verify certain claims or statements. This limitation is inherent in qualitative research, where the data is often based on individual experiences, perceptions, and interpretations.

Despite these limitations, the qualitative, exploratory case study approach remains a valuable method for gaining an in-depth understanding of complex phenomena, such as the integration of NbS into urban design practices. The insights derived from this research, based on the expertise of key stakeholders, can inform future studies, policymaking, and practical implementation strategies. However, it is crucial to acknowledge the need for complementary quantitative data and broader stakeholder engagement to achieve a more comprehensive understanding of the subject matter.



A residential block in Osaka, Japan
Photo from WESTERN

4

CASE STUDIES

This chapter delves into a detailed exploration of six distinct urban design projects in Bangladesh, each showcasing their innovative and contextually relevant application of nature-based solutions (NbS). These case studies offer valuable insights into the challenges, opportunities, and impacts associated with integrating nature-based approaches into urban environments, particularly in a developing country context. These projects, ranging from large-scale infrastructure developments to community-led greening initiatives, showcase the potential of NbS to address a wide range of urban challenges.

4.1 CASE STUDY 1: Integrated Development of the Hatirjheel Area

4.1.1 Overview

NbS approach: Issue-specific ecosystem management

- Blue Infrastructure
 - Lakes/ponds
 - Wetlands/peatlands/marshes

Dhaka, the capital city of *Bangladesh*, is a rapidly growing megacity and one of the most densely populated cities globally. Located in the heart of *Bangladesh*, *Dhaka* serves as the country's economic, financial, cultural, and educational hub, accommodating 44.5% of its urban population. Water plays a defining role in *Dhaka*'s environment, as it is located within the largest delta system globally, where the *Buriganga*, *Turag*, *Balu*, and *Tongi* rivers converge. These rivers encircle the city, flowing along its southern, northern, eastern, and western borders respectively.

Over 50% of *Dhaka*'s landscape is now composed of built-up areas, a consequence of the rapid expansion that has encroached upon lowlands and natural areas. Unplanned urbanization, disregard for zoning regulations, and encroachment on water bodies have resulted in the disappearance of canals, ponds, and low-lying areas within the city. Research indicates a drastic decline in the city's wetlands over the past 50 years. This loss of natural water retention areas has led to significant drainage issues and rainwater stagnation, exacerbating flooding during the monsoon season. *Dhaka* has experienced devastating floods in recent decades (1987, 1988, 1998, 2004, 2020, and 2021), primarily due to heavy

rainfall and inadequate drainage infrastructure. Given predictions of more frequent and severe floods and storms due to climate change, Dhaka needed to prioritize and enact strategies that bolster its resilience to climate-related disasters.



Figure 12 Integrated Development of Hatirjheel Area, Project Location;
Source: Vitti Sthapati Brindo Ltd.



Figure 13 Before and After Scenario of the Project Location; Source: Vitti Sthapati Brindo Ltd.

Hatirjheel, a strategically positioned water retention basin in the heart of Dhaka, connects several key areas, extending from *Tongi Diversion Road* to *Rampura Bridge* on *Pragati Sarani*. This basin is now the largest of its kind in the city, responsible for draining a significant portion of Dhaka's catchment area. Due to its crucial role in flood mitigation, the Bangladesh government initiated a comprehensive project encompassing road infrastructure development and the restoration of *Hatirjheel's* waterfront. The project's primary focus was to safeguard the low-lying floodplain, improve urban connectivity, reestablish water-based transport, connect the northern and southern areas, and revitalize the urban landscape.

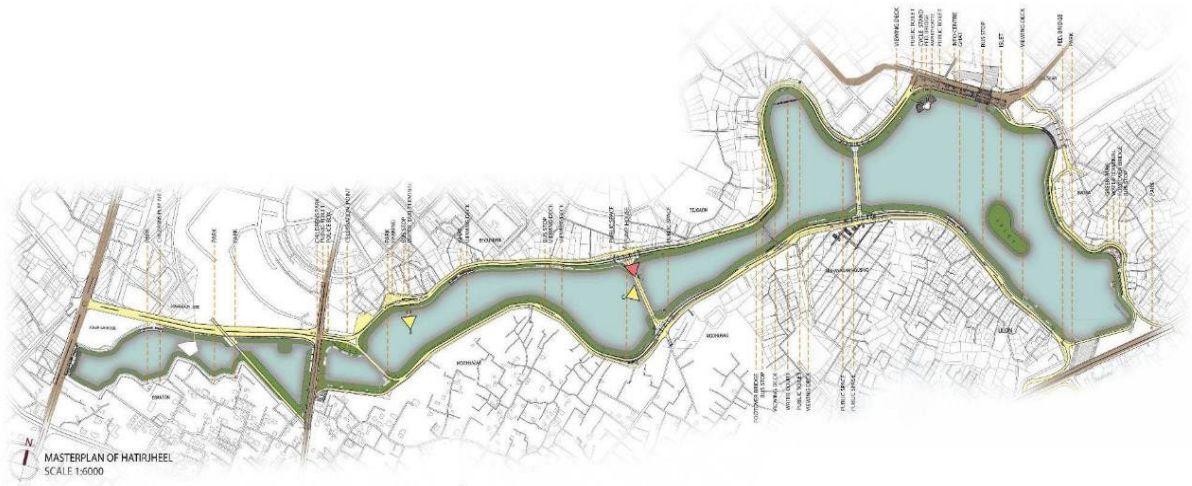


Figure 14 Masterplan of Hatirjheel Project Area; Source: Vitti Sthapati Brindo Ltd.

The project's primary objectives were threefold:

1. **Flood Mitigation:** Ensuring adequate stormwater retention capacity to minimize the risk of flooding in adjacent areas and reduce associated environmental hazards.
2. **Environmental Restoration:** Transforming the degraded *Begunbari Canal* into a freshwater lake, improving water quality, and restoring the ecological balance of the area.
3. **Transportation Improvement:** Constructing a peripheral road system to connect two major arterial roads, the *Tongi Diversion Road* and *Pragati Sarani*, alleviating traffic congestion and improving transportation efficiency in the eastern and western parts of the city.

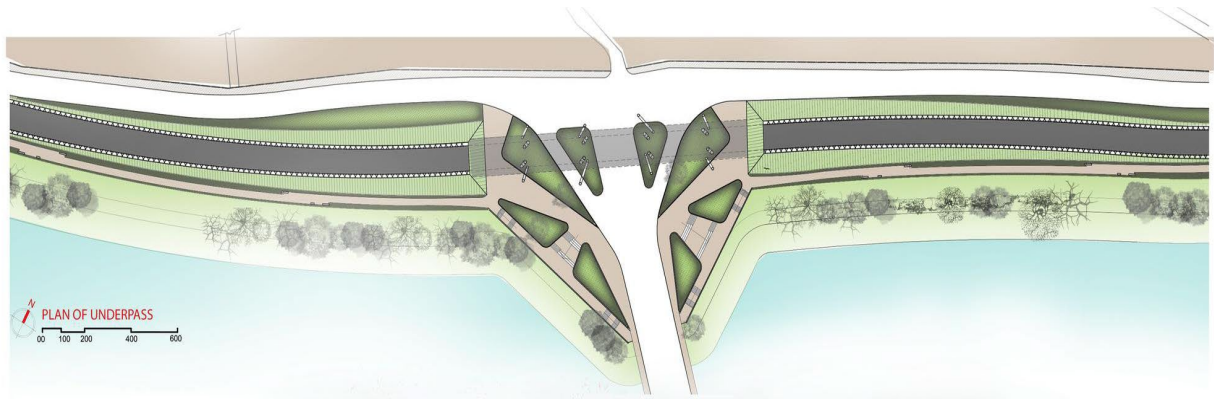


Figure 15 Plan of Underpass in Hatirjheel Project; Source: Vitti Sthapati Brindo Ltd.

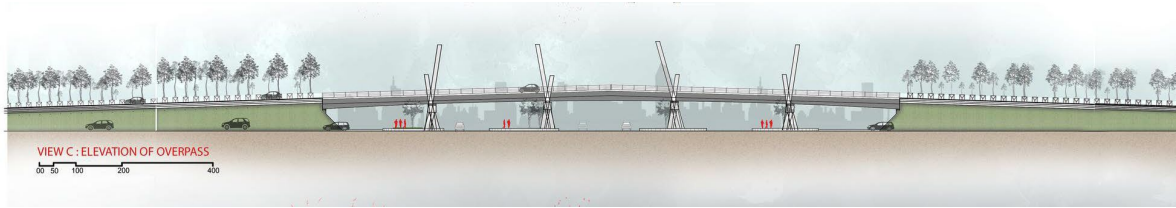


Figure 16 Elevation of Overpass in Hatirjheel Project; Source: Vitti Sthapati Brindo Ltd.

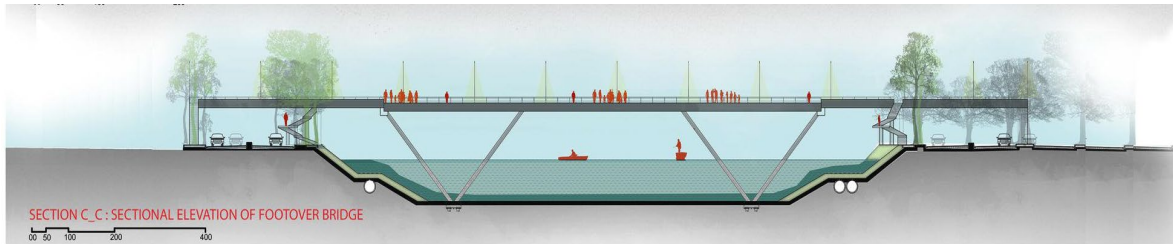


Figure 17 Sectional Elevation of Foot over Bridge in Hatirjheel Project;
Source: Vitti Sthapati Brindo Ltd.

The *Hatirjheel-Begunbari Integrated Development Project* has achieved notable success in mitigating disaster risks by transforming the *Hatirjheel* area into a crucial stormwater retention basin. In addition to the main interventions, the project included the re-excavation of the entire *Hatirjheel* area and sections of the *Begunbari Canal*. This measure aimed to increase the stormwater retention capacity of the lowlands and ultimately enhance its capacity to protect surrounding areas from flash floods, a recurring problem in Dhaka, while also enhancing the aesthetic appeal and ecological value of the *Hatirjheel* area.

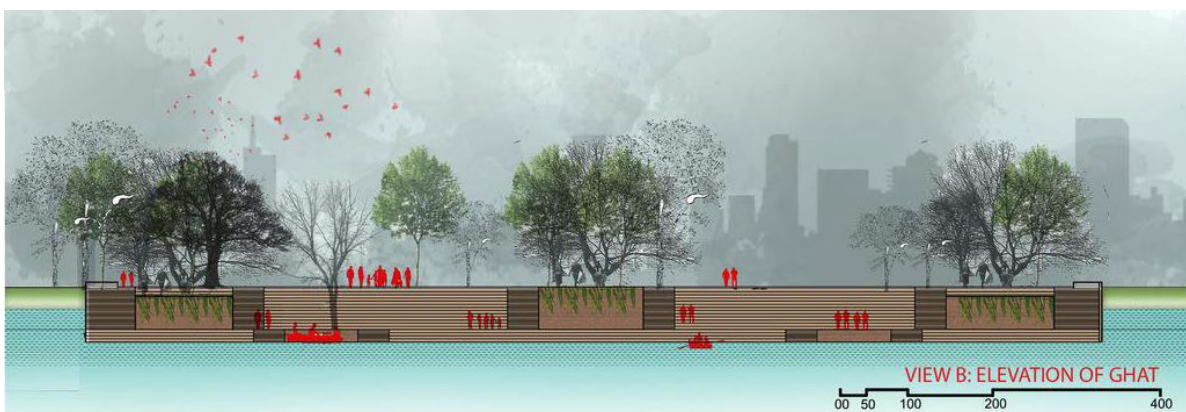


Figure 18 Elevation of Ghat in Hatirjheel Project; Source: Vitti Sthapati Brindo Ltd.

Furthermore, the project revitalized the urban landscape by introducing a variety of recreational amenities, including a children's play area, viewing decks, floating gardens, and walkways, creating a vibrant communal leisure space. The development of peripheral roads, expressways, local roads, and

pedestrian walkways, coupled with the construction of bridges and viaducts, has improved city-wide accessibility and connectivity, notably reducing travel time between *Rampura* and other parts of Dhaka. This improved connectivity has fostered both economic and social integration within the city. Finally, the project's reintroduction of water-based transportation has revived *Hatirjheel*'s historical connection to the Mughal-era canal system, adding another layer of cultural and historical significance to the area.



Figure 19 (a) Bird's eye view of the Hatirjheel project; (b) People's activity in the project;
Source: Vitti Sthapati Brindo Ltd.

4.1.2 Overall Impacts

Environmental impacts

- Climate, energy and emissions
 - Strengthened capacity to address climate hazards/natural disasters
- Water management and blue areas
 - Improved water quality
 - Increased protection against flooding
 - Improved stormwater management
 - Enhanced protection and restoration of freshwater ecosystems
- Green space and habitat
 - Increased conservation or restoration of ecosystems
 - Reduced biodiversity loss

Economic impacts

- Reduce financial cost for urban management
- Attraction of business and investment

Socio-cultural impacts

- Social justice and cohesion
 - Improved access to urban green space
- Health and wellbeing
 - Gain in activities for recreation and exercise

4.1.3 S.W.O.T. Analysis

Strengths

- **Enhanced Flood Resilience:** Transformed *Hatirjheel* into a significant stormwater retention body, increasing its capacity to absorb excess water, thereby safeguarding adjacent areas from flash floods.
- **Revitalized Urban Space:** The creation of diverse recreational facilities, including a children's play area, viewing decks, an amphitheatre, floating gardens, walkways, and more, has transformed the area into a vibrant public space.
- **Improved Accessibility and Connectivity:** The construction of a comprehensive transportation network, including peripheral roads, expressways, local roads, bridges, and viaducts, has significantly improved connectivity throughout the city. This has led to reduced travel times between Rampura and other areas, facilitating economic activity and social interactions.
- **Historical and Cultural Preservation:** The project reinstated water-based transportation in *Hatirjheel*, reconnecting it to its historical role as part of a canal system.

Weaknesses

- **Unplanned Urbanization:** *Dhaka's* rapid and unplanned urbanization, coupled with the disregard for zoning regulations and environmental considerations, has resulted in the loss of valuable natural infrastructure such as canals, ponds, and low-lying areas.
- **Vulnerability to Flooding:** The loss of natural water bodies and the inadequate drainage infrastructure have made *Dhaka* highly vulnerable to flooding during the monsoon season. The city has experienced numerous destructive flooding events in recent years.

Opportunities

- **Enhanced Climate Resilience:** The *Hatirjheel* project serves as a model for exploring and implementing innovative mechanisms and strategies to strengthen *Dhaka's* overall climate resilience and disaster risk reduction capabilities.
- **Flood Mitigation and Protection:** By restoring the waterfront legacy and increasing the water retention capacity, the project has significantly enhanced the city's ability to safeguard a large part of *Dhaka* from flash floods, protecting lives, property, and infrastructure.
- **Sustainable Transportation:** The reintroduction of water-based transportation options presents an opportunity to promote a more sustainable and environmentally friendly mode of travel within the city, reducing traffic congestion and air pollution.
- **Environmental Restoration and Conservation:** The restoration and conservation of the urban environment through the creation of green spaces, the improvement of water quality, and the introduction of native plant species have significantly enhanced the ecological health and biodiversity of the *Hatirjheel* area.

Threats

- **Climate Change-Induced Risks:** The increasing frequency and intensity of floods and storms due to climate change pose a significant threat to the long-term sustainability and effectiveness of the *Hatirjheel* project.
- **Continued Urbanization Pressures:** Unplanned urbanization and encroachment on natural areas remain a constant challenge in *Dhaka*. The continued loss of wetlands and other natural water bodies could further exacerbate flooding risks and undermine the project's overall objectives.

4.2 CASE STUDY 2: CoCreation of Urban Spaces by Naboganga River

4.2.1 Overview

NbS approach: Ecosystem protection and Infrastructure management

- Blue Infrastructure
 - Rivers/streams/canals/estuaries
 - Lakes/ponds
- Grey infrastructure featuring greens
 - Alley and street greens
 - Lakeside greens/Riverbank
- Parks and urban forests
 - Pocket parks/neighbourhood green space

Jhenaidah, a city in southwest *Bangladesh* situated along the *Naboganga River*, experienced a deterioration of its vital water resource due to neglect, pollution, and safety concerns. A grassroots local organization, in collaboration with *Co.Creation Architects* and the local municipality, spearheaded an initiative to revitalize the riverfront. Through extensive community engagement, the project implemented a series of small-scale interventions, transforming the neglected areas into an accessible, open, and vibrant public space. The overarching goal was to re-establish a positive connection between the city and the river, revitalizing the *Naboganga river* as a valuable asset for the community.



Figure 20 Top View of the Public Ghat; Source: Co.Creation Architects



Figure 21 Masterplan showing the existing challenges of the Project; Source: Co.Creation Architects

The initial phase of the project encompasses the incremental construction of a *Public Ghat* (a set of steps leading down to the river) at the river's confluence, an accompanying walkway, a smaller community Ghat (*Shatbaria Community Ghat*), and the establishment of improved connectivity with the river by removing various barriers and obstructions. The linear-wide platform of the *Public Ghat* serves both as a path and space. It is used primarily for walking, relaxing, and small cultural and political events. Sometimes, it serves as a stage for viewers on the river's opposite side. Within the proposed second phase of the project, there are numerous water gardens, small-scale community ghats, pond-side development as public spaces, reuse of old prison and old guesthouses, cultural performance spaces, nature priority spaces, public toilets, 4-kilometre walkways along the river, etc.

With the riverside development, especially after building the *Public Ghat*, the city has a new image of a river-centric city. Environmental groups have regained momentum to clean up the river and restore biodiversity. Through this process, it has been realized that architects' presence, care, and co-creation with people and nature can change a city.

