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Understanding the Ambivalence of Urban Waterscape in Bangladesh

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Abstract

Waterfronts bring vibrance to cities, though they come with challenges. Studies show that climate change and urbanization impact the course of rivers, riverbanks, and surrounding habitats. Most cities are connected by a waterbody; thus, globally, there has been ongoing research to restore their former beauty. Waterfront restoration can revive the beauty an urban area may have lost.
This study aims to provide an overview of the initial development periods of waterscape in Bangladesh through historical analysis to understand the context that influenced the nature of public space and community transformation. The next phase will examine how waterscape can transform into opportunities while balancing socio-environmental needs. This will be based on relevant contextual case studies on spatial design and planning to regenerate waterscapes.
The final phase will address one of the most vulnerable areas in Bangladesh, the port city Chattogram, to focus on reshaping adverse urban waterscape for long term effectiveness. These propositions will address previous regional analysis, to create a rational proposal for relevant areas. These strategies will accelerate community revitalization to enhance cultural, economic, and environmental opportunities for the region by community stewardship which may create metaphorical links between our past, present, and future.

Keywords: *River-restoration, Community stewardship, Urbanization.*

1 Introduction

Every city in the world is connected to one waterbody or another. Water resources include power, food transportation and the water itself. Accordingly, we can see that urban rivers are often impacted by urbanism, such that when it comes to river-side developments insufficient consideration is given (Baron et al., 2002).
The process of urbanism comes with different development methods, such as culverting or channel modification, or narrowing of the river for land reclamation: some methods demand a high volume of water, and most of the time the 'development process' ends up polluting the water (Everard and Moggridge 2012). This process degrades the water eco-system globally and so for decades the world has been losing the benefits of a healthy freshwater eco-system (Everard and Moggridge 2012). Bangladesh is a riverine country with almost 405 rivers. Among them, 165 are on the verge of extinction due to pollution and encroachment, while approximately 230 are at risk (Pandit, 2022). A considerable portion of the population's occupations, agriculture, livelihoods, and literary cultures are directly or indirectly connected with the rivers, yet there is a lack of determination regarding saving the rivers from their foreseeable downfall (Pandit, 2022).

As the world enters an era of 'climate emergency', the awareness of restoring and managing fresh water in a more sustainable manner has increased. This can be credited to the recognition of the services or benefits that society receives from a river eco-system (Baron et al., 2003). Lately the methods and techniques are focusing on rehabilitation rather than restoration, where more importance is placed on eco-system restoration that has not only societal but also long-term environmental benefits through minimal intervention (Everard and Moggridge 2012).

2 Local identity and heritage of urban rivers

The rivers of Bangladesh are wide and distinguish both the physiography of the country and the lives of the citizens. As it has approximately 700 rivers, including tributaries, Bangladesh is often referred to as a land of

rivers. Some of these rivers are among the largest on Earth in terms of catchment size, river length, and discharge volume (Banglapedia 2008). They usually flow south and are the primary source of irrigation water and the main arteries of commercial transportation. Sweet water fish, an important source of protein, is also provided by the rivers. Accordingly, a large segment of the population is involved in the fishing sector that originated in Bangladesh (Britannica 1998).

Widespread degradation of the riverbanks and frequent flooding of the major rivers cause tremendous misery and resource destruction which impedes growth. The river system carries an immense amount of fresh silt that replenishes the natural fertility of agricultural land (Hossen et al., 2019). During monsoon season rivers drain surplus discharge into the bay. Thus, this great river system is the country's main resource and its greatest threat. Throughout Bangladesh's development many of the urban rivers have not been appropriately managed or preserved with the care that has been necessary to provide city life with recreational facilities.

Untreated industrial waste has been identified as the major cause of contamination of common rivers in Bangladesh (Islam et al. 2018). The high volume of industries places great stress on both water quality and quantity. Increased contamination degrades the rivers' quality and, consequently, this affects human and marine life (Ali et al., 2016).

