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Implementation of Nature-Based Solutions (NBS) into Conservation Practices of Urban Built Heritages in Bangladesh: Challenges, Possibilities, and Prospects

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Abstract:
The preservation of rich cultural and architectural heritages in Bangladesh, alongside its diverse natural environment, is increasingly prioritized through conservation efforts. Integration of Nature-based Solutions (NbS) into these practices, leveraging existing green elements and natural landscapes for cost-effective conservation processes. This research explores the potential of Nature-based Solutions (NbS) within the heritage structures of Bangladesh, identifying feasible areas for implementation and examining the benefits beyond regular conservation process. Nature-based Solutions (NbS) not only aids in preserving heritage but also enhances sustainability in water management, promotes health, sequesters carbon, boosts biodiversity, and improves acoustic comfort. By harnessing nature's resilience, these solutions offer sustainable responses to challenges posed by climate change, urbanization, and industrialization, which also threaten heritage sites. Integrating Nature-based Solutions (NbS) requires effective implementation strategies, policy support, and community engagement to ensure success. In this research, specific study- based method was followed and implemented in some heritage sites to generate suggestive conclusions in case of implementation of Nature-based Solutions (NbS).
This study aims to analyze the feasibility and suggest practical approaches for implementing Nature-based solutions (NbS) in the conservation of cultural heritages of Bangladesh, emphasizing resilience, socio-economic benefits, and the preservation of natural and built environments.

Keywords: Nature-based Solutions (NbS), green elements, cultural and architectural heritage, community engagement, sustainable responses.

1. Introduction

The nature-based solutions (NbS) concept has emerged following recognition of the positive (and negative) linkages between people and nature within the nature conservation and development sectors. (Emmanuelle Cohen-Shacham) In cities, the focus is on incorporating natural elements in new development designs- increasingly through planning policy—under the umbrella of green infrastructure

(GI) to maximize social, environmental, and economic benefits. (Tzoulas, 2007) More broadly, other forms of (NbS) can help address major societal challenges including climate change, disaster risks, and economic and social development and inequality. (Emmanuelle Cohen-Shacham) In the heritage sector, the leading international authority on cultural heritage (the United Nations Educational, Scientific and Cultural Organization, UNESCO) also recognizes that the NbS concept offers opportunities for more sustainable solutions to heritage conservation, although discussion has so far largely focused on water management and the mitigation of natural disasters such as floods. (United Nations World Water Development Report 2018: Nature-based Solutions for Water., 2018)

Rapid urbanization is becoming a thread for the heritage sites because most of these sites are in danger of destruction to face the rapidity. Bangladesh is also facing these issues which can find in the management of old structures of Old Dhaka. Bangladesh, a nation with a rich historical and cultural heritage, has a pressing need to preserve its urban built heritage. The preservation of these heritages faces numerous difficulties as urbanization keeps growing quickly. The incorporation of nature-based solutions (NbS) into conservation strategies, though, offers a promising way to deal with these issues while also offering chances and prospects for long-term heritage preservation. This introduction gives a general overview of the use of nature-based solutions for urban built heritage conservation in Bangladesh while highlighting the difficulties, possibilities, and future implications of this strategy.

1.1 Scopes and aims

The term "Nature-based Solutions" refers to a variety of tactics that make use of natural components and processes to address societal problems while offering numerous advantages to both people and the environment. It is possible to achieve a harmonious balance between heritage preservation and sustainable urban development by incorporating Nature-based Solutions principles and techniques into the conservation of urban built heritages.

The aim of this research paper is to examine the difficulties, possibilities, and future implications of incorporating Nature-based Solutions into the urban built heritages of Bangladesh conservation practices. This study aims to offer a comprehensive understanding of the potential advantages, restrictions, and implementation strategies of Nature-based Solutions in the context of Bangladesh through a thorough analysis of the existing literature, case studies, and expert insights.

1.2 Potential opportunities for assimilation

- The study will focus into the difficulties that built heritages of Bangladesh is confronted with in terms of conservation, including encroachment, lack of knowledge, inadequate funding, and the consequences of climate change.
- It will investigate how improving resilience, encouraging sustainable urban development, and encouraging community involvement might help in resolving these issues.
- To explain the significance of including Nature-based Solutions in built heritage conservation practices in Bangladesh.
- It aims to contribute to the body of knowledge and offer insightful information for policymakers, heritage conservation practitioners, urban planners, and other stakeholders involved in the sustainable preservation of urban heritages of Bangladesh by addressing the challenges, exploring the opportunities, and highlighting the prospects.

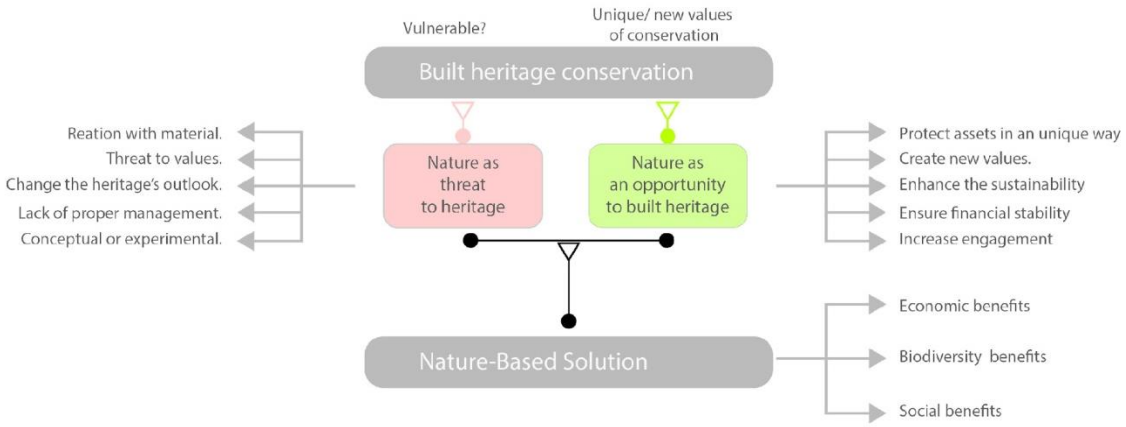


Figure 1: ***Showing the issues with nature when it is used in heritage conservation: both as threat and opportunity. Regenerated by (Rahman, Orthy, Dey, Ar. Iftekhar-2023) Reference: Coombes and Viles, 2021*** **(Viles, 2021)**

2. Nature as a threat in urban built heritage structures

Nature can also pose a significant threat to the heritage structures. Even while everyone frequently awe at the beauty of the forces of nature, such as wind, water, and vegetation, these factors may gradually deteriorate and damage the fundamental foundations of old structures and monuments. For example:

2.1 Rain as a threat

Porous building materials can be penetrated by rain, humidity, and groundwater leakage, which can result in decay, mold growth, and structural instability. Buildings' structural integrity can be weakened by water intrusion, which over time can result in cracks, erosion, and even collapse. Water can also corrode metal reinforcements and degrade the mortar holding stones or bricks together.