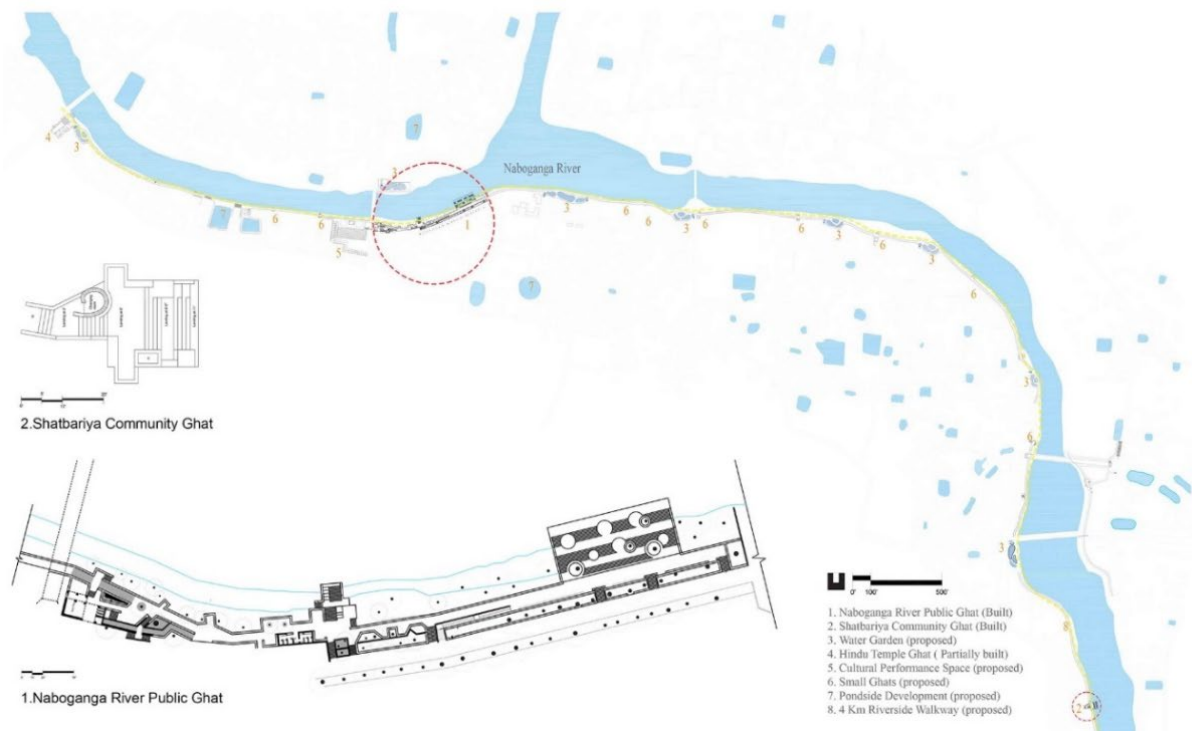


Figure 22 Masterplan showing the Location of the Public and Community Ghats; Source: Co.Creation Architects

A crucial factor in the project's success was the collaborative design process. The architects engaged closely with residents, particularly vulnerable groups such as women, children, the elderly, and individuals with disabilities. By incorporating their feedback—for instance, by including changing cabins and slip-resistant paving—the architects ensured that the design addressed the specific needs of the community. Furthermore, the architects emphasized the concept of co-creation not only with humans but also with the surrounding natural environment. They recognized that communities naturally adapt to their surroundings, and the architect's role is to facilitate communication and bridge the gap between local communities and relevant authorities and professionals. This inclusive approach ensured that the project was both responsive to human needs and harmonious with the natural context.



Figure 23 Mapping of urban spaces during the PRA sessions; Source: Co.Creation Architects

The project's success can be attributed to the collaborative efforts of diverse stakeholders, including:

- **Community Groups:** The project involved a diverse range of community groups, including children, teenagers, women, men, elderly, differently abled individuals, environmental activists, low-income communities, cultural groups, sports groups, street vendors, business groups, teachers, municipality officials, architects, engineers, and shop owners. This inclusive approach ensured that the project addressed the needs and aspirations of various segments of the local population.
- **Jhenaidah Municipality:** The Jhenaidah Municipality played a crucial role as a local authority, supporting community-led housing, city planning, and health facilities. The municipality acted as a platform where different groups could come together and collaborate on the co-creation of the city. It co-hosted events related to the project, mobilized funds with partner organizations, and implemented structures of varying scales. After the implementation, the municipality took responsibility for managing and maintaining the project.
- **Local Team of Experts:** Co.Creation Architects, a local architectural and landscape design studio, has been working on people-led processes in the city. They mobilized other experts, such as engineers, NGOs, and resources from the municipality, to contribute to the project's design and implementation.
- **National and International Volunteer Teams:** The project benefited from the support and consultation of several organizations, including the Platform of Community Action and Architecture (POCAA), the Community Architects' Network (CAN), and the Asian Coalition for Housing Rights (ACHR). Additionally, national young professionals and university students volunteered in the exciting people-led city design process, gaining valuable experience in working collaboratively with communities.

The diverse range of stakeholders involved in the Urban River Spaces project ensured that the initiative was truly community-driven and inclusive. By leveraging the knowledge, skills, and resources of local communities, authorities, experts, and volunteers, the project successfully revitalized a neglected and informal dump site, transforming it into an aesthetically pleasing, accessible, and versatile public space that is cherished by the diverse communities of Jhenaidah.



Figure 24 PRA sessions with the community people from various levels.
Source: Co.Creation Architects

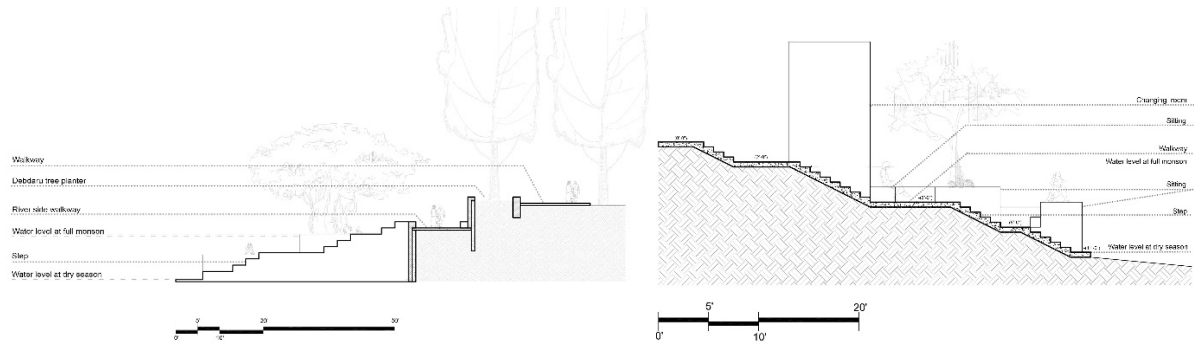


Figure 25 (a) and (b) Sections of the Ghats; Source: Co.Creation Architects

While the project remains ongoing, its positive impact on the quality of urban spaces is already evident and appreciated by both local communities and the city as a whole. By actively participating in the transformation of their environment, residents have gained a deeper understanding of their surroundings and a renewed sense of connection to them. This empowerment has a ripple effect, inspiring other local organizations to initiate similar projects and develop tailored solutions that cater to the specific needs and characteristics of their respective sites. The project serves as a testament to the power of community-driven initiatives in revitalizing urban spaces and fostering a sense of collective ownership and pride. The project has successfully re-established a connection between the river and the people of Jhenaidah, reminiscent of a bygone era. This renewed relationship has fostered a heightened awareness of the importance of protecting the *Naboganga river*. The introduction of greener and more open spaces has also contributed to the restoration of the site's rich biodiversity, signalling a positive ecological shift.



Figure 26 (a) the public ghat is being used by city inhabitants (b) view of the community ghat; Source: Co.Creation Architects

The project's success lies in its ability to foster a sense of ownership and empowerment among the local population, while also addressing environmental, social, and economic concerns through nature-based solutions and participatory urban design practices.

4.2.2 Overall Impacts

Environmental impacts

- Environmental Quality
 - Improved waste management
- Water Management and Blue Areas
 - Increased Protection against flooding
 - Improved Water Quality
- Green space and habitat
 - Increased green space area
 - Reduction of biodiversity loss
 - Increased ecological connectivity across regeneration sites and scales
 - Promotion of naturalistic styles of landscape design for urban development

Economic impacts

- Unknown

Socio-cultural impacts

- Social justice and cohesion
 - Improved liveability
 - Improved access to urban green space
 - Increased opportunities for social interaction
- Health and wellbeing
 - Gain in activities for recreation and exercise
 - Cultural heritage and sense of place
 - Improvement in people's connection to nature

4.2.3 S.W.O.T. Analysis

Strengths

- **Collaborative Partnership:** The project exemplifies a successful collaborative approach, involving architects, the local municipality, and community members in all stages of the revitalization process. This ensures that the project addresses local needs and priorities, fostering a sense of ownership and engagement among residents.
- **Incremental Implementation:** The project's phased approach, focusing on small, accessible interventions along the riverfront, allows for flexibility, adaptability, and a more immediate impact on the community.
- **Inclusive Design:** The inclusive design process prioritizes the needs of vulnerable groups, such as women, children, the elderly, and individuals with disabilities, by incorporating their input into the design of amenities and infrastructure. This ensures that the revitalized spaces are accessible and welcoming to all.
- **Harmony with Nature:** The project embraces the concept of co-creation with the natural environment, adapting to the local context and respecting the ecological balance of the riverfront.

- **Revitalization of Neglected Spaces:** The project successfully transforms underutilized and disconnected spaces along the river into vibrant and accessible public areas, enhancing the overall quality of life for residents.

Weaknesses

- **Ongoing Nature:** The project is ongoing, and some phases are still under development, potentially leaving some areas incomplete and some benefits unrealized.
- **Sustainability of Community Engagement:** While the initial community engagement was strong, maintaining long-term involvement and ownership might be challenging as the project progresses.

Opportunities

- **Ecological Restoration:** The project presents significant opportunities for the continued restoration of biodiversity and environmental quality along the river. This can lead to improved water quality, increased wildlife habitats, and a healthier ecosystem.
- **Raising Awareness:** The success of the project can raise public awareness and generate momentum for further river conservation efforts in the region and beyond.
- **Scalable Solutions:** The project's emphasis on well-adapted, site-specific solutions offers a model that can be replicated and scaled up in other locations facing similar challenges.
- **Inspiration for Further Action:** The positive impact of the project can inspire more community-driven initiatives to address other environmental or social issues within the city.

Threats

- **Environmental Pressures:** Ongoing environmental pressures, such as pollution and climate change, could undermine the project's gains and necessitate continued vigilance and adaptive management strategies.
- **Funding and Resource Constraints:** A significant threat to the project's long-term success is the availability of funding and resources to maintain and expand the revitalization efforts.
- **Changing Political Priorities:** Changes in local government or political priorities could potentially hinder the project's progress or alter its direction.

4.3 CASE STUDY 3: Revitalization of Justice Shahabuddin Ahmed Park

4.3.1 Overview

NbS approach: Ecosystem restoration, Habitat and biodiversity conservation

- Parks and Urban forests
 - Large urban parks or forests
- Blue Infrastructure
 - Lakes/ponds

The accelerated pace of urbanization and population expansion in *Dhaka*, the capital and largest city of *Bangladesh*, has led to a significant reduction in open spaces. To address these challenges, the *Dhaka North City Corporation (DNCC)*, a governmental body responsible for managing and providing essential infrastructure to the city, has launched the *Green Dhaka Campaign*. As part of this initiative, one of the projects involves the *Revitalization of Justice Shahabuddin Ahmed Park*, situated in a densely populated area of *Dhaka*.



Figure 27 Top view of Justice Shahabuddin Ahmed Park; Source: Vitti Sthapati Brindo Ltd.

Initiated in 2017, the intervention involved the refurbishment of the park by enhancing the existing pond, planting new trees, and introducing amenities for the surrounding community. Design choices were made by prioritizing input from various user groups and consulting with naturalists. The aim was to

transform the 9-acre park into a secure, inclusive, and accessible public space free from crime and violence. The renovation efforts focused on preserving the majority of existing trees, which included medicinal, fruit, and floral varieties, to maintain biodiversity and promote a healthy environment. This approach was well-received by visitors, making the park a popular destination among locals. Additionally, three designated lanes were created within the park for jogging, walking, and cycling.



Figure 28 Masterplan of the Justice Shahabuddin Ahmed Park; Source: Vitti Sthapati Brindo Ltd.

The intervention's objectives were specifically tailored to the characteristics of the *Gulshan* neighbourhood where the park is situated. These objectives include:

1. Establishing green spaces for collective activities aimed at fostering the intellectual and physical development of society.
2. Encouraging public engagement by providing opportunities for community members to participate in park consultations and by constructing an amphitheatre.
3. Fostering a healthier lifestyle and increased physical activity through the development of dedicated pedestrian and cycling infrastructure.
4. Conserving and enriching ecosystems by maintaining existing trees and introducing new species with ecological and cultural value, such as medicinal, fruit-bearing, and flowering trees.

5. Promoting a clean and healthy environment through the implementation of waste management systems.
6. Establishing the park as an essential green lung within the *Gulshan* area of the capital city, contributing to improved air quality, climate regulation, and overall environmental health.

The initiative incorporated the planting and preservation of a diverse array of tree species, including medicinal varieties like *Holy basil*, *Justicia Adhatoda*, and *Neem*; flowering plants such as *Garden Croton*, *Gardenia Jasminoides*, and *Singapore Daisy*; and fruit-bearing trees like *Mango*, *Blackberry*, *Jackfruit*, and *Lichi*. This approach capitalized on the area's existing arboreal diversity to create a multi-functional green space with ecological, aesthetic, and health benefits. Additionally, non-environmentally friendly plants were removed and replaced with species better suited to *Dhaka's* climate following extensive consultations with noted naturalists Dwijen Sharma and Mokarram Hossain. The project also involved the establishment of amenities including a library, gym, and women's club, along with the addition of a basketball court and dedicated children's area. Furthermore, an amphitheatre with a seating capacity of 400 people was constructed to facilitate recreational and cultural activities.

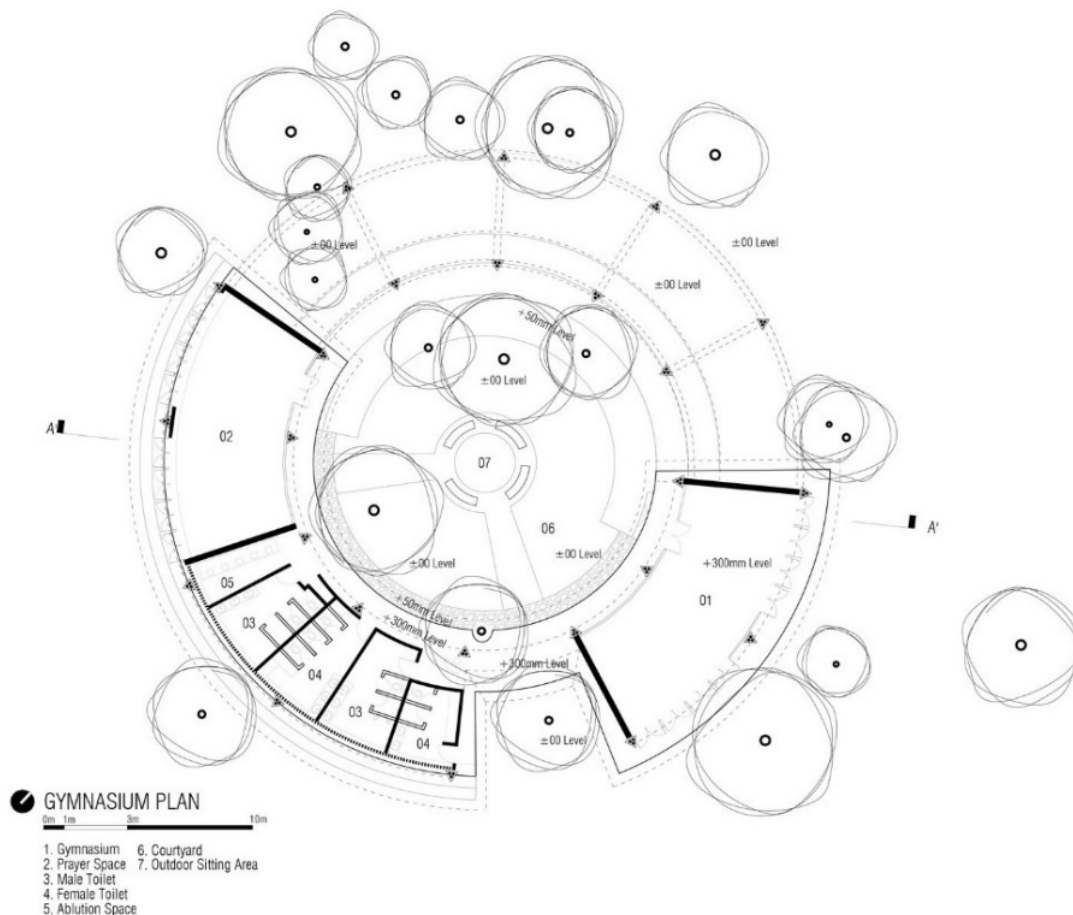


Figure 29 Plan of the Gymnasium of the Justice Shahabuddin Ahmed Park;
Source: Vitti Sthapati Brindo Ltd.

To cater to the diverse needs of users, the park features four different types of paved walkways: brick pavement, concrete block pavements, soft pavements, and wooden plank walkways. Each material offers a unique sensory experience, including variations in sound and texture. Permeable cement pavement is utilized for bicycle lanes to facilitate groundwater recharge into the soil.

The park's central waterbody, which was on the brink of disappearance, has been revitalized through re-excavation, reshaping, and re-identification as a focal point within the neighbourhood. Winding walkways encircle the lake, complemented by viewing decks and two large seating areas ('ghats') on its banks. The pathway is structured across two levels, offering a distinct experience to visitors. The lower tier provides a serene walk along the water's edge, leading to the viewing decks and 'Ghats.' On the other hand, the upper level includes a designated bicycle lane, providing an opportunity for users to navigate through the park's lush surroundings.