3 Study Area: Karnaphuli River in Chattogram

3.1 Background

In Bangladesh, Chattogram is both the second largest city and the primary port city. As a result, it is also the main financial district. It lies on the banks of the Bay of Bengal and the Karnapuli River. Karnaphuli, located in Chattogram and the Chittagong Hill Tracts, is the largest and most important river in the southeastern region of Bangladesh, its width spanning 667-metres. It begins in the Saithah Village of Mamit District in Mizoram, India, and flows 270 kilometres southwest through Chittagong Hill Tracts and Chattogram into the Bay of Bengal. Chattogram seaport, the largest and busiest in Bangladesh, occupies the river's mouth (Chowdhury 2014).

3.1 Historical Significance

Prior to proper transportation infrastructure in Chattogram, Karnaphuli river played a pivotal role in transporting people and commercial goods (Dey, 2022). The riverbank is surrounded by areas formerly occupied by Arab, Portuguese, and Arakanese merchants. The river was the battleground where the Mughals, with the help of Portuguese colonists, claimed victory over the Arakanese (Hoque 1980). It is still used to transport goods while its banks are used to build boats and fishnets. The river's water is used to irrigate nearby agricultural land. For many fishermen in Chattogram this river is vital. Currently, the riverbed has shrunk almost to a canal due to waste disposal from hundreds of households and commercial establishments (Azad, 2022).

3.2 Environmental Significance and Issues

Karnaphuli is home to the Ganges River dolphin, an endangered species. Hilsa, once common in the river, have largely disappeared because of pollution. Like many rivers in Bangladesh, it is heavily polluted by agricultural run-off. This reduces the river's oxygen and damages its aquatic life (Ahsan and Hannan 2002). In 2015, collaborative research between the Biomedical Engineering Department of the University of California and Oceanography Department of Dhaka University concluded that, over the last 30 years, the river ecosystem is gradually being destroyed by the increased level of toxins. The Zoology Department of University of Chittagong found that 20-25 of 66 freshwater fish species are extinct.

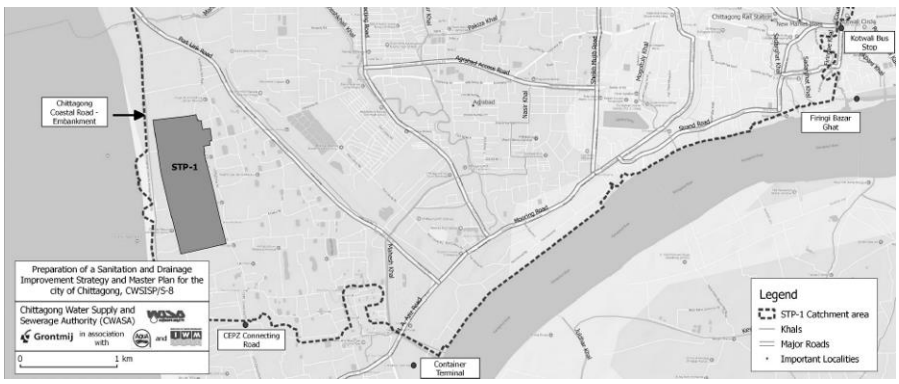

Figure 1. Karnaphuli river catchment map by WASA

Figure 1, which represents one of the riverbanks of Karnaphuli river near Shadarghat area, where the Chaktai canal is located, indicates how most of the city's drainage dispenses in the river. This includes sewage, industrial waste, pesticides, and various types of surface run-off. According to the Department of Environment, there are approximately 300 factories built on both sides of the river whose waste is directly disposed into the river (Majumder, 2023). Almost 7 meters of thick layers of polythene was collected from the riverbed and found inside the guts of fishes (Majumder, 2023).

The area's surface run-off moves to the drainage located under the main roads; from there it travels to the small canals, dispersing into the river (Ashraf and Chowdhury 2009). The water level fluctuates daily due to tidal changes. During monsoon season flooding can occur because of heavy rainfall, especially during high tides. Notably, the last documented heavy flood occurred during the 2017 monsoon (Hossen et al., 2019). Bangladesh's largest wholesale market in the maritime trade is in Khatunganj. The traders are under pressure to leave because they are facing immense loss in trading caused by excessive waterlogging of the Chaktai canal. Temporary measures have been taken over the years, yet no permanent solutions have been proposed.