2.2 Vegetation as a harmful element for old structures.

Even though it is vital for the environment, vegetation can endanger historic urban structures. Closely spaced trees and plants can put pressure on foundations and walls of old buildings, causing cracks and structural harm. Tree roots can pierce the foundation, causing it to lose stability and the structure to shift or settle. By retaining moisture against the building surfaces or encouraging the growth of destructive organisms, invasive plant species might accelerate the decay process.

2.3 Wind and its' impact on heritage structures

Another natural force that can endanger historic structures in areas is the wind. Strong winds can put tremendous pressure on building facades, roofs, and windows, particularly during storms or hurricanes. This can eventually result in the detachment of decorative components, the weakening of structural components, and even possible collapse. The previous problems with water can be made worse by wind-driven rain.

2.4 Impact of temperature fluctuation.

Extreme temperature fluctuations, which are frequently made worse by climate change, can also have an effect on urban heritage buildings. Materials like stone, brick, and concrete can become damaged and develop cracks as a result of frequent freeze-thaw cycles. Different building components' thermal expansion and contraction can cause stress and structural damage and instability.

3. Nature-based solutions (NbS) in conservation of heritage structures

3.1 Green Infrastructures:

Utilizing green infrastructure, such as urban parks, green roofs, and vertical gardens, may reduce the effects of temperature and water changes on historic buildings. For instance, green roofs absorb rain and minimize water runoff while also providing insulation to reduce thermal stress on buildings.

3.2 Vegetation management:

Strategic vegetation management can reduce the growth of invasive plant species that could harm historic structures. A well-planned landscape can provide wind breaks, shade, and moisture control, minimizing the effects of natural forces on the buildings.

3.3 Natural drainage systems:

By implementing natural drainage systems like bio swales, rain gardens, and permeable pavements, storm water runoff can be effectively managed and water intrusion into historic structures can be avoided. Rainwater can be redirected and absorbed by these systems, which relieves pressure on building foundations.

3.4 Erosion control:

Soil erosion can be stopped around historic buildings by using natural erosion control techniques like terracing, geotextiles, or planting native plants on slopes. This helps keep the building's foundations stable and avoids landslides or collapse.

3.5 Adaptive reuse and restoration:

When reusing or restoring historic buildings, nature-based solutions can be used. For instance, incorporating natural ventilation and lighting systems, using locally produced and sustainable materials, or using renewable energy sources can improve conservation efforts while lowering the ecological footprint.

3.6 Conservation of biodiversity:

Protecting and fostering biodiversity around historic buildings improves the overall ecological health as well as the environment's resilience and natural balance. Ecological processes can be restored and a sustainable environment for both the buildings and the surrounding ecosystem can be achieved by creating habitats for local flora and fauna.

3.7 Education and community involvement:

Promoting the value of using natural solutions and involving locals in conservation efforts can help people feel more accountable and responsible. Innovative and efficient nature-based solutions suited to the particular requirements of the heritage structures can be produced by involving local communities, experts, and heritage organizations in cooperative projects.

Durability and resilience of historic buildings can be increased while fostering sustainable urban environments by embracing nature-based solutions. These solutions not only help to preserve historical structures in a useful way, but they also benefit the environment and the community as a whole.

4. Nature-based solutions (NbS): benefits and linkages with heritages

Table 1: Numerous co-benefits and linkages that Nature-based solutions (NbS) can offer when applied to build heritage conservation in urban areas. (Rahman, Orthy, Dey, Ar. Iftekhar-2023)

Some examples include:

References used for the table: (Grete Swensen), (Viles, 2021), (da Mosto, 2020), (Lo, 2015), (Gonzalez Cruz, 2017), (2014), (Sternberg, 2011), (Sheng, 2015), (Adinolfi, 2014), (Gough, 2007)