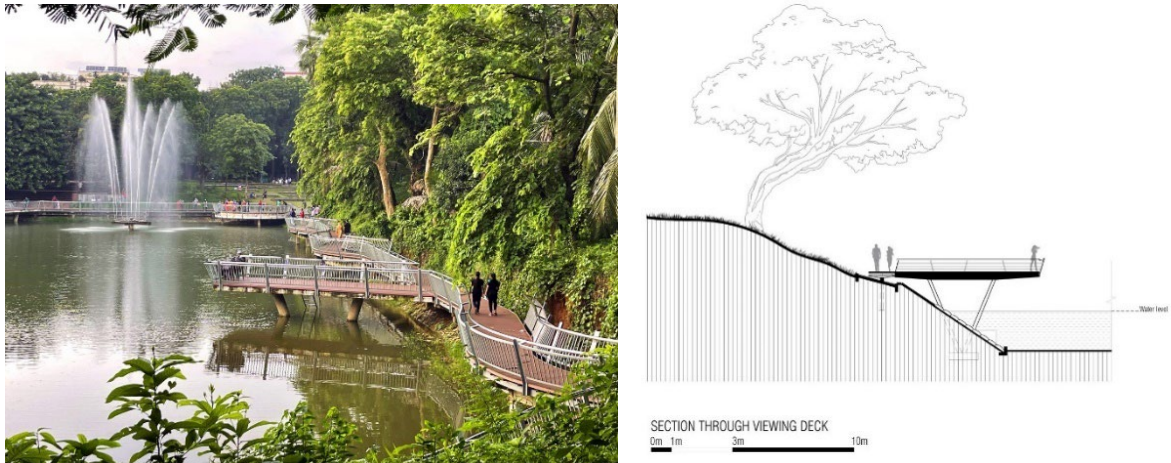


Figure 30 Justice Shahabuddin Ahmed Park (a) Viewing Decks; (b) Section through Viewing Deck; Source: Vitti Sthapati Brindo Ltd.

Additional features incorporated into the park design to encourage social engagement include a small drink corner with a community library, kiosks, a designated women's seating zone, a toddler play area, and toilet facilities. Furthermore, amenities such as a small gym, playground, and exercise yard have been introduced to promote the well-being of the neighbourhood residents. The park's drainage system has been meticulously planned to utilize rainwater harvesting techniques. Rather than installing traditional boundary walls for security purposes, transparent fencing has been implemented, enhancing visibility and accessibility for both commuters and pedestrians.



Figure 31 (a) Different species of plants present in the Justice Shahabuddin Ahmed Park; (b) The Amphitheatre; Source: Vitti Sthapati Brindo Ltd.

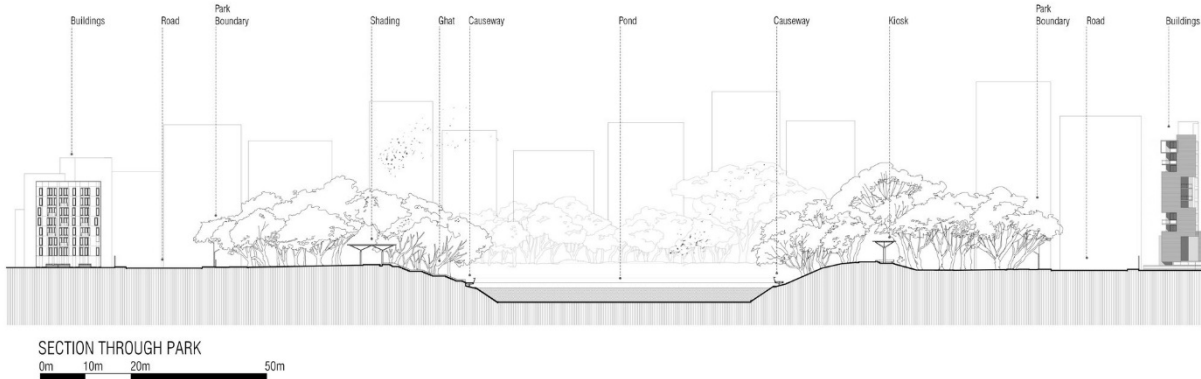


Figure 32 Section through the Justice Shahabuddin Ahmed Park; Source: Vitti Sthapati Brindo Ltd.

To ensure public participation, multiple Participatory Rural Appraisal (PRA) sessions were conducted within the local communities to engage and evaluate their specific needs, guiding both design decisions and implementation. Architect Ishtiaque Zahir emphasized the team's commitment to inclusivity, stating that design elements were not predetermined but rather derived from the needs and desires of the park's future users, as gathered through community feedback. Architect Iqbal Habib emphasizes the necessity for policy-level action to effectively manage the parks and avoid depriving future generations of open spaces. He underscores the comprehensive approach taken in the design process, which involved engaging with various stakeholders and community members to ensure inclusivity and thoroughness. This broader engagement, which extended beyond design considerations, is regarded as a significant achievement of their work.

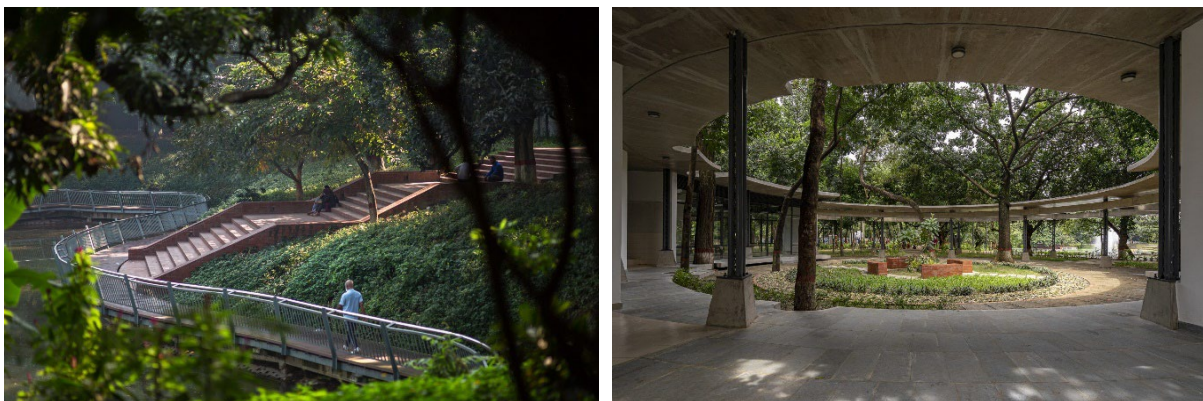


Figure 33 Justice Shahabuddin Ahmed Park (a) Ghats or Large Seating area on the banks; (b) Inside view of the gymnasium and community library; Source: Vitti Sthapati Brindo Ltd.

On a broader scale, the constructed infrastructure within the park is intended to establish a link between the natural features and the diverse range of users by incorporating a green network system. The various amenities, walking paths, and observation decks are strategically placed throughout the landscape to enrich the existing ecosystem and promote biodiversity.

4.3.2 Overall Impacts

Environmental impacts

- Environmental Quality
 - Improved waste management
 - Improved air quality
- Green space and habitat
 - Increased green space area
 - Reduced biodiversity loss
 - Restoration of derelict areas

Economic impacts

- Increased property prices
- Attraction of business and investment

Socio-cultural impacts

- Social justice and cohesion
 - Fair distribution of social, environmental, and economic benefits of the NBS project
 - Increased visibility and opportunity for marginalized groups or indigenous peoples
 - Increased involvement of locals in the management of green spaces
- Sense of Place
 - Improvement in people's connection to nature
- Safety
 - Increased perception of safety

4.3.3 S.W.O.T. Analysis

Strengths

- **Ecosystem Enhancement:** The project significantly contributes to ecosystem restoration and biodiversity conservation through the strategic planting of diverse tree species, including medicinal, fruit-bearing, and flowering varieties, while also removing non-native and invasive plants.
- **Community-Centric Approach:** The utilization of Participatory Rural Appraisal (PRA) sessions ensures that the park's design is responsive to the specific needs and preferences of the local community, fostering a sense of ownership and engagement.
- **Inclusive Design:** The park's design is thoughtfully inclusive, providing a wide range of amenities catering to diverse user groups, such as a library, gym, women's club, amphitheatre, and children's play areas.
- **Health and Wellness Promotion:** Promotion of physical activity and well-being through walking/cycling paths and exercise areas.
- **Sustainable Water Management:** The integration of rainwater harvesting systems and permeable pavements demonstrates a commitment to sustainable water management practices, promoting groundwater recharge and reducing stormwater runoff.

- **Enhanced Accessibility:** The use of transparent fencing improves visibility and accessibility, creating a welcoming and open environment for all members of the community.

Weaknesses

- **Maintenance and Funding Uncertainty:** The lack of information regarding long-term maintenance and funding plans for the park raises concerns about the ability to maintain the park's quality and functionality over time.
- **Potential User Conflicts:** The diverse range of amenities and activities offered within the park may lead to conflicts between different user groups, such as noise from amphitheatre events disturbing nearby residents or competition for space between different age groups.
- **Limited Environmental Impact:** While the project addresses some environmental concerns, it lacks specific details on measures to mitigate the urban heat island effect and improve air quality beyond tree planting and permeable pavements.

Opportunities

- **Model for Sustainable Urban Design:** The park's successful implementation of sustainable practices and nature-based solutions can serve as a model for other cities seeking to create similar green spaces in urban environments.
- **Environmental Education and Awareness:** The park's diverse plant and animal life presents a valuable opportunity to develop environmental education and awareness programs for local schools and community groups, fostering a deeper understanding and appreciation of nature.
- **Green Infrastructure Integration:** The park can be integrated into a broader urban green infrastructure network, connecting with other green spaces and contributing to the city's overall ecological health and resilience.
- **Community Stewardship:** By involving local communities in park management and stewardship programs, a sense of ownership and responsibility can be fostered, ensuring the park's long-term sustainability and success.

Threats

- **Urbanization and Development Pressures:** The rapid pace of urbanization and development in Dhaka poses a significant threat to the preservation of green spaces like this park. Encroachment and competing land uses could diminish the park's size or compromise its ecological integrity.
- **Resource Constraints:** Inadequate funding or resource allocation for ongoing maintenance and conservation efforts could lead to a decline in the park's condition and functionality over time.
- **Vandalism and Misuse:** Vandalism, littering, and misuse of park facilities by visitors can undermine the park's aesthetic appeal, safety, and overall enjoyment for others.
- **Climate Change Impacts:** Climate change-related challenges, such as extreme weather events, and rising temperatures, pose a threat to the park's ecosystem and the health of its plant and animal life.

4.4 CASE STUDY 4: Revitalization of Rasulbagh Children's Park

4.4.1 Overview

NbS approach: Infrastructure-related management

- Green areas for water management
 - Rain gardens
 - Sustainable urban drainage systems
- Grey infrastructure featuring greens
 - School grounds and Green playgrounds
- Parks and urban forests
 - Pocket parks/Urban Forests/Neighbourhood green spaces

Dhaka South City Corporation (DSCC), one of *Dhaka's* municipal local government authorities, launched a project in 2016 to rejuvenate 19 parks and 12 playgrounds across the city. Among them was *Rasulbagh Children's Park*, located in *Azimpur, Old Dhaka*, which had suffered from neglect and poor planning. Surrounded by residential buildings on all sides, the park had narrow alleys, approximately 3 feet wide, as the only means of access for locals. The park had limited entry points, primarily at the southwest corner and along the northern wall, with the adjacent road along the northern wall being congested with makeshift shops and tea stalls, further complicating access.

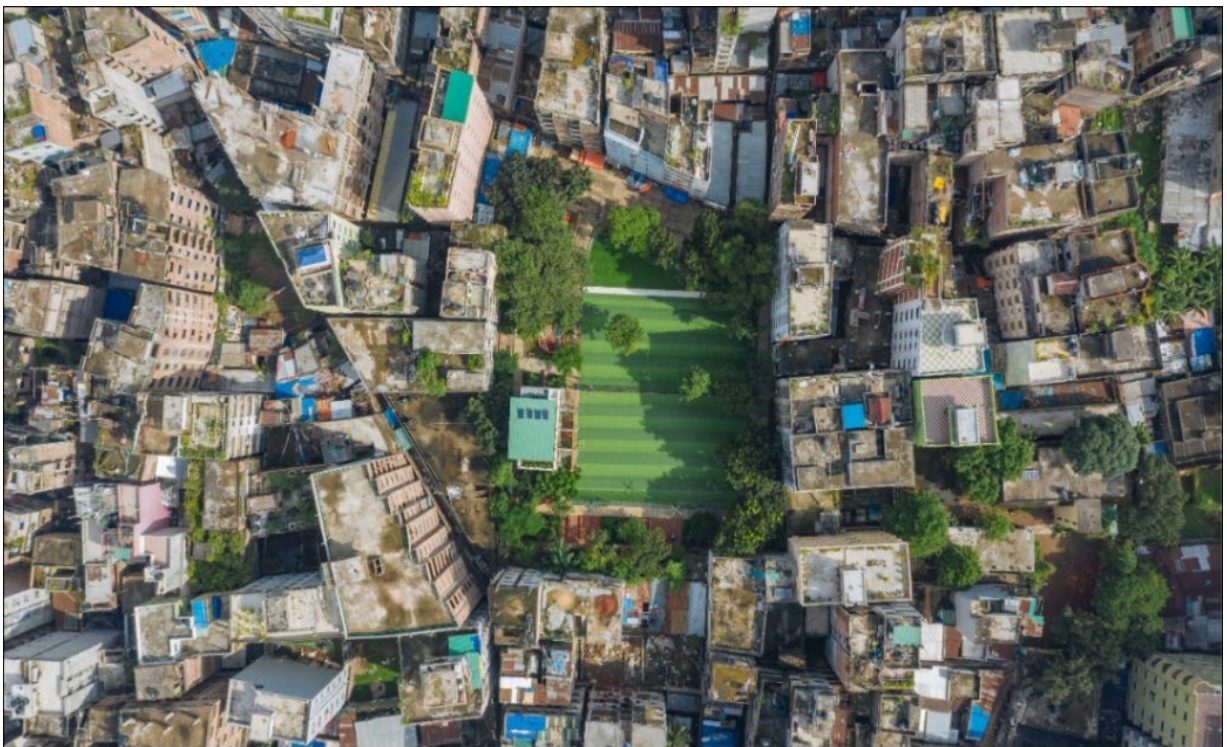


Figure 34 Top view of the Raulbagh Children's Park; Source: Shatotto

The project was implemented by the *Dhaka South City Corporation* and developed by the *Shatotto-Architecture for Green Living* and *JPZ Consulting (Bangladesh) Ltd.* The initiative is part of a larger project

known as “*Jol Shobuje Dhaka*” (meaning “Dhaka as aqueous green”) launched by the *Dhaka South City Corporation* to enhance the southern region of the capital city. This project name alludes to the two fundamental natural elements, water, and greenery, that constitute a natural landscape.

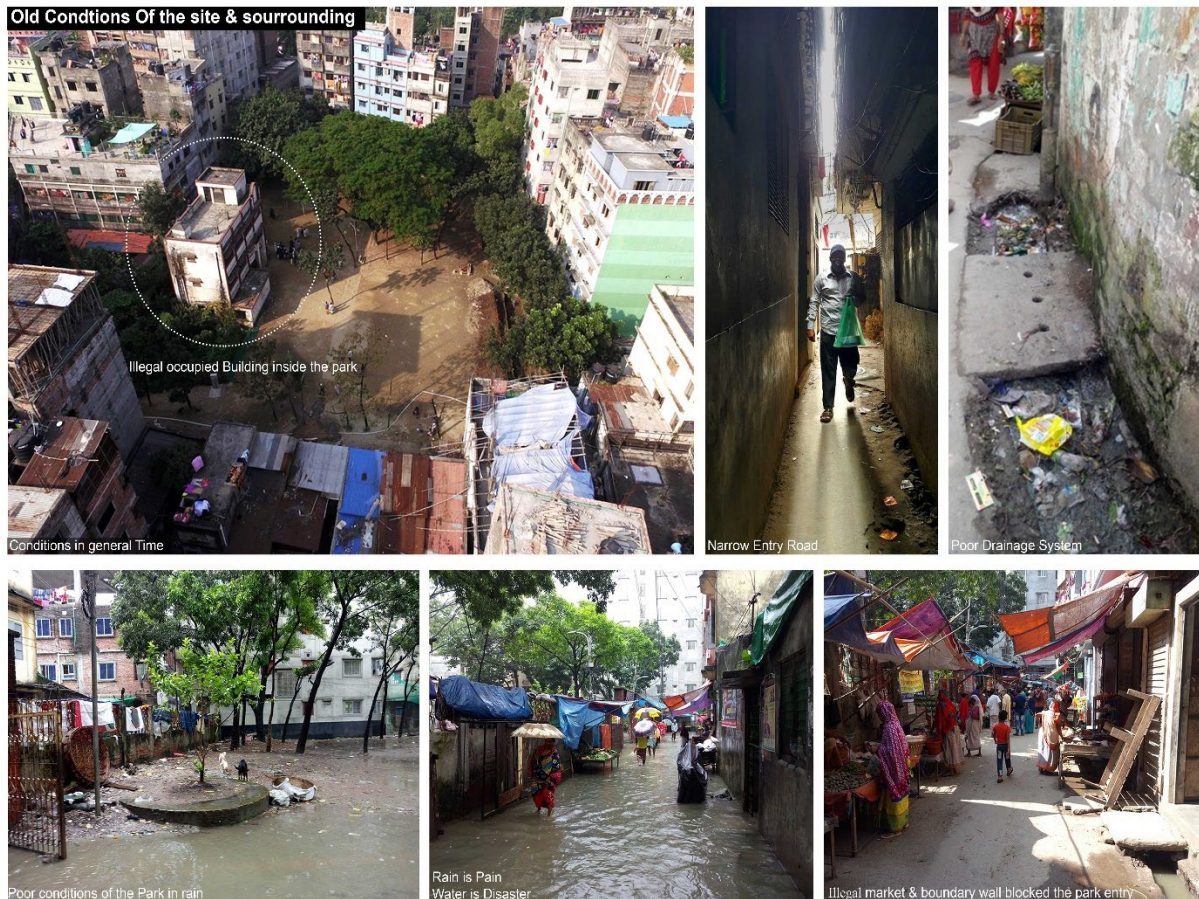


Figure 35 Old conditions of the site and surroundings; Source: Shatotto

The project objectives were twofold, consisting of park renovation and community engagement. In the initial phase, the aim was to enhance the park's overall appearance, accessibility, functionality, and aesthetic appeal. Subsequently, the focus shifted towards fostering community involvement and ensuring long-term maintenance and sustainability. The intervention primarily sought to achieve the following objectives:

1. Establishing a green space for community gatherings and activities, aimed at fostering better community relations and promoting mental, physical, and emotional well-being through the safeguarding of existing trees and the introduction of new ones.
2. Addressing water management issues, including flood control during the rainy season and implementing rainwater harvesting measures.
3. Promoting a healthy and clean environment by providing waste and recycling bins.
4. Enhancing the functionality of the park by transforming the central area into a sports field.
5. Cultivating a sense of community through a participatory approach and grassroots movement, facilitating community involvement in the maintenance and management of the green area.