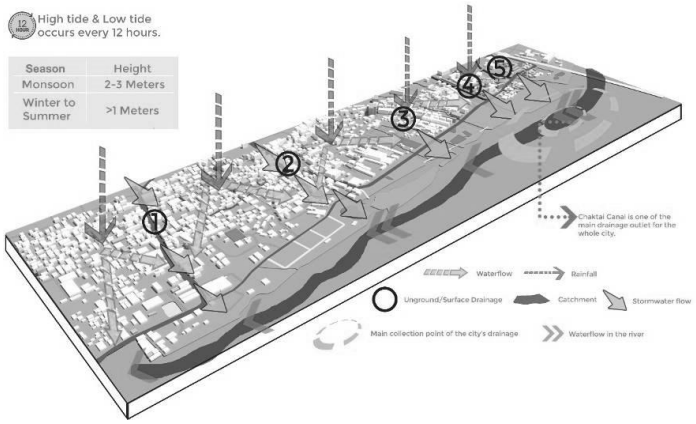

Figure 2. Sewage system diagram of Chattogram City

The WQI (Water Quality Index), states that the best water quality scores range from 0-25; as that rises the quality decreases. The worst quality water, which is unusable without treatment, scores above 100. Based on a 2017 survey, the water in this area scores 100.1-113.93 (Hossen et al., 2019); consequently, the water is unsuitable for drinking or fish culture, and requires proper treatment before usage. According to a report by the Department of Environment, black water flows to the river from the Chaktai and Rajakhali canals. 5000 Tonnes of household waste enter the river from 36 canals every day. Due to the poor water quality, water-borne diseases in the area are increasing at an alarming rate.

4 National and international approaches

4.1 Ningbo Yong River Waterfront Riverpark, Ningbo, China

This multiple award-winning river-side park in China is located in the Ningbo high-tech industrial zone's 84 hectares of neglected land on the Yong riverfront. It focuses on responding to the local conditions of the area to combat flooding and enhance the ecological environment through community stewardship. According to AECOM, the firm responsible for the design, they successfully built a park suitable for all age groups and genders in terms of accessibility and recreational activities while taking measures to adapt to climate change and natural disasters. To ensure environmental and ecological sustainability, native and seasonal low-water plants were used, and the plantation system was integrated with the drainage system. "The riparian wetland, storm water retention system, grasslands with beautifully contrasting sculptural landforms, and the iconic elevated walkway have become the perfect place to overlook Ningbo's revitalized waterfront (AECOM 2013)". The park is an extension of a five-phase community development planning project by the city. In the first phase the park was constructed to give the community open recreational space, prevent flooding, and revive the ecological condition of the waterscape. The next phases will focus on building high-rises for the new urban community, technology sectors, universities, and cultural facilities including historic temples. While the chronology is not yet set, these are the issues they intend to address.

4.2 Urban River space, Jhenaidaha, Bangladesh

This Agha Khan Award winning riverbank (ghat) is located in Jhenaidaha's Nabaganga river in Bangladesh. According to Agha Khan Trust, most of the urban water sources have been reduced to backyards and dumping grounds. This had also been happening to the Nabaganga river, until Urban River space was built. The 115 metre long 'public ghat' includes stairways and ramps for the disabled, walkways, and spaces for cultural and recreational activities. The upper retaining wall acts as a public exhibition space while the lower retaining wall is green space, with various trees, some which are centuries old. Smaller community ghats are directly connected to the water edge and are open for communities to use the water for their daily necessities, such as bathing and washing. Changing rooms and benches are also available. All structures are built by local masons using local materials. From conceptualization to practical implementation, this was achieved with community participation.

5 Scopes and Limitations

Wetlands are defined as ecologically critical areas and are in dire need of conservation (ECA 2010). The Bangladesh Environmental Conservation Act has made amendments to enforce penalties and legal actions on any group that pollutes the entity (ECA 1995). To protect the wetlands and waterbodies, there are several significant national policies, such as the National Water Policy (NWP 1999), which protects natural aquatic environments with minimum disruption for fish breeding. There is also the National Water Management plan (NWM 2001), the National Policy for Safe Water and Sanitation (NPWS 1998), and amendments to keep the water safe. Other relevant acts, rules, and laws to protect waterbodies are the Embankment and Drainage Act (1972), Bangladesh Water Act (BWA 2013), and Water Supply and Sanitation Act (WSS 1996).