Benefits of NbS in cities (after Xing et al., 2017).	Benefits of NbS for built heritage conservation in urban areas.	Benefits of built heritage conservation for the successful delivery of NbS in urban areas.	Examples
Health impacts	Attractive green spaces promote interaction with the urban environment and result in happier and more frequent visitors to historic sites in urban areas.	The addition of cultural components to NbS can improve wellbeing. A sense of place is fostered and mental health is improved by historical connections and cultural engagement.	Engagement with urban cemeteries as green heritage spaces improves calmness and selfesteem (Swensen et al., 2016).
Urban heat island (UHI) mitigation	reduced exposure of sensitive materials to thermal extremes and cycles in urban areas. Conditions for people residing in, working at, and visiting historic structures and sites are improved by buffered microclimates. less energy is required to heat and cool historic buildings.	Additional locations for UHI mitigation projects in cities can be found at heritage sites. Local-scale buffering can be provided by green approaches to heritage conservation.	Ivy on historic walls reduces the frequency and magnitude of potentially damaging extreme temperatures (Coombes et al., 2017, 2018).
Carbon sequestration	reductions in the potential for chemical weathering in urban areas (for example, less acidic soiling and environment). enhanced sustainability credentials of historical objects or locations.	Heritage sites offer additional locations where local-scale sequestration can help reduce the effects of climate change. Local-scale sequestration advantages may result from NbS to heritage conservation problems.	Holistic management and conservation of historic cities can contribute to urban sustainability by supporting ecosystem services across the full range of heritage assets (including grey, blue, and green types), such as carbon sequestration by salt marsh and seagrass habitats in Venice Lagoon, Italy (da Mosto et al., 2020).
Biodiversity	improved visitor value and attraction of green spaces. increased incentive to protect heritage as a resource for urban habitat. Some species are significant culturally and add to heritage values.	In urban areas, heritage structures and sites can add to the available habitat. The preservation of biodiversity is aided by the support of novel, rare/endangered, and relict biota provided by built heritage.	Historic walls function as novel habitats in urban areas (Francis, 2010) and wall flora have cultural associations and values (e.g., Lo and Jim, 2015).
Sustainable water	Reduced risk of water-related damage to heritage assets and sites, e.g., flooding and water ingress to historic buildings.	Heritage sites provide additional locations for urban sustainable water management plans and historical examples of effective low-tech water management strategies.	Engineering knowledge of ancient civilisations provides inspiration for modern sustainable water management (Gonzalez Cruz, 2017).
Urban agriculture	Produce grown and sold at historical locations, such as vegetables, cut flowers, and bee products in historic gardens, can help fund maintenance and conservation efforts. Heritage sites can be valued as productive locations for horticultural knowledge and traditional methods of growing fruits and vegetables.	Kitchen gardens and traditional orchards are just a couple of the productive urban agriculture examples that can be found at many heritage sites. These might be improved, restored, or used as models for fresh ideas. Urban agriculture can also be practiced in contemporary heritage structures, institutions, and buildings.	Fruit growing has a long tradition at heritage sites, helping preserve heritage varieties, and horticultural skills and traditions alongside other benefits to biodiversity and people (English Heritage, 2014a).
Air quality	Better air quality slows down the chemical deterioration of delicate building materials and the staining and discoloration of walls and structures. better internal and external air quality for those who work in, reside in, or visit historic structures and sites.	Heritage sites provide additional locations for projects aimed at managing air quality. Locals-cale particulate filtration can benefit from environmentally friendly approaches to heritage preservation.	Vegetation on and around historic walls traps airborne particulates and limits surface soiling (Sternberg et al., 2010).
Acoustic	The distinctive "acoustic heritage" of some locations can be preserved by reducing noise pollution in cities. space for those who reside in, work at, or visit historic buildings and sites to be quiet and peaceful.	Numerous historical sites provide cities with peaceful, traffic-free areas as well as additional locations for acoustic management projects. Appropriate Local-scale acoustic buffering is provided by landscaping and planting at historical sites.	Acoustic comfort is considered crucial to the sustainability of route-based heritage tourism in cities (Sheng and Tang, 2015).
Jobs and investment	The "honeypot effect" of urban redevelopment projects that increasingly include NbS may benefit historic structures and sites. more people visiting Enhancing public interaction and engagement with heritage as a prized element of the modern city can benefit the areas receiving investment.	Using NbS to enhance built heritage management and conservation promotes a more robust heritage sector, which can draw investment to urban areas and generate employment. Investment opportunities in NbS can be found in heritage crafts and traditional practices, such as local reed production for thatch, willow for basket weaving, and horticulture.	Employment in sustainable tourism, and tourism revenue, can be enhanced in historic cities through the incorporation and conservation of green spaces (Adinolfi et al., 2014).
Social cohesion	Heritage values, a sense of ownership, and stewardship of local heritage are strengthened in thriving, environmentally conscious communities. People can appreciate and participate in their local heritage in more ways thanks to nature.	NbS can aid in managing, preserving, and improving sites and assets that are valued locally, regionally, and nationally. Opportunities for green business and community engagement (such as volunteering, education, etc.) are presented by heritage structures and sites.	Integration of culturally valued sculpture, memorials and planting in community gardens fosters social cohesion and reconciliation (Gough, 2007).

5. Methodology

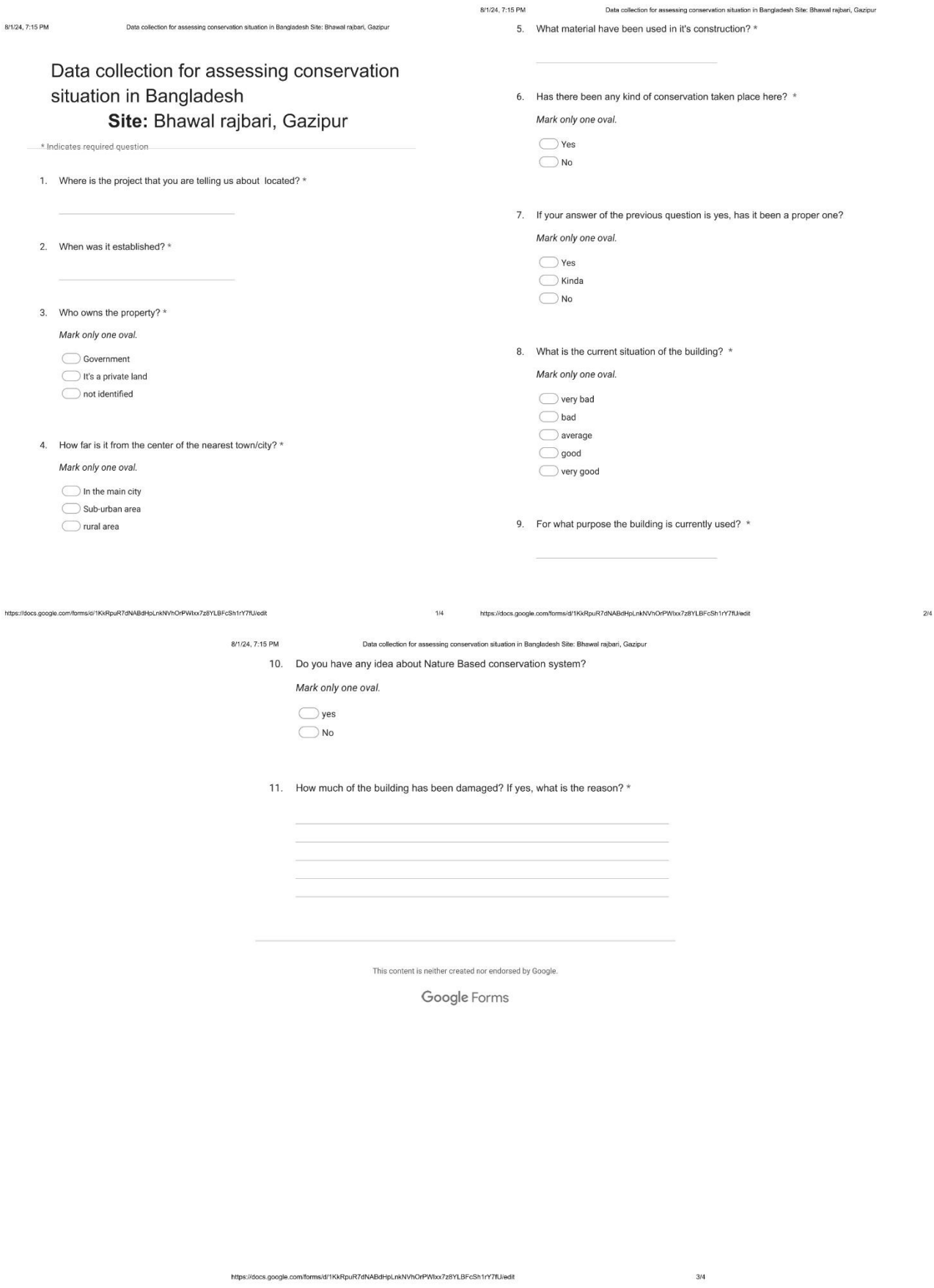
The research was conducted with some defined steps to explore the potential of Nature-Based Solutions