Figure 36 Masterplan of the Raulbagh Children's Park; Source: Shatotto

Existing trees were conserved while additional ones were planted, considering both their functionality and their capacity to absorb water. A variety of flora, including *Sofeda*, *Chalta*, *Carissa Carandas*, *Bilimbi*, and others, were introduced to create an environmentally sustainable and visually appealing boundary. Native shrubs and trees now form rows along the park's perimeter, camouflaging its deteriorating walls and seamlessly blending them with the surroundings. Additionally, various plants, including flowers and fruit trees, have been planted along the park's outer edges to establish an eco-friendly and aesthetically pleasing boundary.

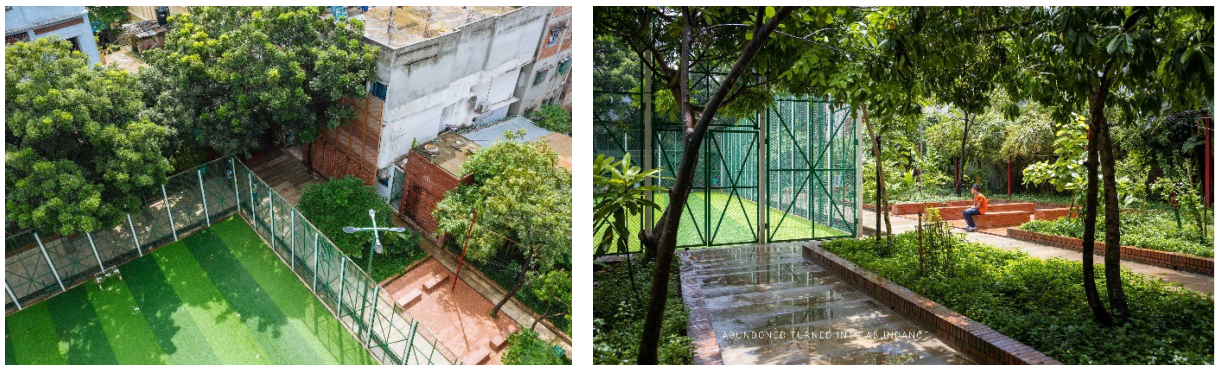


Figure 37 Lush greenery in the Raulbagh Children's Park; Source: Shatotto



Figure 38 List of trees and plants incorporated in the Raulbagh Children's Park project; Source: Shatotto

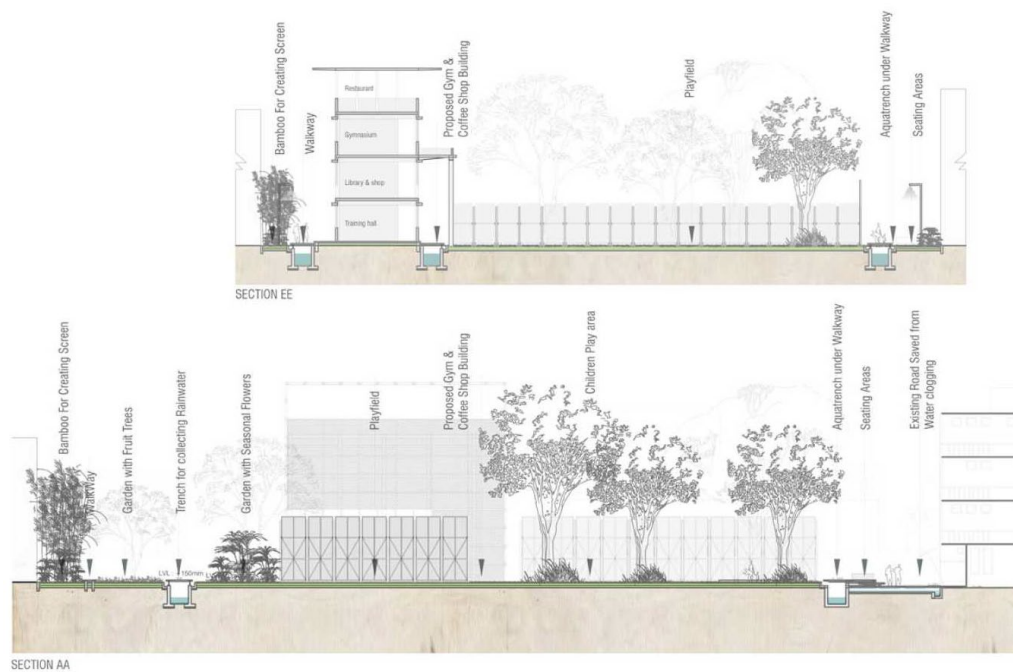


Figure 39 Site sections of Raulbagh Children's Park; Source: Shatotto

Initially, the rain was a pain for *Rasulbagh* residents, but now it is a cause of celebration. 100,000 litres of harvested and filtered rainwater below the walkway trench have solved the community's drinking water crisis along with the waterlogging issue. The project's most significant contribution has been the provision of potable water to the community through the collection and treatment of rainwater. The public tap situated at the park's periphery has evolved into a well-frequented communal gathering point.

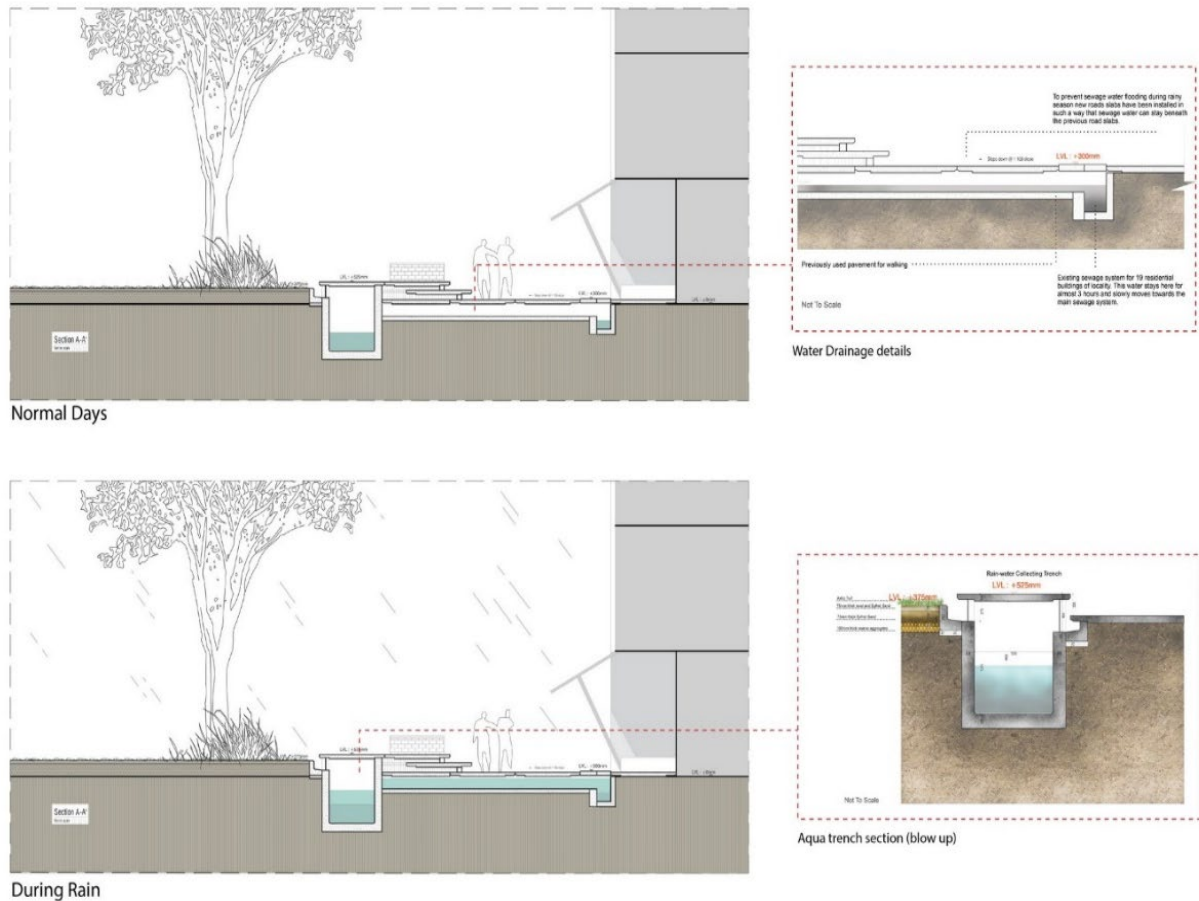


Figure 40 Aqua trench section and related site sections of Raulbagh Children's Park;
Source: Shatotto

Rainwater collection trenches measuring 5 feet deep and 4 feet wide were excavated along the park's perimeter and covered with reinforced concrete slabs to create peripheral walkways. These trenches are linked to an underground reservoir designed to store rainwater for filtration and future usage. Additionally, an elevated promenade contains a temporary sewage hold that directs wastewater into the city drain. When combined with the aqua trenches, this system effectively addresses waterlogging issues. The rainwater collection trenches also serve as aqueducts, redirecting rainwater away from sewage ducts and channelling it into a new filtration system. Moreover, wastewater collection, filtration, and diversion trenches have been installed, alongside new drainage and piping systems beneath the park, facilitating the growth of new grass on previously barren soil.



Figure 41 *Different activities in the project; Source: Shatotto*

The park now caters to a wide range of activities, including sports, recreation, prayer, and education, truly living up to its designation as a "Children's Park". Notable additions include a dedicated open field for sports, a children's playground, a pavilion, a 500-foot walkway, a public plaza for relaxation, a library, a gymnasium, a community hall, and public restrooms. An abandoned building on the premises underwent extensive renovation and repurposing, now serving as a multi-functional facility offering employment opportunities and generating income for park maintenance. Emphasizing the importance of a clean environment, waste and recycling bins have been strategically placed throughout the park to promote cleanliness and sustainability.



Figure 42 PRA sessions with the community during the project; Source: Shatotto

Community engagement was prioritized throughout the entire renovation process, facilitated by a series of meetings and public hearings that enabled community input and feedback. The implementation team devoted considerable time and effort to involve various stakeholders, including residents, businesses, the elderly, local religious leaders, and youth, who stood to benefit from the project. At these hearings, the proposed plans were presented to the entire community to ensure broad consensus. Upon finalizing the design and securing approval from all stakeholders, renovations commenced with the demolition of the north wall. The implementation team aimed to instil a sense of ownership and attachment among community members toward the redeveloped area, enhancing its prospects for sustainability. Consequently, positions such as manager, cleaner, caretaker, and gardener at the park are occupied by young members of the local community. This fosters stronger community bonds as they collaboratively manage and maintain the park.

4.4.2 Overall Impacts

Environmental impacts

- Water management and blue areas
 - Increased protection against flooding
 - Improved stormwater management
- Green space and habitat
 - Increased green space area

Economic impacts

- Increase of jobs

Socio-cultural impacts

- Social justice and cohesion
 - Improved access to urban green space
 - Increased opportunities for social interaction
 - Increased involvement of locals in the management of green spaces
- Safety
 - Increased perception of safety

4.4.3 S.W.O.T. Analysis

Strengths:

- **Environmental Impact:** Addressed critical issues like waterlogging, sewage disposal, and drinking water scarcity through the implementation of nature-based solutions like rainwater harvesting and filtration systems.
- **Biodiversity Enhancement:** Preserved existing trees and planted native species, contributing to enhanced biodiversity and the creation of an eco-friendly environment.
- **Community Development:** Transformed an abandoned space into a vibrant community hub with diverse amenities like sports facilities, playgrounds, a library, and a community hall, fostering social interaction and well-being.
- **Participatory Approach:** Adopted a participatory approach, involving the community in the design and maintenance processes, ensuring that the park's design aligns with local needs and promoting a sense of ownership for long-term sustainability.
- **Economic Opportunities:** Created employment opportunities for local residents in park management and maintenance, contributing to the local economy and social development.

Weaknesses:

- **Limited Accessibility:** Limited accessibility due to narrow alleys surrounding the park, although efforts were made to improve entry points.
- **Incomplete Sewage Solution:** The project's inability to fully address sewage disposal issues could pose a long-term threat to the park's hygiene and environmental sustainability.
- **Artificial Turf:** The use of artificial turf instead of natural grass while necessitated by soil conditions, may diminish the ecological benefits and aesthetic appeal of the park.

Opportunities:

- **Replicability:** The successful community engagement model employed in this project can be replicated and adapted in other urban renewal initiatives, fostering greater community ownership and sustainability.
- **Holistic Integration:** Scope for further integration with broader urban planning initiatives like "Jol Shobuje Dhaka" for a more holistic approach.
- **Eco-Tourism:** Opportunity to promote eco-tourism and environmental education by showcasing the park's sustainable features.

Threats:

- **Deterioration Due to Neglect:** Lack of long-term maintenance and community involvement could lead to deterioration of the park's facilities.
- **Misuse and Encroachment:** The park's vulnerability to misuse or encroachment by anti-social elements, as observed in the past, poses a continuous threat to its safety and upkeep.
- **Climate Change Vulnerabilities:** Climate change impacts like increased rainfall or flooding could strain the park's water management systems.

4.5 CASE STUDY 5: Social Sciences Square, University of Dhaka

4.5.1 Overview

NbS approach: Green space creation and/or management

- Nature in Buildings
 - Atriums/Courtyards
- Green areas for water management
 - Sustainable urban drainage systems
 - Rain gardens

Situated within a complex of notable structures including the Central Mosque, Central Library, Central Student Union Building, a historic Canteen, and the newly constructed Faculty of Social Science building, the original open space was underutilized and lacked a distinct purpose. Despite its prime position within the *University of Dhaka campus*, the area was disregarded for an extended period. It provided minimal utility to users and was frequently employed solely as a pathway or a repository for construction waste. The natural landscape exhibited a state of disorder, shaped by factors such as sunlight exposure, soil conditions, and limited human interference.



Figure 43 Masterplan of the Social Sciences Square project; Source: Sthanik Consultants

The project sought to create a gathering spot for young intellectuals, offering a space for intimate gatherings that would facilitate contemplation and reflection for both students and faculty members. Maintaining an open landscape in such a central location required meticulous attention, leading to the incorporation of a semi-open food kiosk to serve as a catalyst for upkeep while simultaneously invigorating the area.



Figure 44 Chronological conceptual development of the Social Sciences Square project;
Source: Sthanik Consultants

Inspired by the traditional "Dig and Mound" approach prevalent in this context, the design utilizes topographical layers within a 3-foot range below and above ground level to sculpt the landscape terrain. The contours and spatial arrangements within the land formation are harmonized with the existing tree patterns and the unique characteristics of the surrounding built environment, both in terms of aesthetics and functionality. This intervention aims to provide users with a curated space for orchestrated encounters, serving as an extension of the central library's reading area, a gathering point following prayers at the central mosque, and an expanded discussion area adjacent to *DUCSU* and *Modhur Canteen*.

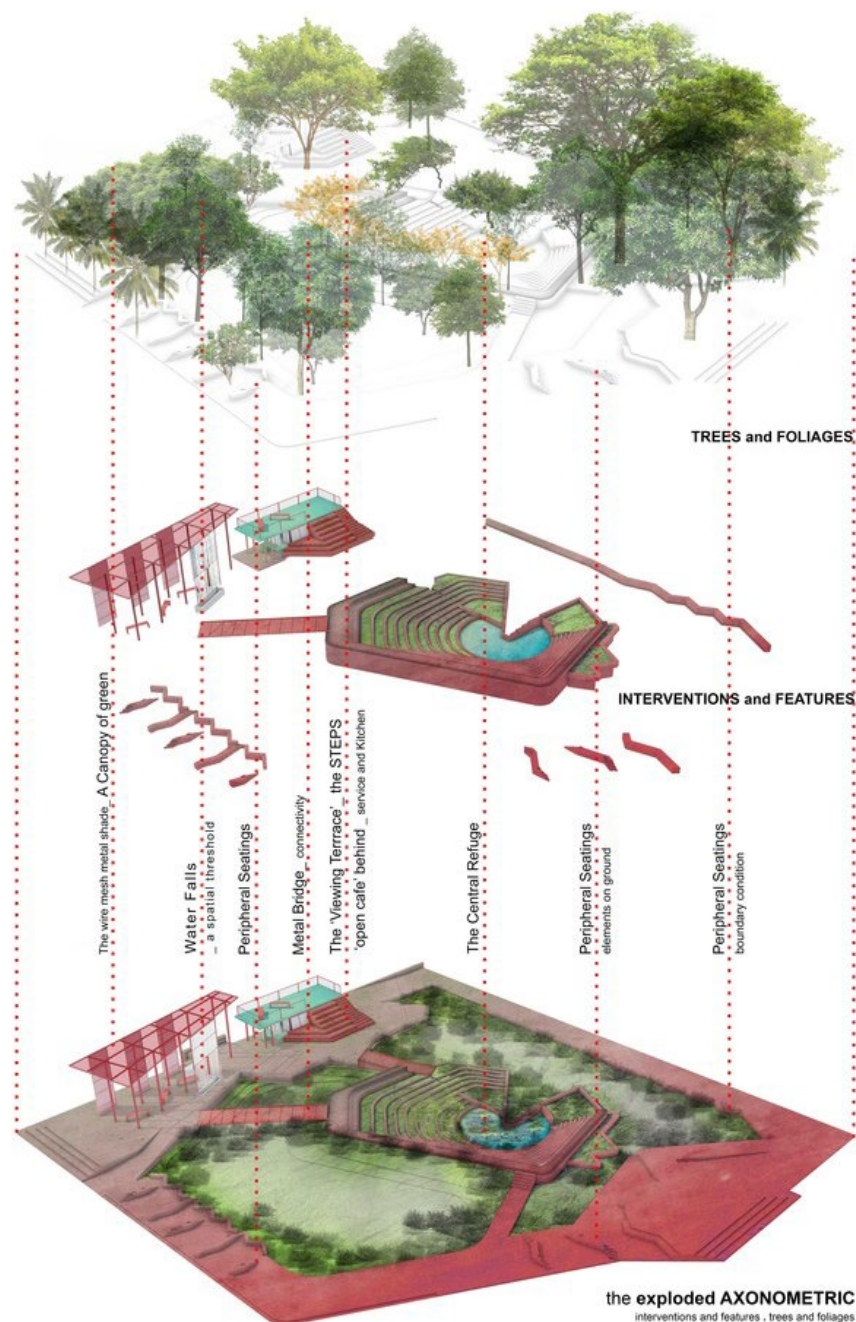


Figure 45 Exploded Axonometric Diagram of the Social Sciences Square;
Source: Sthanik Consultants

In order to transform an unremarkable area into a meaningful and resonant space, the design approach focused on creating an "archive of memories." This was achieved through the incorporation of a sunken reflective water feature, which captures and mirrors the image of the notable Rain Tree, portions of the library facade, and the ever-changing interplay of light, shadow, sky, and clouds. This reflective element fosters an environment conducive to contemplation and introspection. Situated at the heart of the water feature, the "Hijol Tree" (*Barringtonia Acutangula*) serves as a central element, reminiscent of village ponds and evoking a sense of nostalgia. The deliberate choice of materials further enhances this multi-sensory experience, steeped in a feeling of reminiscence.

Furthermore, the introduction of fruit and flower-bearing plants such as *Dalim* (*Pomegranate*), *Kamini* (*Murraya Paniculata*), *Radhachura* (*Lagerstroemia Indica*), *Lantana*, and *Joba* (*Hibiscus*) aims to attract butterflies and birds, thereby promoting biodiversity. The central water body is adorned with aquatic plants and inhabited by small fish, contributing to the ecological sustainability of the site. It has become a popular bathing spot for local birds, with pairs of birds frequently seen touching down on the water's surface.

4.5.2 Overall Impacts

Environmental impacts

- Environmental Quality
 - Enhanced air quality and reduced pollution
- Green space and habitat
 - Promotion of naturalistic landscape design
 - Expansion of green space area
- Water management and blue areas
 - Improved stormwater management

Economic impacts

- Unknown

Socio-cultural impacts

- Social justice and cohesion
 - Enhanced liveability for residents.
 - Equitable access to urban green spaces.
 - Increased opportunities for social interaction and community building.
- Health and wellbeing
 - Improvement in physical health outcomes
 - Greater access to spaces for recreation and exercise, promoting active lifestyles.

4.5.3 S.W.O.T. Analysis

Strengths:

- **Transformation of Underutilized Space:** Successfully repurposes a neglected area into a dynamic and engaging social hub for students and faculty.
- **Innovative Landscape Design:** Employs traditional "Dig and Mound" techniques to create a distinctive and aesthetically pleasing landscape terrain.
- **Contextual Integration:** Seamlessly integrates existing trees and the unique characteristics of the surrounding built environment into the design.
- **Multi-Functional Spaces:** Provides versatile spaces that cater to diverse activities such as reading, group discussions, and individual contemplation.

- **Evocative Design:** Evokes a sense of nostalgia and connection to local heritage through elements like the "*Hijol Tree*" and the village pond-inspired water feature.
- **Ecological Sensitivity:** Promotes biodiversity by attracting birds, butterflies, and other wildlife, while preserving existing natural habitats.
- **Sustainable water feature:** Incorporation of water-loving plants and small fish species within the central water body to create a self-sustaining ecosystem that requires minimal external maintenance and resources.

Weaknesses:

- **Maintenance Challenges:** The open landscape's prominent location may pose difficulties in ensuring consistent upkeep and cleanliness.
- **Potential for Disturbance:** The semi-open food kiosk, while intended to enliven the space, could contribute to litter or noise pollution, disrupting the intended atmosphere of tranquillity.

Opportunities:

- **Enhanced Campus Experience:** The revitalized space has the potential to significantly improve the overall campus environment, fostering a stronger sense of community and belonging among students and faculty.
- **Exemplary Design:** The project can serve as a model for future sustainable and nature-based design interventions within the university and beyond.
- **Educational Potential:** The diverse plant and animal life within the space can provide valuable opportunities for educational programs and research projects related to biodiversity and ecology.

Threats:

- **Overuse and Misuse:** The popularity of the space may lead to overuse or misuse by visitors or students, potentially causing damage to the landscape and installations.
- **Vandalism and Damage:** The open nature of the site makes it vulnerable to vandalism or intentional damage, requiring ongoing monitoring and security measures.
- **Maintenance and Upkeep Challenges:** Ensuring the long-term maintenance and upkeep of the space may be difficult due to limited resources or changing priorities within the university administration.

4.6 CASE STUDY 6: Shakuni Lake Development

4.6.1 Overview

NbS approach: Ecosystem restoration, wetland restoration, and biodiversity conservation

- Blue Infrastructure
 - Lakes/ponds
- Green areas for water management
 - Sustainable urban drainage systems
- Grey infrastructure featuring greens
 - Lakeside greens/Riverbank
- Parks and urban forests
 - Pocket parks/neighbourhood green space

Shakuni Lake, also known as *Shakuni Dighi*, is a significant urban landmark and water retention project located in the heart of *Madaripur town, Bangladesh*. Established in 1943 during the British colonial era, the lake was initially conceived as a man-made urban water retention basin, around which the town's main infrastructure and buildings were subsequently constructed.

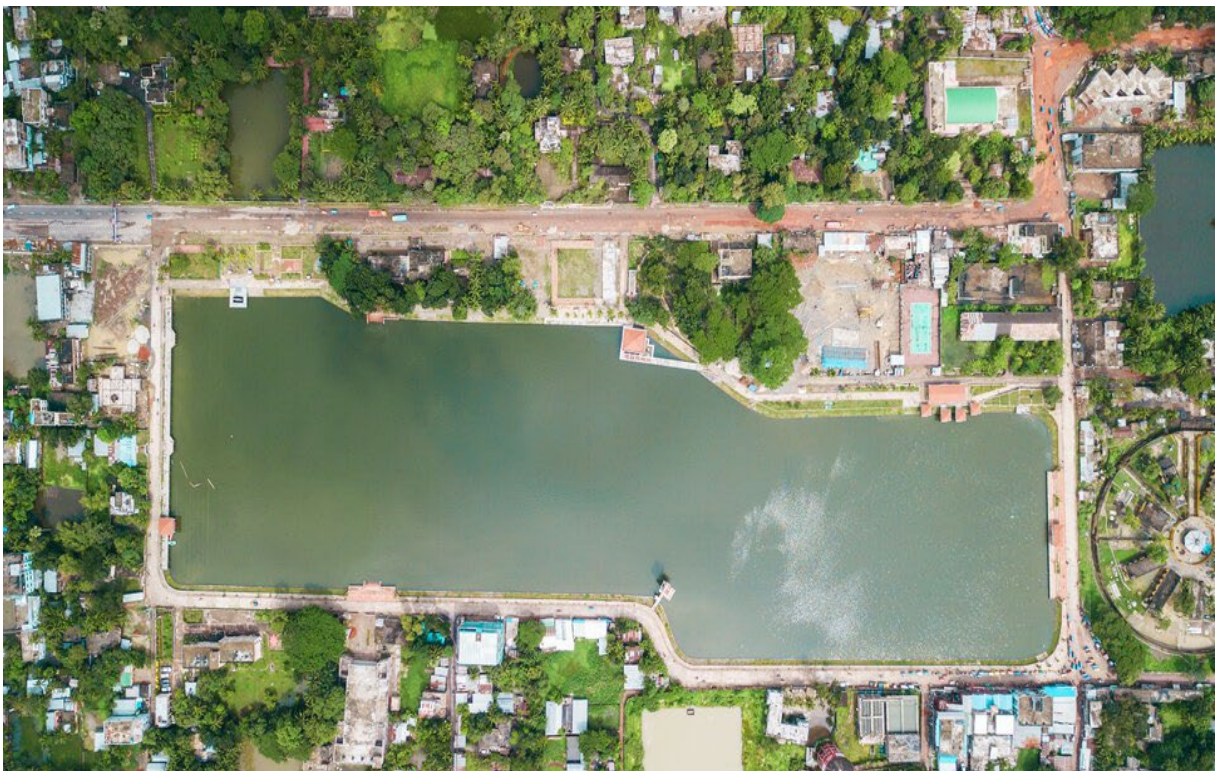


Figure 48 Top view of the Shakuni Lake; Source: Vitti Sthapati Brindo Ltd.

Over the years, the lake faced challenges due to encroachment and pollution. However, a revitalization project was undertaken to restore its ecological health and enhance its role as a public space. The project aimed to create an open, accessible, and vibrant area that catered to the recreational and leisure needs of *Madaripur's* residents while also addressing essential urban facilities.

Today, Shakuni Lake is a thriving hub of activity, attracting locals and visitors alike. It is surrounded by various important landmarks, including the *District Circuit House*, *Bangabandhu Mural*, *Shaheed Kanan*, *Shishu Park*, *Swadhinata Angan*, *MP Theater Stage*, the *Madaripur Clock Tower*, and a watch tower. Visitors can enjoy the serene ambience, beautiful seating arrangements, and the surrounding greenery. The lake's tranquil waters and the interplay of light and shadow offer a peaceful escape from the urban bustle.

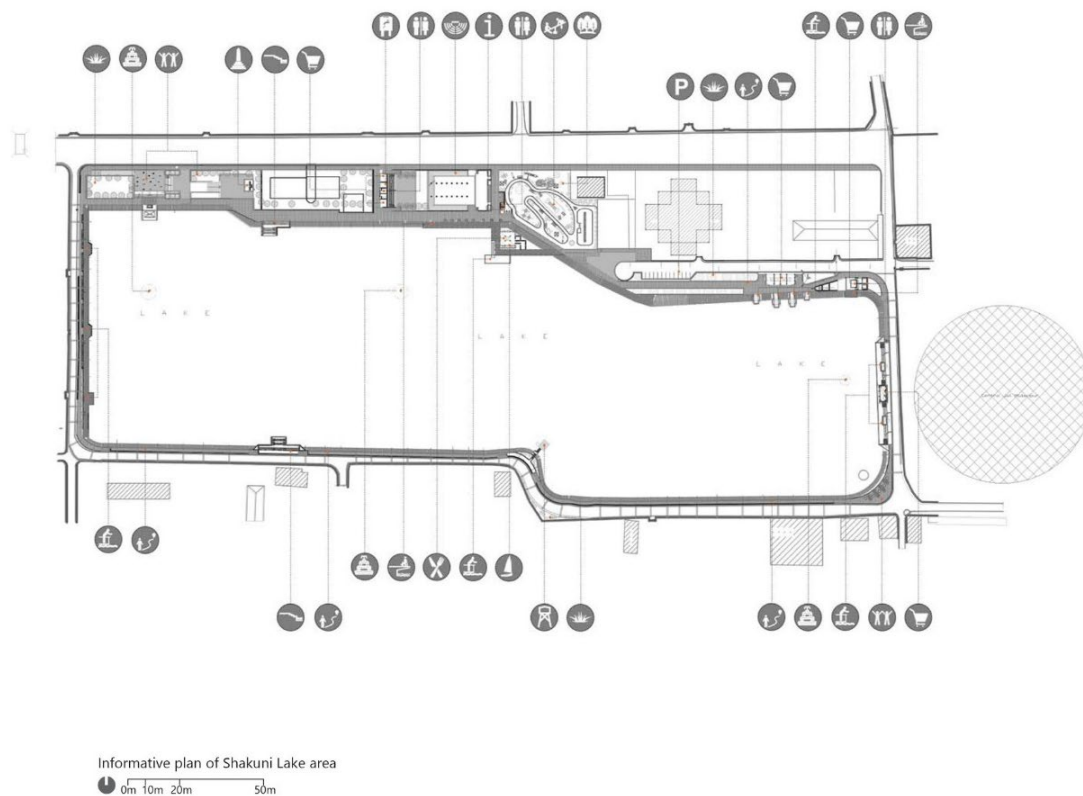


Figure 49 Masterplan of the Shakuni Lake Development project; Source: Vitti Sthapati Brindo Ltd.

The lake's central location and proximity to key institutions like Bangabandhu Law College, Children's Academy, Tennis Club, and government offices make it a vital part of Madaripur's social and cultural fabric. The lake not only enhances the town's natural beauty but also provides a space for recreation, leisure, and community gatherings.



Figure 50 Aerial View of the Shakuni Lake; Source: Vitti Sthapati Brindo Ltd.

While Shakuni Lake serves as a testament to successful urban revitalization, it also highlights the challenges faced by water bodies in rapidly urbanizing areas. Balancing the need for development with the preservation of natural resources remains an ongoing challenge for cities like *Madaripur*. However, the restoration and enhancement of *Shakuni Lake* demonstrate that with careful planning and community engagement, it is possible to create urban spaces that benefit both people and the environment.

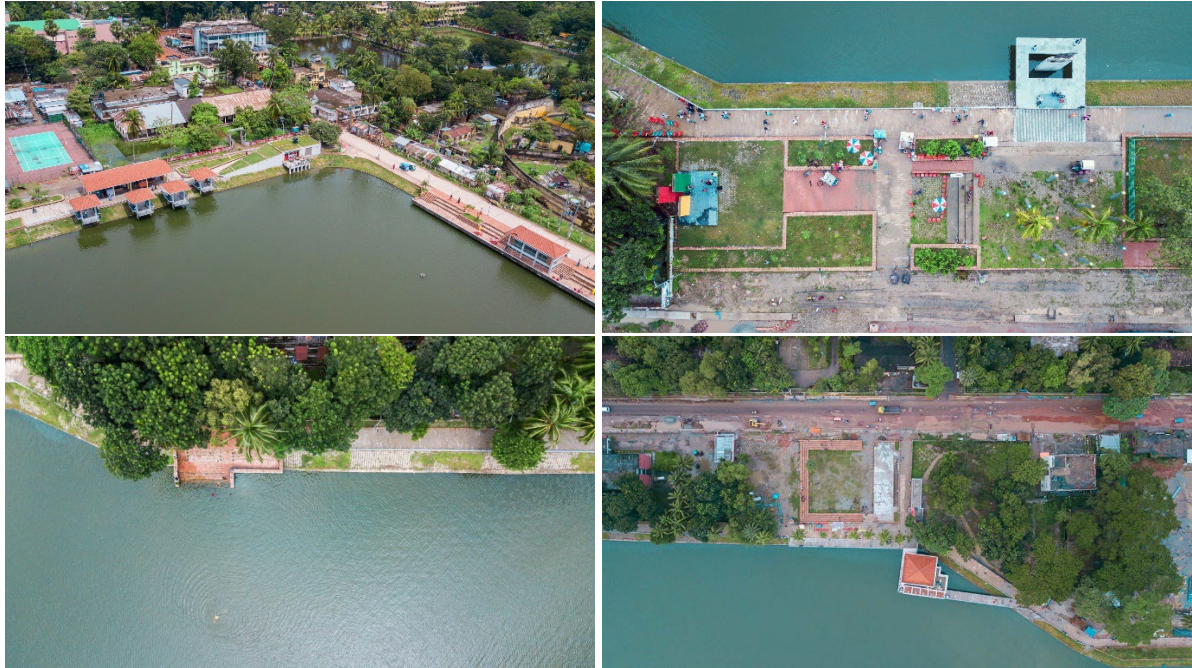


Figure 51 Areas showing design interventions for public gatherings;
Source: Vitti Sthapati Brindo Ltd.

4.6.2 Overall Impacts

Environmental impacts

- Environmental Quality
 - Improved waste management
 - Improved air quality
- Green space and habitat
 - Increased green space area
 - Reduced biodiversity loss

Economic impacts

- Increased property prices
- Attraction of business and investment

Socio-cultural impacts

- Social justice and cohesion
 - Increased visibility and opportunity for marginalized groups

- Increased involvement of locals in the management of green spaces
- Sense of Place
 - Improvement in people's connection to nature
- Safety
 - Increased perception of safety

4.6.3 S.W.O.T. Analysis

Strengths:

- **Environmental Restoration:** Successful restoration of the lake's ecological health and water quality, leading to improved waste management and air quality, increased green space, and reduced biodiversity loss.
- **Economic Boost:** The revitalization project has increased property values and attracted business and investment to the surrounding area, contributing to the local economy.
- **Social and Cultural Hub:** The lake serves as a vibrant communal space, fostering social cohesion and providing opportunities for marginalized groups and local residents to participate in the management of green spaces.
- **Connection to Nature:** The park enhances people's connection to nature, offering a peaceful and scenic environment for relaxation and recreation.
- **Enhanced Safety:** The improved infrastructure and lighting have increased the perception of safety around the lake, encouraging more people to use the space.

Weaknesses:

- **Ongoing Maintenance:** The long-term sustainability of the project relies on consistent maintenance and funding to preserve the lake's ecological health and the functionality of its amenities.
- **Vulnerability to Encroachment:** The lake's central location and attractiveness make it vulnerable to potential encroachment and misuse, requiring ongoing vigilance and enforcement of regulations.
- **Limited Accessibility:** While efforts have been made to improve accessibility, the lake may still present challenges for certain user groups, particularly those with disabilities or limited mobility.

Opportunities:

- **Eco-Tourism Potential:** The lake's natural beauty and diverse ecosystem can be leveraged to promote eco-tourism, attracting visitors and generating additional revenue for the local community.
- **Educational and Research Opportunities:** The lake can serve as an outdoor classroom and research site for environmental education and ecological studies, raising awareness about the importance of nature conservation.
- **Community Engagement:** Further community involvement in the management and stewardship of the lake can ensure its long-term success and sustainability. This could include organizing volunteer clean-up days, educational workshops, and cultural events.