(NbS) for heritage conservation:

- To gather information and insights, questionnaires and desktop research were used as survey tools.
- Various aspects of the built heritage, including typology, significance, past and present use, ownership status, surroundings, condition, conservation approach, and risks, were documented using a questionnaire format that was created and distributed to resource persons.
- To assess the viability of implementation of Nature-based Solutions for each heritage property, the collected data was evaluated.
- When developing core strategies, opportunities and challenges related to the implementation of the NbS were carefully considered.
- Alternative approaches to problem-solving were taken into consideration to get around the challenges if NbS was not practical for a specific heritage site.

  In the whole research, some specific steps and activities are followed which are defined in the method. In the following points, those steps are defined and described to create an overview of the research process.

- **Objective:** The research took place to learn more about the potential of nature-based solutions (NbS) for heritage preservation, particularly in relation to Bangladesh.
- **Study Design:** There were two phases to the study's execution. In the initial stage, the researchers concentrated on comprehending the fundamental elements of studies based on nature that could be used to conserve cultural heritage. In the second stage, data were gathered from various sites in Bangladesh using a study-based methodology.
- **Site Selection:** Information was gathered from ten different sites spread across ten distinct Bangladeshi regions. These locations are picked to represent a variety of historically significant buildings. Primary focus of the study was covering heritage sites every region of Bangladesh, and data were gathered from ten different heritage sites from various regions to ensure an overview of Nature-based Solution for each part of the country.
- **Data collection tool:** To conduct the survey; a mix of desktop research and questionnaires were used. Desktop research provided context and insights, whereas questionnaires were made to elicit information from resource people.
- **Development of the Questionnaire:** A set of questions covering various facets of the built heritage properties was included in the questionnaire format that was created. These factors included the type of building, significance, past and present uses, ownership status, location, current state, approach to conservation, and risks faced by heritage properties. The questionnaire was prepared separately for individual sites considering their characteristics and locations. One of the questionnaire is provided in the following way:



8/1/24, 7:15 PM Data collection for assessing conservation situation in Bangladesh Site: Bhawal rajbari, Gazipur

Data collection for assessing conservation situation in Bangladesh

Site: Bhawal rajbari, Gazipur

* Indicates required question

1. Where is the project that you are telling us about located? *
2. When was it established? *
3. Who owns the property? *

Mark only one oval.

- Government
- It's a private land
- not identified

4. How far is it from the center of the nearest town/city? *

Mark only one oval.

- In the main city
- Sub-urban area
- rural area

8/1/24, 7:15 PM Data collection for assessing conservation situation in Bangladesh Site: Bhawal rajbari, Gazipur

5. What material have been used in it's construction? *
6. Has there been any kind of conservation taken place here? *

Mark only one oval.

- Yes
- No

7. If your answer of the previous question is yes, has it been a proper one?

Mark only one oval.

- Yes
- Kinda
- No

8. What is the current situation of the building? *

Mark only one oval.

- very bad
- bad
- average
- good
- very good

9. For what purpose the building is currently used? *

https://docs.google.com/forms/d/1KkRpuR7dNABdHpLnkNVhOrPWlxx7z8YLBFcSh1rY7fU/edit 2/4

8/1/24, 7:15 PM Data collection for assessing conservation situation in Bangladesh Site: Bhawal rajbari, Gazipur

10. Do you have any idea about Nature Based conservation system?

Mark only one oval.

- yes
- No

11. How much of the building has been damaged? If yes, what is the reason? *

Image 1: Google form for questionnaire survey: (Rahman, Orthy, Dey, Ar. Iftekhar-2023)

- **Resource Persons:** The questionnaire was given out to a variety of experts and knowledgeable individuals who were resources for the study's particular historic properties. These experts were in charge of researching and compiling the relevant information for each structure.
- **Data Assessment:** Following data collection, the information was evaluated to determine whether implementing NbS would be feasible for each heritage property. In this evaluation, NbS's suitability for the unique site challenges and conditions was taken into account.
- **Analysis of Opportunities and Challenges:** A critical analysis of the opportunities and challenges were conducted related to the implementation of NbS In order to develop the core strategies for NbS Implementation, this analysis was done while taking into account the unique context and needs of each site.
- **Alternative Approaches:** Alternative approaches to problem-solving were analyzed when NbS was deemed impractical for individual specific heritage sites. These alternative methods were created to get around any difficulties and come up with workable solutions for heritage preservation.

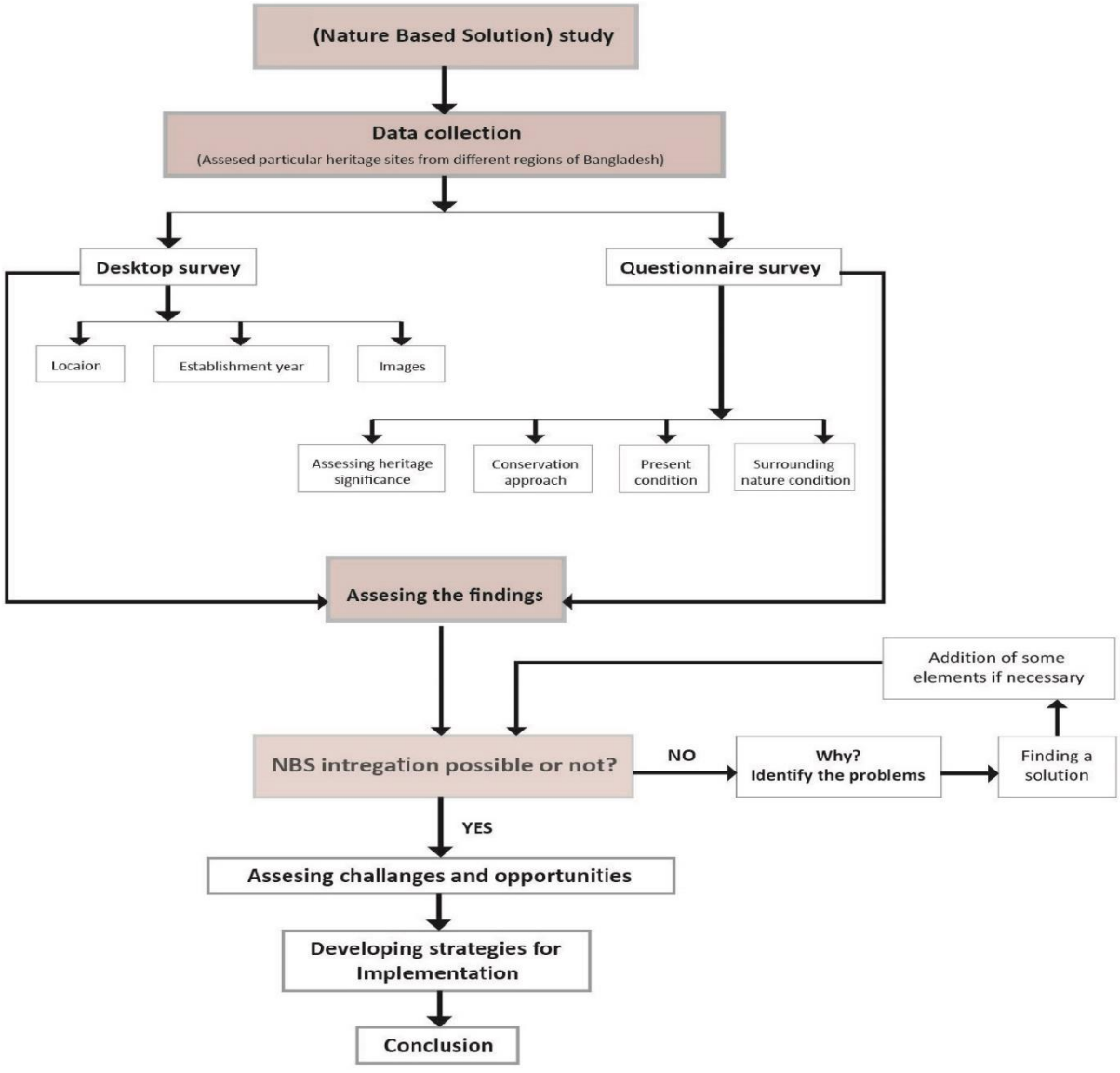


Figure 2: Step wise flow diagram of NbS system. (Rahman, Orthy, Dey, Ar. Iftekhar-2023)

5. Findings from Questionnaire survey:

The survey was conducted in 10 specific heritage sites which were chosen from every part of Bangladesh and there were almost 100 respondents who have given their opinions over our questionnaire.

The findings of the questionnaire are presented in the following diagram:

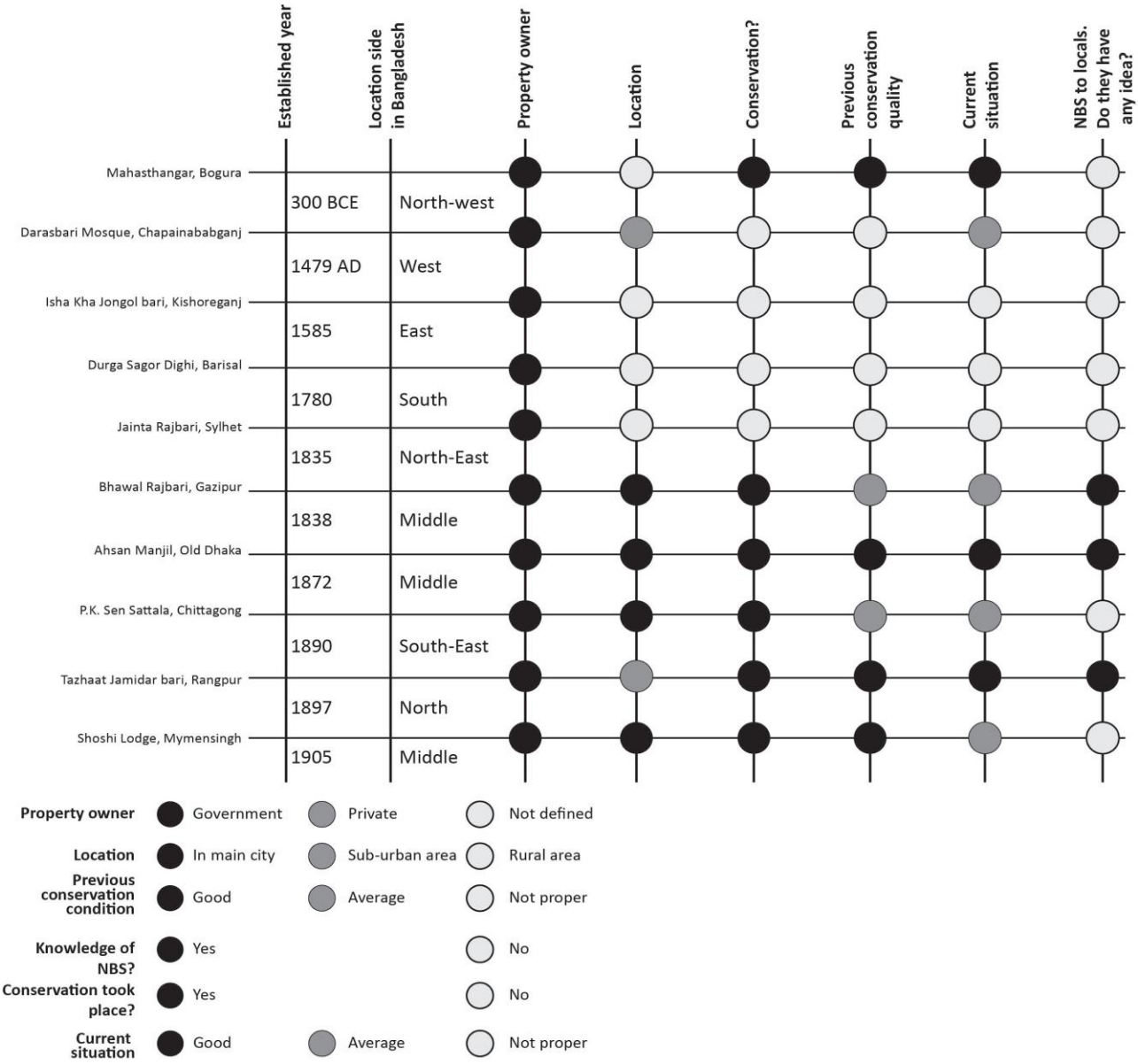


Figure 3: Findings of Questionnaire survey (Rahman, Orthy, Dey, Ar. Iftekhar-2023)