Threats:

- **Urbanization Pressure:** The rapid urbanization of *Madaripur* poses a threat to the preservation of the lake and its surrounding green spaces. Encroachment and competing land uses could compromise the lake's ecological integrity.
- **Climate Change:** The increasing frequency and intensity of extreme weather events due to climate change, such as floods and droughts, could impact the lake's water levels and ecological balance.
- **Pollution:** The risk of pollution from surrounding areas and human activities remains a concern, necessitating continuous monitoring and mitigation efforts to protect the lake's water quality.



Largest waste dumping zone in Bangladesh
Photo from WESTEND61

5

DISCUSSION

The case studies presented in Chapter 4 show an overview associated with the integration of Nature-based Solutions (NbS) into the urban design practices in Bangladesh. While each project demonstrates unique approaches and outcomes, several common themes and lessons can be drawn from their experiences. The purpose of this chapter is to provide answers to the research questions based on the findings from these experiences. Through a detailed analysis of these case studies, this chapter aims to contribute to the growing body of knowledge on the effective implementation and evaluation of NbS in diverse urban contexts, ultimately informing future urban development strategies that prioritize sustainability, resilience, and the well-being of both people and the environment. This chapter will also explore the diverse perspectives of stakeholders involved in these projects, shedding light on the key drivers and barriers to the wider adoption of NbS in urban planning and design. Finally, this chapter will reflect on this research method, its limitations, and future research directions.

5.1 COMPARISON OF IMPACTS

The six analyzed urban design projects in Bangladesh, each utilizing different Nature-based Solutions (NbS), demonstrate a consistent pattern of positive environmental and socio-cultural outcomes. While the economic impacts were not always emphasized and varied across projects, the overall benefits were substantial. Significantly, these case studies contributed to multiple Sustainable Development Goals (SDGs), with a particular emphasis on SDGs 3 (Good Health and Well-being), 11 (Sustainable Cities and Communities), and 13 (Climate Action). These goals were consistently addressed across most projects, underscoring their central role in integrating NbS into urban design practices in Bangladesh. Table 4 shows the summarization of issues addressed by the projects and identifies the SDGs implemented.

By addressing health, community well-being, and climate change mitigation, NbS projects contribute to creating urban environments that are more resilient, sustainable, and inclusive for all residents. The presented analysis here suggests that NbS can serve as a powerful tool for achieving multiple sustainability targets simultaneously in the context of urban resilience in similar contexts.

Table 4: Summarization of the issues addressed by the case studies

Case Study	NbS Approaches Used	Issues Addressed	SDGs Implemented
Case Study 1 <i>Integrated development of the Hatirjheel Area</i>	<i>Issue-specific ecosystem management</i>	-Disaster-risk reduction -Climate change adaptation -Creation of opportunities for recreation	
Case Study 2 <i>Co.Creation of Urban Spaces by Naboganga River</i>	<i>Ecosystem protection and Infrastructure management</i>	-Sense of community and community engagement -Waste management	
Case Study 3 <i>Renovation of Justice Shahabuddin Ahmed Park</i>	<i>Ecosystem restoration, Habitat and biodiversity conservation</i>	-Habitat and biodiversity restoration -Improving mental & physical health -Creation of opportunities for recreation	
Case Study 4 <i>Revitalization of Rasulbagh Children's Park</i>	<i>Infrastructure-related management</i>	-Disaster-risk reduction -Flood protection -Stormwater and rainfall management and storage	
Case Study 5 <i>Social Sciences Square, DU</i>	<i>Green space creation and/or management</i>	-Promote natural styles of landscape design for urban development	
Case Study 6 <i>Shakuni Lake Development, Madaripur</i>	<i>Ecosystem restoration</i>	-Disaster-risk reduction -Flood protection -Creation of opportunities for recreation	

1. Environmental Impacts:

The projects consistently showcased positive environmental effects, with a particular emphasis on improving water management and enhancing green spaces.

Water Management: *Integrated Development of the Hatirjheel area, Revitalization of Justice Sahabuddin Ahmed Park and Rasulbagh Children's Park* projects stand out for their significant improvements in stormwater management and flood protection. These projects utilized NbS such as wetland restoration, rain gardens, and sustainable urban drainage systems (SUDS) to mitigate the risk of flooding, a significant issue in *Dhaka* due to its low-lying topography and frequent monsoons. The *Co-Creation of Urban Spaces by the Naboganga River* project also focused on restoring water quality, highlighting the importance of NbS in maintaining the health of urban waterways.

Green Space Enhancement: All projects increased green space within the city, contributing to a range of benefits including improved air quality, carbon sequestration, reduced pollution, and biodiversity

conservation. The *Social Sciences Square* project at *Dhaka University* exemplifies this by transforming a neglected area into a vibrant green space that provides recreational opportunities and enhances the aesthetic appeal of the campus.

Public Health and Wellbeing: Nearly all projects enhanced the quality of life by making these areas more comfortable for residents. Green spaces promote relaxation and encourage physical activity, thereby improving overall health.

2. Economic Impacts:

While economic impacts were less explicitly reported, some projects demonstrated indirect economic benefits.

Increased Property Values and Investment: The *Integrated Development of the Hatirjheel area*, *Revitalization of Justice Shahabuddin Ahmed Park* and *Shakuni Lake Development* projects, through their comprehensive revitalization efforts, contributed to increased property values and attracted business and investment in the surrounding areas. This suggests that NbS can have a positive impact on local economies by enhancing the desirability and value of urban spaces.

Job Creation: The *Rasulbagh Children's Park* project created employment opportunities for local residents in park management and maintenance, demonstrating the potential of NbS to contribute to local economic development and livelihoods.

3. Socio-Cultural Impacts:

The projects also reported positive outcomes related to social justice and cohesion. This was achieved through improved access to urban green spaces, fostering a sense of community ownership, and promoting social interaction.

Increased Accessibility and Social Interaction: The *Co-Creation of Urban Spaces*, *Rasulbagh Children's Park* and the *Revitalization of Justice Sahabuddin Ahmed Park* projects exemplify the focus on community engagement and empowerment. By involving local residents in the design and management of these spaces, the projects ensured that the needs and preferences of the community were met, leading to increased use and enjoyment of the spaces. The availability of recreational facilities, playgrounds, and community halls further encouraged social interaction and fostered a sense of belonging among residents.

Social Justice and Inclusion: the *Revitalization of Justice Sahabuddin Ahmed Park* and *Rasulbagh Children's Park* projects aimed to enhance social justice by ensuring equitable access to the park's amenities and resources for all members of the community, including marginalized groups. This approach highlights the potential of NbS to promote social equity and inclusivity in urban environments.

In summary, these projects not only address critical environmental challenges like flooding and pollution but also contribute to social cohesion, community well-being, and economic development. The extent of economic impacts varied across the projects, with some demonstrating more indirect benefits than others. This suggests the need for further research to fully understand and quantify the economic potential of NbS in the context of Bangladesh's urban development.

5.2 COMPARISON OF S.W.O.T. ANALYSIS

The S.W.O.T. analysis comparison across the six urban design case studies in Bangladesh reveals both shared patterns and unique challenges and opportunities, offering valuable insights for future NbS implementation.

Strengths:

Environmental Restoration and Enhancement: All projects demonstrate a strong focus on improving environmental quality through various NbS interventions. This includes enhancing water management (*Integrated Development of the Hatirjheel area, Rasulbagh Children's Park, Co-Creation of Urban Spaces by the Naboganga River*), increasing green spaces, and promoting biodiversity (*Justice Shahabuddin Park, Social Sciences Square, Shakuni Lake*).

Social Cohesion and Community Well-being: The projects consistently highlight the positive socio-cultural impacts of NbS, particularly in fostering community engagement and improving access to green spaces. Projects like the *Co-Creation of Urban Spaces by the Naboganga River* and the *Rasulbagh Children's Park* showcased the transformative power of community engagement, empowering residents to actively participate in the design and management of their local environment. This not only enhanced the sense of ownership and belonging among residents but also led to more inclusive and contextually relevant designs.

Weaknesses:

Long-Term Sustainability: A common concern across the projects is the long-term maintenance and funding required to sustain the benefits of NbS. This highlights the need for robust financial and institutional mechanisms to ensure the continued upkeep and functionality of these interventions. Without adequate support, the initial gains in environmental and social well-being could be eroded.

Vulnerability to External Threats: The projects face shared vulnerabilities to external factors such as climate change impacts (e.g., increased rainfall and flooding), urbanization pressures, and potential misuse or vandalism. These threats underscore the importance of designing resilient and adaptable NbS solutions.

Opportunities:

Scalability and Replication: The successful implementation of NbS in these projects demonstrates the feasibility and effectiveness of these approaches in the Bangladeshi context. This can serve as a model for scaling up and replicating similar initiatives in other cities and regions facing similar challenges.

Community Empowerment: The success of these community-led initiatives in the studied projects also underscores the opportunity for greater community engagement and empowerment in future NbS endeavours.

Integration with Urban Planning: The case studies highlight the importance of integrating NbS into broader urban planning frameworks, such as the *"Jol Shobuje Dhaka"* project. This presents an opportunity to create more holistic and sustainable urban development strategies that address multiple challenges simultaneously.

Threats:

Urbanization and Encroachment: The rapid pace of urbanization and development in *Bangladesh* poses a significant threat to the preservation of green spaces and natural habitats. Encroachment and competing land uses could undermine the effectiveness and longevity of NbS interventions.

Financial and Resource Constraints: The lack of adequate funding and resources for long-term maintenance and conservation efforts remains a major challenge. This could lead to the deterioration of NbS infrastructure and the loss of their intended benefits.

Climate Change and Environmental Degradation: The increasing frequency and intensity of climate change-related events, such as increased rainfall, floods, and heat waves pose a significant threat to the resilience of NbS. Additionally, pollution and other forms of environmental degradation can undermine the ecological integrity of these projects.

Overall, the comparative SWOT analysis reveals that while NbS projects in Bangladesh have demonstrated significant potential in addressing urban challenges and improving environmental and social well-being, their long-term success hinges on addressing key weaknesses and threats. This requires a multi-faceted approach that includes securing sustainable funding, strengthening institutional capacity, promoting community engagement, and integrating NbS into broader urban planning frameworks. By learning from the successes of these case studies, more effective and resilient NbS strategies can be developed for a sustainable future.

5.3 INTERVIEW FINDINGS

The assessment of the implementation of Nature-Based Solutions (NbS) in Bangladesh presented a multifaceted landscape of challenges and opportunities, as highlighted by in-depth interviews with 14 key stakeholders involved in various urban design projects. This section here presents and analyses the key quotes from the interviews (Annex IV).

5.3.1 Challenges to face

The interviews provided some key insights into the challenges faced while implementing the projects. They are listed below.

Conflicting Interests and Lack of Collaboration: A recurring theme was the lack of coordination and communication breakdowns between different government agencies working on NbS projects. Respondent 06 highlighted this issue, stating,

"There was a conflict of interest between the government agencies working on the project. At times, no communication was present, and as a result, no collaboration of works."

This lack of collaboration often led to inefficiencies and missed opportunities for maximizing the impact of NbS interventions.

Financial Constraints and Design Compromises: Budgetary limitations were a significant barrier to implementing optimal design solutions. Respondent 06 further explained,

"Everything that was designed was somehow not implemented... The most important [reason] would be financial constraints."

This suggests that while innovative and effective NbS approaches may be conceived, their realization is often hampered by limited funding.

Land Encroachment and Political Pressure: The issue of land encroachment, particularly in urban areas, emerged as a major obstacle to NbS implementation. Respondent 07 described the challenges of dealing with illegal land grabbers, stating,

"One of the main challenges was to evict illegal land grabbers. The project space was occupied and used by an illegal street market. They had to be evicted before the project started and it was troublesome."

Political pressure and interference further compounded this issue, creating additional barriers to project progress.

Knowledge Gaps and Social Barriers: Interviewees emphasized the need to bridge the knowledge gap between designers, engineers, and the public regarding the benefits of NbS. Respondent 02 also observed a societal preference for engineered solutions over traditional or nature-based approaches, stating,

"People prefer engineering solutions, not the traditional ones. Everyone wants to have a social status."

These factors can create resistance to the adoption of NbS and hinder their integration into urban planning.

Geographical Challenges: Working remotely from project sites presented difficulties in conducting workshops, maintaining communication, and addressing on-ground issues promptly. Respondent 02 noted that,

"One challenge was working from far... It was sometimes difficult to conduct workshops or maintain communications because the site was not close to the capital and also time was a constraint."

Lack of Long-Term Vision and Prioritization: Some respondents expressed concerns about the lack of long-term vision and commitment among leaders, as well as disparities in prioritizing NbS implementation across different regions and administrative bodies. Respondent 10 noted:

"There is a lack of vision among leaders... For example, Dhaka North is doing good work in addressing the climate change effects, while Dhaka South is falling behind day by day, because of the priority settings."

This highlights the need for consistent and coordinated efforts across different administrative bodies to ensure the successful and sustainable implementation of NbS. Respondent 12 stated,

"The political challenge was a huge issue. Everything was connected and strings were pulled which hindered the progress of the work."

Lack of Skilled Professionals: Respondents highlighted the lack of skilled professionals with expertise in this emerging field. This deficiency stems from gaps in educational curriculum, professional practices, and established codes of conduct. Due to these gaps, many professionals lack awareness of the innovative design solutions and approaches associated with NbS. To overcome this barrier the respondents suggested targeted training programs, workshops, and educational initiatives to equip professionals with the knowledge and skills necessary to integrate NbS into their work. Additionally,

revising professional codes and standards to incorporate NbS principles can further encourage their adoption in mainstream practice.

Political Pressure and Instability: Changes in political leadership and the lack of continuity in project support from new officials posed significant challenges to project progress. Respondent 02 highlighted that this resulted in delays and disruptions in project implementation.

"The previous mayor was so closely involved that when the mayor changed it stopped the progress of the project. And since the new mayor was not well informed on the project it hindered the progress."

Top-Down Approach and Boundary Constraints: The dominance of top-down approaches in decision-making and the limited coordination between different administrative bodies with overlapping jurisdictions posed challenges to the integrated and holistic implementation of NbS. Respondent 07 stated in this regard,

"As the capital city, Dhaka is prioritised before anything else. So, most of the projects are in Dhaka."

And Respondent 10 mentioned,

"There will always be a boundary constraint because every town/city/district has their own governing body, and they are responsible for the development works between their borders. So, it is necessary to appoint an authoritative body that will organize and oversee the work of the other organizations."

Benefits are Underestimated: A further concern raised by respondents was the absence of established valuation methods to quantify the effectiveness of NbS. The benefits derived from the implementation of NbS are often not adequately recognized or measured, making it difficult to comprehensively assess the overall impact and effectiveness of these solutions in real-world scenarios.

5.3.2 Notable Opportunities

The interviewees also shed light on some opportunities and provided recommendations. Those are highlighted below.

Community-Centric Approaches: The importance of community engagement in the design and implementation of NbS was underscored by several respondents. This includes consulting with local residents, understanding their needs and preferences, and empowering them to take ownership of the solutions. Respondent 04 advocated for a consultative approach, stating,

"Consult with the local people; what is their needs, what they want to see implemented; and if they want to be included."

This emphasis on community involvement aligns with the principles of participatory design and can lead to more effective and sustainable NbS projects. Emphasizing the inclusion of citizens Respondent 01 stated,

"The most important stakeholders are the citizens. The objectives of the project were all things based on the ideas and needs of the citizens. Getting people together and making them empowered is important. Then they start to make their city greener, and they start to think about the other issues like the surrounding environment, and climate."

Knowledge Sharing and Capacity Building: The need for horizontal knowledge sharing and capacity building among stakeholders was highlighted as a crucial step towards scaling up NbS implementation. Respondent 01 suggested organizing meetups between different regions to facilitate the exchange of knowledge and best practices. Furthermore, Respondent 10 emphasized the importance of contextualizing global plans and standards to local actions, ensuring that NbS solutions are tailored to the specific needs and conditions of each community.

Leveraging Traditional Knowledge: Recognizing and incorporating the existing knowledge and practices of local communities in NbS implementation can enhance the effectiveness and sustainability of these projects. This is mentioned by several respondents. As stated by Respondent 01,

"Bangladesh has a long history of implementing NbS but lacks evidence of effectiveness. Communities within Bangladesh have been working with nature for many years to adapt to climatic impacts and have a rich body of unstructured knowledge on how to implement NbS."

Evidence-Based Policy Making: Building a robust knowledge base and tracking the progress and impacts of NbS projects can provide valuable evidence to inform policymaking and guide future investments. Respondent 10 stressed the need for evidence-guided inclusive policymaking to ensure that NbS projects are designed and implemented in a way that benefits all members of society.

Long-Term Vision and Commitment: The need for long-term vision and commitment from government agencies and leaders was highlighted as crucial for the sustained success of NbS initiatives. Respondent 07 expressed concerns about the lack of long-term planning, stating,

"There are no long-term visions regarding the implementation of Nature-based solutions by the Government agencies. They are only focused on Budget and meeting Deadline."

Addressing this issue requires a shift in focus from short-term gains to long-term sustainability.

Overall, the interviews highlighted the complex interplay of factors influencing the successful implementation of NbS in general and specifically in *Bangladesh*. Addressing these challenges and seizing the opportunities in future projects will require a multi-faceted approach that combines technical expertise with strong community engagement, political will, and a commitment to long-term sustainability.

5.4 KEY LEARNINGS

The case studies reveal several common patterns in the implementation of NbS in urban design projects in *Bangladesh*. These learnings can also be associated with other similar contexts in the global south.

Planners and researchers interviewed in this study generally viewed NbS favourably, though there was notable doubt regarding the precise definition of the concept. This suggests that while the potential benefits of NbS are recognized, there is a need for greater clarity and shared understanding of what constitutes as an NbS approach in the context of urban design and planning (Dorst et al., 2022). This lack of a unified definition led to inconsistencies in project implementation and evaluation, hindering the widespread adoption and effectiveness of NbS. The literature emphasizes the educational value of NbS projects, highlighting their potential to serve as learning platforms and to generate and disseminate knowledge about NbS. This knowledge exchange can inform future projects, improve design and

implementation strategies, and promote wider adoption of NbS approaches (Interreg Europe, 2017; Potschin et al., 2016).