5.1 Ten selected sites:

Tazhaat Jamidar bari, Rangpur | Shoshi Lodge, Mymensingh | Durga Sagor Dighi, Barisal

Figure 1: Images of selected sites (Rahman, Orthy, Dey, Ar. Iftekhar-2023)

6. Implementation possibilities of Nature-based Solutions in Heritage sites:

For each heritage site, different types of possible Nature-based solutions are summarized below which were found out through the methodology and surrounding survey of those sites.

6.1 Tajhat Palace, Rangpur

Image 2: Tajhat Palace; photo credit: Arman Habib Raihan

Existing condi

- Enriched natural condition.
- Adaptive re-use.

- Developed existing landscape.
- Good enough structural condition.

Nature based solution (NbS) implementation:

- **Restoration of vegetation**: As the Structure is surrounded by enriched natural landscape, to restore native vegetation; reforestation and afforestation projects can be carried out. This can make the area more aesthetically pleasing, offer habitat for wildlife, and lessen soil erosion.
- **Sustainable Land Management:** Implementation of sustainable land management techniques on Tajhat Palace's property can be a solution and this could entail using organic and environmentally responsible landscaping techniques; like using local plant species, mulching, and composting. To maintain healthy soil and safeguard the local ecosystem, use chemical pesticides and fertilizers as little as possible.

6.2 Shashi Lodge, Mymensingh

Image 3: ***Shashi Lodge: image source: https://in.worldorgs.com/catalog/mymensingh/amusement-center/shashi-lodge***

Existing condition:

- A large front yard garden.
- Enriched landscape: trace of some rare trees, Padma bagan.
- Adaptive re-use.
- Impactful on locals.

Nature based solution (NbS) implementation:

- **Green landscaping:** Creating green spaces on the lodge's property by incorporating native plant species and Use of landscaping strategies that resemble natural ecosystems, such as putting in native plants like local trees, shrubs, and flowers can be some of those solutions to work on. These strategies can enhance the site's overall aesthetics, provide habitat for nearby wildlife, and improve air quality.
- **Waste Management:** A thorough waste management strategy that includes composting, recycling, and waste reduction can also improve the existing premise’s condition. Promoting the use of biodegradable and environmentally friendly materials inside the lodge would reduce the environmental impact of waste produced by visitors and staff by implementing appropriate segregation and disposal systems.

6.3 Durga Sagor Dighi, Barisal

Image 4: Durga Sagor Dighi; Image source: Barisal Times

Existing condition:

- Great religious value.
- Habitat for seasonal birds.
- Surrounded by natural landscape.

Nature based solution (NbS) implementation:

- **Habitat conservation:** Identification, evaluation, and ensuring the preservation of the area's vibrant green surroundings can enhance the condition of existing habitats. To sustain the habitat for seasonal birds and other wildlife, preservation of the natural vegetation and ecological balance can be a solution. Proper actions need to be taken to protect the area's natural biodiversity by preventing encroachment, deforestation, and habitat degradation.
- **Wetland restoration:** The main focus should be on restoring and conserving Durga Sagor Dighi's ecological functions as it is a wetland. To keep the dighi healthy and productive, use of wetland management strategies like pollution prevention, sediment control, and water level management can be undertaken for consideration. The development of aquatic plants and increasing the habitat for seasonal birds in an appropriate state can be also considered as solution.
- **Water management:** Implement water management techniques to preserve the dighi's water quality and quantity. This could involve taking steps to collect rainwater, control water inflow and outflow, and stop over-extraction of water. The sustainability of the seasonal bird habitat and the ecosystem's general health are guaranteed by effective water management.
- **Cultural Preservation:** Local communities, religious organizations, and institutions can be trained in preserving and upholding the dighi's religious and cultural traditions. This can entail undertaking projects like planning cultural events, advocating environmentally friendly behaviors at religious gatherings, and keeping the environment clean.
- **Ecological monitoring:** Monitoring of the dighi's ecological parameters, such as water quality, bird populations, and vegetation, should be done on a regular basis. This data can aid in evaluating the success of conservation efforts and adjusting management strategies as needed.

6.4 Jainta Rajbari, Sylhet

Image 5: Jainta Rajbari, Sylhet; Image source: Off road Bangladesh

Existing condition:

- No significant structures exist from the past.
- Great topographical location with scenic beauty.
- Great historic value.

Nature based solution (NbS) implementation:

- **Ecotourism Development:** Creation of ecotourism explores that take advantage of the topographical area's scenic beauty. Implementing hiking paths, nature walks, or bird-watching routes that highlight the region's natural beauty and historical significance. Make sure that tourism-related activities are carried out with consideration for the environment, minimizing harm to the ecosystem.

  As this heritage site does not have that many traces of the past, so to incorporate NbS, some relevant activities need to be done. Such as:

1. **Environmental Education and Awareness:** Educational initiatives and campaigns to raise public awareness of Jainta Rajbari's historical and ecological significances can be organized. Engagement of local communities, schools, and colleges need to be implemented to advance environmental stewardship and sustainable lifestyles. Information about the history, natural features, and conservation efforts of the site can be found in interpretive signage and visitor centers.
2. **Collaboration and Partnerships:** Partnerships with pertinent parties, including neighborhood associations, environmental groups, and community organizations must be encouraged and need to work together to secure funding, technical know-how, and resources for putting nature-based solutions into action. Involvement of the neighborhood's residents in decision-making process and enlist their active support for conservation initiatives should also be included.

6.5 Mahasthangarh, Bogra

Image 6: Mahasthangarh, Bogra, image source: Keren Su/China Span / Alamy Stock Photo

Existing condition:

- Structure of ancient period.
- Huge impact on the regional history.
- Enriched natural landscape.