A recurring theme across the case studies is the emphasis on addressing water-related challenges, such as flooding, waterlogging, and water scarcity. Projects like the *Integrated Development of the Hatirjheel area*, *Revitalization of Justice Shahabuddin Ahmed Park*, *Shakuni Lake Development*, and *Rasulbagh Children's Park* have integrated rainwater harvesting, drainage systems, and wetland restoration to mitigate flood risks and enhance water resource management. These mechanisms and their positive impact on flood risk reduction have been described throughout the literature as well (Asare et al., 2023; Gehrels et al., 2016; Raymond, Frantzeskaki, et al., 2017). In addition, the results from the studies by Burek et al., (2012) and Mentens et al., (2006) confirm the importance of NbS for flood management. This highlights the critical role of NbS in addressing the country's vulnerability to water-related disasters and promoting sustainable water management practices in urban areas.

The case studies highlight the inherent multi-functionality of NbS, showcasing their ability to deliver a wide range of benefits beyond their initial objectives. For example, the *Integrated Development of the Hatirjheel area* project successfully addressed flood mitigation while also enhancing transportation connectivity and creating valuable recreational spaces. Similarly, the *Rasulbagh Children's Park* went beyond water management to provide sports facilities, a playground, and a community hall, fostering social cohesion and well-being within the community. This multi-faceted nature of NbS aligns with existing literature, which emphasizes their capacity to address a variety of interconnected social, environmental, and economic challenges simultaneously (Cohen-Shacham et al., 2016; European Commission, 2015).

One of the primary challenges identified across the case studies is the need for a comprehensive and integrated approach to NbS implementation. Many projects have focused on addressing specific issues, such as flood mitigation or urban greening, without fully considering the interconnectedness of various urban systems and the potential for NbS to provide multiple benefits. For instance, the *Integrated Development of the Hatirjheel area* project primarily focused on flood control and transportation improvements, while the potential for enhancing biodiversity and ecological connectivity was not fully explored. This finding aligns with previous research (Fink, 2016; Tzoulas et al., 2007), emphasizing that considering a holistic approach and incorporating measures to improve aspects like biodiversity enrichment can significantly enhance the overall effectiveness and impact of green spaces and NbS interventions.

The case studies underscore the significance of integrating NbS harmoniously with the existing urban fabric and cultural context. The *Social Sciences Square* project at the *University of Dhaka* serves as a prime example, as it seamlessly blends with the surrounding built environment and incorporates elements of local heritage and traditions into its design. This approach not only enhances the aesthetic appeal of the project but also cultivates a stronger sense of place and belonging among users. This observation is consistent with findings in the literature, where studies like the one by Gehrels et al. (2016) have highlighted the potential of NbS to significantly improve the attractiveness of urban spaces, contributing to their overall value and appeal.

Another challenge is the limited engagement of local communities and stakeholders in the planning and implementation processes of NbS projects. Scholarly literature emphasizes the inherently transdisciplinary nature of the NbS concept, highlighting the necessity of engaging diverse stakeholders who possess a wide range of knowledge and perspectives in project development and implementation (Eisenberg & Polcher, 2019; Byrne et al., 2015). The *Co-creation of urban spaces by the Naboganga River* exemplifies a successful community-led initiative that empowered residents to contribute their

knowledge and preferences, resulting in a revitalized public space that caters to the needs of diverse user groups. Similarly, the *Revitalization of Justice Shahabuddin Ahmed Park* and *Rasulbagh Children's Park* involved community consultations to ensure the park's design aligned with local aspirations. While these three projects show the engagement of the local community others lacked robust participatory mechanisms. This can lead to a disconnect between the intended outcomes of NbS projects and the actual needs and aspirations of the local population.

The case studies reveal that economic opportunities and job creation are recurring themes in the implementation of NbS. Four out of the six projects demonstrate the potential, and in some instances, provide concrete examples, of how NbS can create employment opportunities and contribute to the local economy. This observation aligns with existing literature, which emphasizes the economic benefits of NbS projects. Raymond et al., (2017) highlight the job creation potential of NbS, while Maes and Jacobs (2017) point to the generation of additional green jobs as a significant advantage. This suggests that beyond their environmental and social benefits, NbS projects in *Bangladesh* hold promise for stimulating local economic development and improving livelihoods.

The findings from the case studies showed the absence of long-term vision and commitment among political leaders as a significant barrier to the widespread adoption and implementation of NbS in *Bangladesh*. These findings align with the literature's assertion regarding the lack of political will for sustainable choices, particularly in the context of NbS (Maes & Jacobs, 2017). This lack of political interest can manifest in various ways, such as inadequate funding allocation for NbS projects, and inconsistent policy support. Without sustained political support and adequate funding, these projects may struggle to achieve their full potential and could deteriorate over time.

Another key observation is the "green space paradox", where improving green spaces in lower-income neighbourhoods can inadvertently lead to increased housing costs, displacing the existing residents. This phenomenon, observed in the *Integrated Development of the Hatirjheel area* and the *Shakuni Lake Development Project*, is also supported by existing literature, such as the work of Wolch et al., (2014). Addressing this paradox necessitates a range of multifaceted strategies to ensure that the benefits of improved green spaces do not result in the unintended consequence of displacing lower-income residents. Strategies to mitigate this issue may include inclusive urban planning, mixed-income housing development, collaboration with nonprofits and community organizations, equitable development initiatives etc.

Furthermore, the case studies reveal the importance of considering the long-term maintenance and sustainability of NbS interventions. Many projects face challenges in securing adequate funding and resources for ongoing maintenance, which can lead to the degradation of the implemented solutions over time (Byrne et al., 2015). For example, *Rasulbagh Children's Park*, while successfully addressing waterlogging and providing community amenities, may face challenges in maintaining its rainwater harvesting and filtration systems without sustained community involvement and financial support. This highlights the importance of developing robust maintenance plans, involving local communities in stewardship roles, and exploring innovative financing mechanisms to ensure the long-term viability and effectiveness of NbS projects.

The implementation of NbS in urban environments is often hindered by the disconnect between short-term political goals and long-term sustainability objectives. This misalignment, frequently exacerbated by short municipal election cycles, leads to a prioritization of immediate actions over long-term planning. This is evidenced in the *Co-creation of Urban Spaces by the Naboganga river* project and supported by existing literature (Kabisch et al., 2016; Maes & Jacobs, 2017). Additionally, poor governance and corruption frequently undermine the effectiveness of NbS interventions.

Also, the absence of established valuation methods to quantify the effectiveness of NbS exacerbates this issue. The difficulty in measuring and demonstrating the cost-effectiveness of NbS interventions compared to traditional engineered solutions, as well as their resilience to climate change impacts (Seddon et al., 2020), makes it challenging for policymakers to justify allocating funding for the implementation and maintenance of these projects. This lack of quantifiable evidence can lead to a preference for conventional approaches that may offer more immediate and tangible results, even if they are less sustainable in the long run.

Despite these challenges, the case studies also highlight significant opportunities for integrating NbS into urban design practices in Bangladesh. For example, the *Co-creation of urban spaces by the Naboganga river* project demonstrates the transformative potential of community-led initiatives in revitalizing neglected urban areas and fostering a sense of ownership among residents and the *Revitalization of Justice Shahabuddin Ahmed Park* showcases the importance of preserving existing green spaces and incorporating biodiversity considerations into urban design.

5.5 SUCCESS FACTORS

The success of the analysed projects can be attributed to several key factors:

- 1. Available Funding:** The availability of funding played a crucial role in supporting the implementation of these projects, ensuring that financial resources were allocated to cover the costs of design, construction, and maintenance.
- 2. Multiple Sectors/Partners Collaboration:** Collaboration between various sectors, including government agencies, NGOs, community organizations, and private entities, was instrumental in pooling resources, expertise, and support for the successful execution of the projects.
- 3. Decentralized Decision-Making:** Empowering local communities and stakeholders through decentralized decision-making processes fostered a sense of ownership and ensured that the projects aligned with the specific needs and aspirations of the people they were intended to benefit.
- 4. Increased Citizen Engagement:** The active participation of citizens in the planning, design, and implementation phases of the projects was a key factor in their success. This engagement ensured that the projects were responsive to community needs and fostered a sense of ownership and pride among residents.
- 5. Existing Clear Monitoring System:** The presence of a clear and effective monitoring system helped track the progress of the projects, identify potential issues early on, and ensure that the intended outcomes were achieved. This also facilitated adaptive management and continuous improvement of the projects over time.

These success factors highlight the importance of a holistic and participatory approach to implementing NbS in urban environments. By combining financial resources, multi-sectoral collaboration, community engagement, and effective monitoring, these projects have demonstrated the potential of NbS to address complex urban challenges and create more sustainable, resilient, and liveable cities.



Largest Eid prayer gathering in Kishoreganj
Photo from WESTEND61

6

CONCLUSION

6.1 GENERAL CONCLUSION

Nature-based Solutions (NbS) represent comprehensive, systemic approaches designed to address multifaceted socio-ecological challenges. These solutions are inspired by and supported by natural processes, delivering a wide array of social, cultural, ecological, and economic benefits. Due to their characteristics, NbS hold significant potential for enhancing urban resilience and sustainability. However, the innovative nature of NbS, the limited evidence base of their impacts, and various existing barriers often lead to their neglect as viable options, resulting in numerous uncertainties and obstacles.

To address this problem, this research analyzed six urban NbS projects located in Bangladesh and documented the challenges encountered during their implementation. This study employed a qualitative case study methodology, utilizing interviews as the primary data collection method. The collected data underwent both inductive and deductive qualitative content analysis to derive meaningful insights and patterns. Building upon the findings of this study, the following concluding remarks are presented.

The six studied projects in Bangladesh implemented diverse NbS, including urban gardens, sustainable urban drainage systems (SUDS), wetland retention, water management, and green space creation. These projects were perceived as capable of generating multiple positive environmental, economic, and social impacts, although the actual magnitude of these impacts was not quantitatively assessed. Qualitative analysis of participant feedback consistently revealed a strong emphasis on the positive outcomes associated with these NbS projects. In addition to their primary objectives, the projects were anticipated to provide co-benefits addressing various other urban challenges.

The urban challenges for which the projects were believed to provide the largest positive impacts included climate resilience and disaster risk reduction, followed by public health and well-being, social justice, participatory approaches, water management, green space management, urban regeneration, and economic opportunities. Benefits for air quality and biodiversity were also identified. However, certain potential negative impacts of the projects were reported, primarily concerning the potential lack of long-term maintenance of the projects.

The six case studies provided empirical evidence supporting the multifunctional nature and predominantly positive impacts of NbS in addressing urban challenges and SDGs. The diverse nature of the projects—ranging from large-scale urban development to community-led park revitalizations—demonstrated the adaptability and wide-ranging applicability of NbS. These projects showed that NbS

could effectively tackle pressing urban issues such as disaster risk reduction, climate adaptation, flood mitigation, creation of recreational opportunities and social well-being. For instance, the *Integrated Development of the Hatirjheel area* and the *Revitalization of Justice Shahabuddin Ahmed Park* projects showcased significant environmental and social benefits, contributing to disaster risk reduction and enhancing community well-being.

This study found that water management was the most explored objective for NbS development. Projects like the *Integrated Development of the Hatirjheel area* and the *Rasulbagh Children's Park* showcased successful flood mitigation and the creation of vibrant community spaces. The *Co-Creation of Urban Spaces by the Naboganga River* project exemplified the restoration of ecological connectivity and the revitalization of neglected urban areas. The socio-cultural impacts of the projects were also noteworthy, with all case studies reporting positive outcomes related to social justice, cohesion, and community engagement. Partnerships among various stakeholders were found to significantly enhance NbS uptake, with the *Co-creation of urban spaces by the Naboganga River* and the *Rasulbagh Children's Park* serving as exemplary cases and addressing this barrier could help mitigate others. A potentially effective solution for overcoming this barrier is the development of information systems that facilitate access to NbS knowledge.

Despite the positive impacts, the study identified several challenges and barriers to the successful implementation of NbS. The analysis of barriers revealed that a lack of knowledge is a critical impediment to the uptake of NbS. Also, understanding of NbS among stakeholders and technical expertise among professionals hindered widespread adoption and implementation. The risk of encroachment was also an important challenge found in the study. Additionally, the long-term maintenance of NbS projects emerged as a critical concern, with many projects struggling to secure adequate funding and resources for ongoing upkeep. This issue was particularly evident in the *Rasulbagh Children's Park*, where sustaining rainwater harvesting, and filtration systems posed significant challenges without continuous community involvement and financial support.

In conclusion, the case study analysis of urban NbS projects in Bangladesh highlights the transformative potential of these solutions in addressing multifaceted urban challenges. Despite existing barriers, the predominantly positive impacts and the success factors identified provide a strong foundation for promoting NbS as a viable strategy for enhancing urban sustainability and resilience. The insights gained from this research are essential for empowering stakeholders involved in NbS projects to achieve desired outcomes while mitigating or avoiding negative consequences, ultimately contributing to the creation of more sustainable and resilient urban environments.

6.2 IMPLICATIONS AND RECOMMENDATIONS FOR POLICY AND PRACTICE

The case studies presented highlight several opportunities for the integration of nature-based solutions (NbS) into urban design practices in Bangladesh. To effectively integrate NbS into urban design practices in Bangladesh, and also in other countries, several proposals can be considered:

- 1. Developing a national NbS framework:** A comprehensive national framework for NbS implementation is essential. Such a framework would provide guidance and support to urban planners, policymakers, and practitioners by outlining clear objectives, strategies, and guidelines for incorporating NbS into various urban sectors. Engaging local communities and indigenous peoples is also crucial, as their traditional knowledge and experience can significantly contribute to the design, implementation, and monitoring of effective NbS projects. Furthermore, establishing an NbS certification process, akin to

LEED or BREEAM, specifically tailored for NbS projects, could ensure the correct application of NbS concepts. This certification would verify that all necessary aspects are considered, thereby promoting best practices and standardizing NbS implementation across different urban contexts.

2. Developing a national platform for NbS with concerned stakeholders: A national platform dedicated to NbS can serve as a centralized hub for sharing knowledge and information among diverse stakeholders, including policymakers, local communities, experts, and other relevant parties. This platform can facilitate discussions on the challenges and strategies associated with effective NbS implementation. Moreover, the implementation of the NbS certification system could enhance transparency by publishing the results of each project on a public platform. Additionally, a web portal could be established to collect and disseminate data and information on NbS interventions in Bangladesh, bridging the knowledge gap between policymakers, practitioners, and local communities, and ultimately promoting their wider adoption and integration into urban planning and development strategies.

3. Reinforcing inter-departmental and inter-ministerial coordination: Enhanced collaboration and coordination between ministries and departments are necessary to ensure a sustainable future. Since NbS encompasses a wide range of sectors—such as water, disaster management, land use, soil, and infrastructure—it is vital to establish strong inter-sectoral coordination at all governance levels, from local to national, to effectively implement these solutions.

4. Strengthening professional capacity: Enhancing the capacity of local authorities, institutions, and professionals is vital for the effective implementation of NbS. This can be accomplished through targeted training programs, workshops, and knowledge-sharing platforms that emphasize NbS design principles, implementation strategies, and monitoring and evaluation techniques. Moreover, integrating NbS principles and practices into urban planning curricula can raise awareness and prepare the next generation of professionals with the requisite knowledge and skills to design and execute sustainable urban solutions.

5. Expanding research and innovation: Further research and innovation are needed to develop and implement NbS effectively. This includes exploring the potential of emerging technologies to monitor and evaluate the effectiveness of NbS interventions. Additionally, research should focus on identifying locally suitable plant species, developing climate-resilient infrastructure designs, and optimizing natural resource use for sustainable urban development.

6. Securing sustainable financing: To ensure the long-term viability and maintenance of NbS, robust and sustainable funding mechanisms must be established. This can be achieved by fostering public-private partnerships, implementing environmentally conscious tax policies, reducing fees associated with NbS interventions, and utilizing incentive or compensation schemes to encourage investment. Leveraging international funding opportunities, such as those available through global climate change negotiations, can provide additional financial support for NbS initiatives, particularly in regions vulnerable to climate change impacts.

7. Promoting community engagement: Active participation of local communities and stakeholders is essential for ensuring the relevance, effectiveness, and sustainability of NbS projects. This can be facilitated through participatory planning processes, community consultations, and co-design workshops that empower residents to contribute their knowledge, ideas, and preferences.

8. Replicating successful models: The successful implementation of community-led initiatives can serve as a model for other urban renewal projects. This approach can empower local communities, foster a

sense of ownership, and ensure that NbS projects are tailored to the specific needs and aspirations of the local population.

The findings of this study underscore the importance of a holistic and participatory approach to implementing NbS in urban environments. By integrating financial resources, multi-sectoral collaboration, community engagement, and effective monitoring, future NbS projects can pave the way to address complex urban challenges and create more sustainable, resilient, and livable cities. NbS are tailored to specific contexts, yet many lessons learned in Bangladesh have broader applicability. Policymakers, urban planners, and practitioners can draw on these insights to foster greater support for NbS and facilitate their widespread adoption. The successful integration of NbS into urban design practices can not only mitigate the adverse impacts of climate change and urbanization but also enhance the well-being of urban residents and promote a harmonious relationship between citizens and nature.

6.3 FUTURE RESEARCH

This study represents a significant step forward in understanding the implementation aspects of Nature-based Solutions (NbS), particularly in climate-vulnerable areas such as Bangladesh, while also offering insights applicable to other countries. It establishes a solid foundation for further research on these critical issues by highlighting existing challenges and potential opportunities, exploring their relationship to implementation levels, and providing valuable insights for ongoing exploration.

Despite limitations such as the lack of monitoring data from project stakeholders and constraints on independent assessment due to resource and expertise availability, this study effectively captures the informed opinions, expectations, and experiences of experts involved in Bangladeshi projects. These expert insights offer a valuable perspective on the potential impacts of NbS in similar urban contexts.