Nature based solution (NbS) implementation:

- **Cultural and Historical Interpretation:** The natural landscape of Mahasthangarh should be better understood from a cultural and historical perspective. Educational resources, signage, and guided tours can be created that emphasize the natural features and their importance in relation to the site's history. Highlighting the interactions between the built environment and the surroundings can also help to implement NbS in a fluent way.
- **Responsible Tourism Practices:** Responsible tourism practices can be promoted to reduce the negative effects on Mahasthangarh's environment. Visitors should be encouraged to respect the

environment, staying on paths that have been designated, and refraining from littering or destroying vegetation. Visitor management strategies can consider and control visitor numbers to maintain a balance between tourism and conservation.

- **Restoration of vegetation:** The area around Mahasthangarh could be examined to find any degraded or bare land; improvising native plant species in reforestation and afforestation projects to revive the native flora. This can improve the area's ecological integrity, offer habitat for wildlife, and produce an attractive landscape.

6.6 P.K. Sen Sat-tala Bhaban, Chittagong

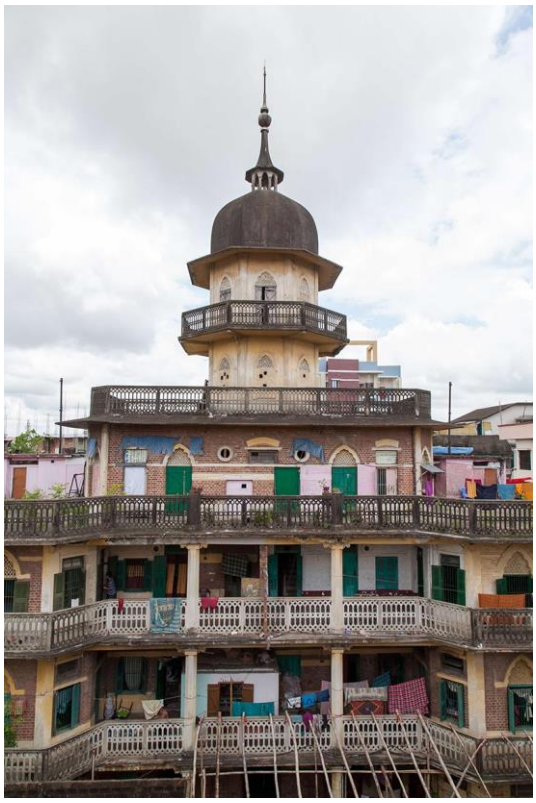


Image 7: P.K.Sen Sat-tala Bhaban, Chittagong: image source: URONTO

Existing condition:

- Situated in urban area.
- First tall structure of that area.

Nature based solution (NbS) implementation:

- **Vertical Greening:** Climbing plants can be used to cover the outside of the building or install green walls to incorporate vertical greening techniques. These green components can improve air quality, lessen the heat island effect, and provide habitat for urban wildlife. Additionally improving the structure's aesthetic appeal is vertical greening.
- **Gardens on Rooftops:** Rooftop spaces can be modified to build gardens or green roofs. Storm water runoff can be reduced, energy use can be decreased, and more green space can be added to urban areas by using green roofs. Visitors can enjoy themselves in these gardens while also helping to preserve biodiversity.
- **Urban Tree Planting:** The best spots can be identified to plant trees near the building. Choose tree species that can withstand pollution, confined spaces, and inclement weather and are adapted to

urban environments. Urban trees offer shade, lessen air pollution, and generally improve the microclimate in cities.

6.7 Isha Kha Jungle Bari, Kishoreganj

Image 8: Isha Khan Jungle bari, Kishoreganj: image source: Offroad Bangladesh

Existing condition:

- Situated in the rural area.
- Archeological establishment excavated during Isha Khan.
- There are three ponds, a charity hospital, a dark pit and a memorial with the zamindar bari.

Nature based solution (NbS) implementation:

- **Cultural Heritage Preservation:** The archaeological features of Isha Kha Jungle bari should be preserved and protected, such as the Excavated establishment from the Isha Khan era, the memorial, and the zamindar bari. Nature-based solutions like landscaping with native plants can be used to enhance the aesthetics while maintaining historical authenticity.
- **Biodiversity Enhancement:** Biodiversity surveys could be conducted to identify the flora and fauna present in Ishakha Jongolbari. Strategies can be developed to enhance biodiversity by creating wildlife habitats, planting native species, and establishing green corridors. Local community should be encouraged to participate in conservation efforts and raise awareness about the importance of preserving local biodiversity.

6.8 Darashbari Mosque, Chapainababganj

Image 9: Darashbari Mosque, Chapainababganj; source: Wikipedia

Existing condition:

- The ‘Bengali Sultanate Architecture’ is ingredient of this consent
- A happy blending of local influences and the Sultanate style express the connection with the people, land, air and water. In another ward Sultans ruled Bengal with elaborate time span.
- Situated in sub-urban area.

Nature based solution (NbS) implementation:

- **Sustainable Landscaping:** Sustainable landscaping principles could be included to improve the mosque's aesthetics while preserving its historical significance. In the area around the mosque, native plant species, such as those were popular during the Sultanate era can be used. Areas with greenery, gardens, and courtyards filled with climatically appropriate plants can be included to encourage biodiversity and create a welcoming atmosphere for visitors.
- **Cultural Heritage Interpretation:** Awareness about the unique Bengali Sultanate architecture and the historical significance of Darashbari Mosque should be raised by developing educational programs, interpretive signage, and guided tours that highlight the cultural and architectural aspects of the mosque, as well as its integration with the natural surroundings. This can promote a deeper understanding and appreciation of the site's historical and ecological value.

6.9 Ahsan Manjil, Old Dhaka

Image 10: Ahsan Manjil, Old Dhaka; source: Ranadipam Basu/Wikimedia

Existing condition:

- Currently used as museum.
- Large green plaza as front yard.
- Contain huge attraction to local tourists.
- Bear the history of Dhaka.
- Situated in dense urban area.