Although not all project sites were visited, this limitation had minimal influence on the study findings, as the primary data collection method relied on expert interviews. The time invested in coordinating these interviews yielded invaluable insights that greatly enriched the study. Future research can build on this work by incorporating quantitative and qualitative analyses of actual project impacts, including final reports, relevant documents, and comprehensive site observations.

While the qualitative nature of this study and the small sample size limits the generalizability of the findings, they provide a crucial starting point for further investigation. Future studies employing quantitative methods and larger sample sizes across different countries are necessary to validate and generalize these results, thereby enhancing the robustness of NbS research.

Moreover, recognizing that the representation of interview data is inherently subjective and influenced by the researcher's perspective invites other researchers to contribute their findings. This openness to diverse perspectives will enrich the overall understanding of NbS implementation in urban areas, ultimately leading to more effective and widely adopted solutions.



People fishing in group in Rajshahi
Photo from WESTEND61

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Annexes

ANNEX I: Information about legislation, policies, and strategies at the national level supporting the implementation of NbS in Bangladesh

*Table 5: Legislations at the national level that contribute to NbS implementation in Bangladesh.
(Fernandes et al., 2022)*

Legislation	Description
The Forest Act, 1927	The Act introduces social forestry practices and facilitates the formation of village forests. It aims to promote community participation through afforestation and other plantation activities. Ecosystem-based adaptation, mitigation, and forest restoration programs are also encompassed by this Act.
Bangladesh Environment Conservation Act, 1995	The Environment Conservation Act of 1995, amended in 2010, is the principal environmental law in Bangladesh. It encompasses the protection of wetlands and ecologically critical areas, alongside broader environmental conservation efforts. The Act also prohibits deforestation in hilly regions to reduce GHG emissions and promotes the implementation of ecosystem-based strategies.
Playgrounds, Open Spaces, Parks, and Natural Reservoirs in all Municipal Areas of the Country, including Municipalities in Metropolitan, Divisional Cities and Districts Act, 2000	The Act ensures the protection of urban green spaces, including parks, playgrounds, open green spaces, gardens, and natural water reservoirs such as lakes and wetlands. It aims to promote and conserve green areas in cities, towns, and other municipal regions. The law also encourages the implementation of NbS within infrastructure-related approaches. Under this Act, any actions that interfere with the ecological balance of green spaces without proper approval are strictly prohibited.
The Wildlife (Conservation and Security) Act, 2012	The Wildlife (Conservation and Security) Act, 2012, formerly the Bangladesh Wildlife (Preservation) Order, 1973, focuses on safeguarding the nation's wildlife, forests, and biodiversity. This act empowers the government to designate areas as national parks, sanctuaries, or eco-parks, aligning with established conservation strategies like protected area management, which fall under the umbrella of NbS. Moreover, the government can declare specific wetlands, rivers, or other bodies of water as special zones for biodiversity conservation.
National River Conservation Commission Act, 2013	Establishes a commission responsible for monitoring river health and advising the government on measures to tackle pollution, encroachment, and ensure the ecological balance and sustainable management of river systems.
Bangladesh Water Act, 2013	Grants citizens the right to access water for essential needs like drinking and sanitation, while also promoting water conservation. The Act establishes water management bodies, namely the National Water Resources Council and the Water Executive Committee, with the overarching goal of promoting integrated water resource management, facilitating the implementation of the National Water Policy, and ensuring adequate water supply.

Legislation	Description
Ecologically Critical Area Management Rules, 2016	Developed under the Bangladesh Environment Protection Act, 1995, the Ecologically Critical Area Management Rules, 2016, establish committees at national, district, upazila, and village levels to oversee ecologically sensitive areas. These rules outline prohibited activities within these areas, including restrictions on land use changes, to protect their ecological integrity.
Bangladesh Biodiversity Act, 2017	The Act promotes environmental protection and the conservation of biodiversity, forests, wildlife, and wetlands. It commits to the sustainable management and protection of the country's natural resources, aligning with the objectives of the Convention on Biological Diversity, which includes the sustainable use of resources, biodiversity conservation, and fair distribution of benefits derived from the land.
Protected Area Management Rules, 2017	These rules are particularly important for the successful implementation of coastal afforestation projects and community engagement initiatives that benefit all. They also introduce the country's first co-management model, emphasizing the role of local communities in managing protected areas.

Table 6: Policies and strategies at the national level that contribute to NbS implementation in Bangladesh. (Fernandes et al., 2022)

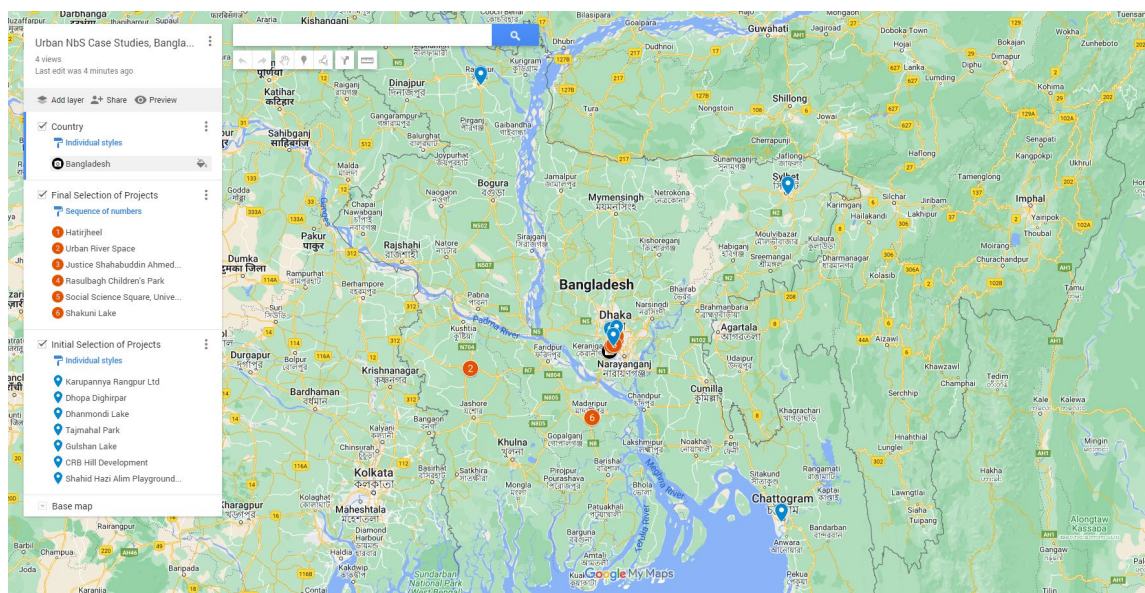
Policies / Strategies	Description
Environment Policy, 1992	In response to the 1992 Earth Summit in Rio de Janeiro, the Bangladesh government formulated its inaugural Environment Policy. This policy emphasizes the vital role of sustainably managing natural resources to achieve both social and environmental well-being. It also explicitly acknowledges environmental threats and seeks to lessen the negative impacts of climate change by advocating for national development grounded in sustainability principles.
National Water Policy, 1999	The Ministry of Water Resources introduced the National Water Policy in 1999 to ensure comprehensive, integrated, and fair management of the country's water resources. This policy encompasses measures for various aspects of water management, including resource planning, supply and sanitation, agriculture, fisheries, wildlife, and environmental preservation. Notably, it emphasizes ecosystem-based management approaches, particularly for the conservation of haors, baors, and beels, as well as river basins. The policy also promotes private sector involvement in developing groundwater for irrigation and prioritizes the enhancement of surface water resources.
Coastal Zone Policy, 2005	The Coastal Zone Policy prioritizes the development of coastal areas to provide both economic opportunities and environmental sustainability for local communities. It promotes a holistic approach to coastal management, aiming to reduce disaster risks, sustainably manage resources, create livelihoods, ensure gender equity, and protect vital ecosystems.
Bangladesh Climate Change Strategy and Action Plan (BCCSAP), 2009	This action plan outlines programs structured around food security, disaster management, infrastructure, mitigation, and low-carbon development. This comprehensive policy document aims to create a climate-resilient nation by bolstering institutions responsible for environmental management. It proposes a series of actions to address climate change challenges faced by communities at all levels, offering opportunities to incorporate NbS to tackle these issues.
National Agriculture Policy, 2013	The revised National Agriculture Policy, formulated by the Ministry of Agriculture, builds upon the 1999 policy. It prioritizes increasing crop production and productivity through measures like intensifying cultivation and utilizing fallow land. The policy also aims to guarantee food and nutrition security for all citizens by diversifying crops. Additionally, it promotes the development of a sustainable agricultural system to support the long-term livelihoods of farmers in the sector.
National Strategy for Water Supply & Sanitation, 2014	This strategy aims to ensure safe and sustainable access to water, sanitation, and hygiene for improved health and well-being, based on the principle of equitable sharing. It seeks to manage solid waste efficiently, reduce the impacts of disasters and climate change, and advance sanitation practices. Additionally, it includes provisions for adopting and integrating water resource management practices, thus offering opportunities for implementing NbS.

Policies / Strategies	Description
Nationally Determined Contributions (NDC), 2021	The Nationally Determined Contribution (NDC) outlines several mitigation strategies aimed at reducing greenhouse gas emissions in Bangladesh's power, transport, and industrial sectors. It consists of elements related to mitigation efforts, adaptation measures, and implementation strategies. Some of the mitigation actions, such as composting organic waste, generating thermal energy from waste biomass, installing solar panels, and providing off-grid solar power, align with the outcomes of NbS interventions.
National Forest Policy, 2016	This policy advocates for the sustainable management of forests and wildlife, including the restoration of degraded lands and forest cover, to guarantee a consistent flow of ecosystem services and resources to the people of Bangladesh. It places emphasis on enhancing ecosystem services and incorporates payment for these services in forest planning and management. The policy also holds potential for integrating NbS into its broader actions, by promoting climate-resilient development.
National Biodiversity Strategy and Action Plan (NBSAP) of Bangladesh (2016–2021)	The plan pinpoints key focus areas such as conserving and restoring ecosystems, reviving endangered species, and connecting biodiversity conservation efforts with mitigating the impacts of climate change. Its objectives encompass creating strategies for the sustainable utilization of Bangladesh's biological diversity and building capacity to implement NbS at various community levels. This action plan emphasizes several conservation elements, aligning with the goals of the Convention on Biological Diversity, ultimately aiding the nation in achieving its targets.
Bangladesh 8th Five Year Plan (2020–2025)	During the COVID-19 pandemic, Bangladesh launched its 8th Five-Year Plan, prioritizing six key areas to reduce poverty, foster low-carbon development, achieve Sustainable Development Goals, and build a climate-resilient economy. The plan reaffirms the country's commitment to the Rio Convention, Paris Agreement, and Sendai Framework while emphasizing the need to conserve biodiversity and increase forest cover. In line with the environmental goals outlined in the Perspective Plan 2021-2041, the plan stresses the importance of implementing NbS in cities to improve living conditions, drainage, waste management, and air quality for urban residents.
The Bangladesh Delta Plan (BDP), 2100	The Bangladesh Delta Plan (BDP) is a comprehensive plan for achieving environmental sustainability in the country. It centers on the responsible use of water resources and safeguarding against water-related disasters like cyclones and droughts. The BDP aims to provide lasting flood protection, ensure water and food security, enhance climate resilience, and promote overall economic growth, aligning with the principles of NbS. The plan includes a framework for managing integrated river and estuary systems, restoring wetlands, and conserving coastal ecosystems. It also addresses the challenges faced by urban areas, outlining strategies to combat industrial water pollution and improve urban services like water supply, sanitation, and waste management.

ANNEX II: Interactive map showing the locations of the selected case studies

To use the interactive map tool

1. Click the following link
https://www.google.com/maps/d/u/0/edit?mid=1O3T7s8zr7S939xfVLXgR_1Ak3ED_16w&usp=sharing
2. Select layers to see each of the projects
 - Final selection of case studies
 - Initial selection of case studies
3. To see additional photos associated with the projects click on 'view in Google Maps'



Location markers showing the location for each project

ANNEX III: Information about the Interview Participants

Reference	Project	Organization	Roles and responsibilities in the project	Field(s) of expertise
Respondent #1	_Urban Spaces by Naboganga River _Integrated Development of Hatirjheel Area	Co.Creation Architects	• Project Lead • Involvement of and communication with citizens and stakeholders • Knowledge distribution	• Landscape Architecture • Project management
Respondent #2	_Urban Spaces by Naboganga River	POCAA	• Involvement of and communication with citizens and stakeholders • Knowledge distribution • Assessment of social impact	• Architecture • Project management
Respondent #3	_Integrated Development of Hatirjheel Area _Revitalization of Justice Sahabuddin Ahmed Park	Vitti Sthapati Brindo	• Project Lead • Technical design of the project • Architectural and urban design issues • Knowledge distribution	• Education • Architecture • Project management
Respondent #4	_Urban Spaces by Naboganga River	Co.Creation Architects	• Assessment of Environmental impacts • Knowledge distribution	• Architecture • Project management
Respondent #5	_Renovation of Dhopadighi, Sylhet	SDA	• Technical design of the project • Knowledge distribution • Involvement in architecture students in NbS design	• Education • Architecture • Project management
Respondent #6	_Integrated Development of Hatirjheel Area	LGED	• Technical design of the project • Involvement of and communication with citizens and stakeholders	• Project management
Respondent #7	_Rasulbagh Children's Park	Shatotto	• Technical design of the project • Involvement of and communication with citizens and stakeholders	• Education • Architecture • Project management
Respondent #8	_Revitalization of Justice Sahabuddin Ahmed Park _Shakuni Lake Development	Vitti Sthapati Brindo	• Technical design of the project • Involvement of and communication with citizens and stakeholders	• Architecture • Project management
Respondent #9	–	LGED	• Project Lead • Involvement of and communication with citizens and stakeholders • Link to other projects in the same district	• Urban Planner

Reference	Project	Organization	Roles and responsibilities in the project	Field(s) of expertise
Respondent #10	–	ICCCCAD	• Research and development activities • Assessment of Environmental impacts • Knowledge dissemination	• Independent consultant and researcher on Environment and Climate change
Respondent #11	_Rasulbagh Children's Park	Shatotto	• Project Lead • Technical design of the project • Involvement of and communication with citizens and stakeholders	• Architecture • Education • Project management
Respondent #12	_Revitalization of Justice Sahabuddin Ahmed Park	Vitti Sthapati Brindo	• Project Lead • Core concept development and supervision	• Architecture • Project management
Respondent #13	_Social Sciences Square	Sthanik Consultants	• Project Lead • Technical design of the project • Knowledge distribution	• Architecture • Project management
Respondent #14	–	ICCCCAD	• Research and development activities • Technical expert for NbS • Knowledge distribution	• Independent Researcher

ANNEX IV: Key quotes from the interviews

Horizontal Sharing

(Respondent 01) *'The exchange of knowledge between regions can be a good idea. Try to arrange meet-ups between them and let them listen and learn from each other.'*

One Challenge was working from far

(Respondent 02) *'It was sometimes difficult to conduct workshops or maintain communications because the site was not close to the capital and also time was a constraint.'*

International Workshop hosted by Community Architects Network

(Respondent 02) *'50/60 participants intensely worked with various levels of stakeholders (Elderly, Disabled, Women, Cyclist club, etc.). This helped to address issues through mapping and informed decisions.'*

Political Instability

(Respondent 02) *'The previous mayor was so closely involved that when the mayor changed it stopped the progress of the project. And since the new mayor was not well informed on the project it hindered the progress.'*

Conflict of Interest between the working agencies

(Respondent 06) *'There was a conflict of interest between the government agencies working on the project. No communication was present, and as a result no collaboration of works.'*

Everything that was designed was somehow not implemented

(Respondent 06) *'Some of the design ideas that would be good for the project were not implemented in the project. There were several reasons behind this. The most important would be financial constraints.'*

To be informal is a conscious decision; Let People be the solution

(Respondent 04) *'Consult with the local people; what is their needs, what they want to see implemented; and if they want to be included.'*

Social acceptance of the design solutions

(Respondent 02) *'People prefer engineering solutions, not the traditional ones. Everyone wants to have a social status.'*

Knowledge gap

(Respondent 06) *'There is an age gap and difference in thinking between designers and engineers. It hinders the smooth workflow of projects.'*

Defining the NbS based on the local context is a must

(Respondent 10) *'It is important to define which solutions are we considering as NbS and why. The type of NbS should be space/area/locality dependent.'*

Contextualisation

(Respondent 10) *'There is a burning need to translate global plans and standards into local actions.'*

Knowledgebase

(Respondent 10) *'We need to track and measure our progress, and this will ensure evidence-guided inclusive policymaking.'*

Lack of vision among leaders

(Respondent 10) *'For example, Dhaka North is doing good work in addressing the climate change effects, while Dhaka South is falling behind day by day, because of the priority settings. And there is a difference in commitment between leaders.'*

Land encroachment

(Respondent 07) *'One of the main challenges was to evict illegal land grabbers. The project space was occupied and used by an illegal street market. They had to be evicted before the project started and it was troublesome. Also, as being the lowest land in the area, it was supposed to retain water naturally, but due to encroachment, it was not serving the purpose.'*

Political Pressure

(Respondent 07) *'The political challenge was a huge issue. Everything was connected and strings were pulled which hindered the progress of the work.'*

Top Down Approach

(Respondent 07) *'As the capital city, Dhaka is prioritised before anything else. So, most of the projects are in Dhaka.'*

Boundary Constraint

(Respondent 10) *'There will always be a boundary constraint because every town/city/district has their own governing body, and they are responsible for the development works between their borders. So, it is necessary to appoint an authoritative body that will organize and oversee the work of the other organizations.'*

NbS Beliefs

(Respondent 01) *'Bangladesh has a long history of implementing NbS but lacks evidence of effectiveness. Communities within Bangladesh have been working with nature for many years to adapt to climatic impacts and have a rich body of unstructured knowledge on how to implement NbS.'*

Participatory Design Process

(Respondent 01) *'The most important stakeholders are the citizens. The objectives of the project were all things based on the ideas and needs of the citizens. Getting people together and making them empowered is important. Then they start to make their city greener, and they start to think about the other issues like the surrounding environment, and climate.'*

No Vision'

(Respondent 07) *'There are no long-term visions regarding the implementation of Nature-based solutions by Government agencies. They are only focused on Budget and meeting Deadline.'*