Nature based solution (NbS) implementation:

- **Green Space Improvement:** Advantages of the chance to create a vibrant and ecologically diverse green space in the significant plaza in front of Ahsan Manjil can be considered. Introduction of suited urban environment native plant species, trees, and shrubs can be a solution. Landscaping strategies like flowerbeds, vertical gardens, and urban farming initiatives can be utilized to maximize the area's greenery and make it inviting for guests.
- **Educational Signage and Interpretation:** To inform visitors about the historical and ecological importance of Ahsan Manjil, educational signage and interpretation boards all over the museum's grounds can be installed. In order to promote sustainable living and urban conservation, emphasizing the value of nature-based solutions can create a strong impact. Visitors need to be encouraged to learn about the importance of green spaces and how they contribute to the overall improvement of urban life.
- **Green Roof and Vertical Gardens:** The possibility of installing vertical gardens and green roofs on appropriate Ahsan Manjil locations need to be investigated. Green roof and vertical gardening can be

a impactful nature-based solution for such type of heritage structure. Green roofs can increase green space, control temperature, and lessen storm water runoff. Vertical gardens can add some natural elements to vertical surfaces, resulting in a feature that is both aesthetically pleasing and environmentally friendly.

6.10 Bhawal Rajbari, Gazipur

Image 11: Bhawal Rajbari, Gazipur; source: Rahman

Existing condition:

- Currently used as main admin zone of Gazipur.
- Contain value of Zamindari practice.
- Situated with a large Dighi.
- Contains many native old trees in between the site,

Nature based solution (NbS) implementation:

- **Ecological Restoration:** The site's ecological state need to be evaluated carefully, taking into account the Dighi and its surroundings. Any damage, encroachment, or loss of native vegetation must be identifiedwhich will help to create a restoration strategy that emphasizes protecting and enhancing the natural ecosystem. This may entail planting native trees, providing habitat for wildlife, and putting policies in place to safeguard the water quality of the Dighi.
- **Native Tree Preservation:** Site's old, native trees and evaluate their health and condition should be analyzed to ensure their protection and preservation. In order to prevent damage during any construction or renovation activities, this may involve creating tree protection zones as well as performing routine tree maintenance procedures like fertilization and pruning.
- **Enhancing biodiversity:** Evaluating the site's biodiversity and look for opportunities, habitats for native plants and animals can be made, such as butterfly gardens, birdhouses, and plantings that are beneficial to pollinators. Include educational signage to spread the word about the value of protecting biodiversity.
- **Cultural Heritage Interpretation:** Utilization of natural solutions to improve how the cultural and historical significance of the site is interpreted. Creating walking-routes that emphasize the connection between the surrounding environment and the background of the Zamindari religion can be a solution. Use of signage, guided tours, and interactive exhibits can be implemented to inform visitors about the cultural significance of Bhawal Rajbari and its natural surroundings.

According to the analysis of existing site and the surrounding natural settings, these suggestions can be taken under consideration for incorporating NbS in these heritage structures and after successful implementation, these cases can be introduced as case studies for future conservation practice all over the world.

7. Conclusion

The integration of nature-based solutions in the conservation practice of urban built heritages in Bangladesh will offer promising opportunities for sustainable development and preservation of cultural and historical assets. However, it also presents challenges that require careful consideration and strategic planning. For example, NbS can sometimes be seen as detrimental to the heritage site. And most of the heritage sites in Bangladesh already have surrounding natural features, and it goes well with the outlook. That's why, in the context of Bangladesh, this hypnosis very much falls short of substance. By addressing these kinds of challenges, capitalizing on the available opportunities, and leveraging the prospects, Bangladesh can enhance its heritage conservation efforts through the incorporation of nature-based solutions, contributing to the overall resilience and sustainability of urban areas. And it can be assumed that a cost-effective method such as NbS will not put any significant dent on the overall maintenance cost already required for these sites.

This research will not ensure that the suggested fields of NbS are the successful one considering the conservation of heritage structures of Bangladesh but the data will help the experts of that field to consider Nature-based solution as a way of future conservation system in any part of the world.

According to the analysis and discussing possible implementation of Nature-Based Solution in the conservation technique of the heritage sites, some specific points have been found out in which NbS can work on. Those are:

- **Restoration of vegetation**
- **Cultural Heritage Interpretation**
- **Native Tree Preservation**
- **Enhancing biodiversity**
- **Ecological Restoration**
- **Green Roof and Vertical Gardens**
- **Green Space Improvement**
- **Educational Signage and Interpretation**
- **Sustainable Landscaping**
- **Urban Tree Planting**
- **Vertical Greening**
- **Responsible Tourism Practices**
- **Collaboration and Partnerships**
- **Habitat conservation and wetland restoration**

These are the specific values or points where Nature-Based solution can be implemented in the heritage structures of Bangladesh for conservation purposes. It will add many possibilities and will help to open new paths in the conservation techniques of heritage structures.

Moreover, the results of this research suggest a number of challenges possibilities, and prospects related to the use of nature-based solutions for urban built heritage conservation in Bangladesh.

Challenges:

- Heritage conservation stakeholders lack knowledge of and understanding for solutions based on nature.
- Insufficient institutional frameworks and policies to direct the incorporation of natural solutions in

heritage conservation initiatives.

- Insufficient technical expertise and financing to successfully implement nature-based solutions.
- Conflicts between the demands of urban development and conservation goals that could result in trade-offs.

Opportunities:

- Possibility of using natural approaches to improve the ecological sustainability of heritage sites.
- Impacts those are favorable to urban resilience, such as climate adaptation and mitigation.
- Provision of ecosystem services, including preservation of biodiversity, regulation of the microclimate, and improved air quality.
- The incorporation of environmentally friendly solutions can improve visitors' overall experiences and foster tourism potential.

Prospects:

- Increasing recognition and promotion of natural solutions by appropriate governmental organizations and conservation groups.
- Aligning heritage preservation with sustainable development objectives through the incorporation of nature-based solutions into urban planning and development policies.
- Collaboration and joint ventures among interested parties, such as heritage authorities, urban planners, environmental specialists, and local communities.
- Adoption of cutting-edge techniques and tools to successfully integrate nature-based solutions in practices for heritage conservation.

8. Limitation to the Study:

This research tried to identify some of the Nature-based Solutions which can be implemented or can be considered for any other heritage structures of Bangladesh; moreover, for the heritage structures for other context as well. But, these Solutions are not scientifically proven in this research and none of these solutions are implemented in any heritage sites of Bangladesh. This research only intends to suggest some of those Nature-based Solutions for further studies considering the heritages of Bangladesh.

List of abbreviations:

NbS Nature-based Solutions
GI Green Infrastructure
UNESCO United Nations Educational, Scientific and Cultural Organization

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