According to Bangladesh Delta Plan (BDP) 2100, strategies at national level include flood risk management that focuses on climate resilient development though a participatory process. Fresh Water (FW) strategies are made to guarantee water availability by ensuring supply and demand for sustainable and inclusive growth. This includes strategies for maintaining water quality for health, livelihood, and the eco-system. In terms of specific zones of interest, Chittagong Hill Tracts are an area of prominence. Strategies for providing protection from flood and storm surges are well received, as they ensure water security and sustainable sanitation.

6 Methodology

The research supports the idea that the current condition of Karnaphuli riverbank, based on local context and historical analysis, demands a restoration that address solutions for flood prevention, water filtration and river eco-system rejuvenation, and adopting to the changing climate through modern sustainable solutions and community participation.

6.1 Three-step Water Filtration System with Flood Prevention

At their core the issues regarding the river and riverbank are embedded in the life of the water. Lack of water reserves have caused flash floods during the monsoon and the degrading quality of the water itself has driven away the diverse species that previously thrived. By referring to the international approach, Karnaphuli riverbank can adopt a similar process through organizing systemic water filtration combined with flood prevention methods and water eco-system restoration solutions.

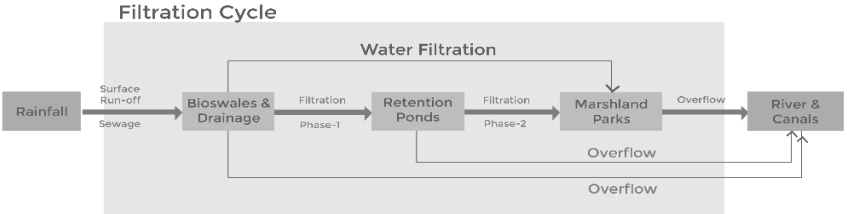

Figure 3. Conceptual 3-step water filtration diagram

6.2 Bioswales

As indicated in Figure 3, bioswales that are integrated with street drainage can be used to filter the surface run-off and sewage. The filtered water from the first stage can flow to the retention ponds or water reservoirs. In terms of excessive waterlogging, secondary or tertiary streets can be designed to hold excess water while also providing accessibility for pedestrians in case of emergency. For primary drainage in Chattogram, water carrying

capacity is 45.30 m^3; for secondary drainage it is 27.17 m^3; and for tertiary drainage it is 9.06 m^3 (Papry and Ahmed, 2015). Conversely, bioswales can hold 120m^3 of water, soil, and vegetation.

6.3 Retention Ponds

Natural retention ponds or reservoirs can capacitate the holding of large volumes of water. If it is a green retention pond, it can increase biodiversity in the riverbank by acting as a sanctuary for various species of climate adopting aquatic plants, insects, birds, and other animals. A retention basin, according to the minimum standards, has 50-90% sediment removal efficiency and 40-90% soluble nutrient removal efficiency. Planting marshes on sloped embankments of the rivers prevents landslides and erosion. Retention ponds can be used to hold excessive surface run-off, and during the dryer seasons, become sloped land that can be used for seasonal plantation and as recreational space. Furthermore, they can hold thousands of gallons of water during heavy rainfall. The retention pond in Chulalongkom University Centenary Park in Bangkok, Thailand, can hold up to a million gallons of water during heavy rainfall to prevent city-wide waterlogging. This is ideal for a city like Chattogram that disperses 5000 tonnes of wastewater to the river, as mentioned in the environmental issues section.

6.4 Marsh Parks

Marsh parks that home various living species can increase ecological diversity. Marshland is able to contain the overflow of the surface run-off before it flows to the rivers or before the overflow water of the river spills onto either bank. Certain species of marshes are effective at water filtration and reducing land degradation.

Broadleaf cattail (*Typha latifolia)*, Indian Lotus - Shapla (*Nelumbo nucifera)*, Saltgrass (*Distichlis spicata)*, Cat tail – Kashful (*Saccharum spontaneum)*, Purple marshlock (*Potentilla palustris)*, Purple lythrum (*Lythrum salicaria)*, Lawangrass - Durba (*Zoysia japonica)*, Perennial ryegrass (*Lolium perenne)* are several of the many local plants that are suitable to grow in bioswales, retention ponds, and marsh parks. The benefits include beautification, increase of biodiversity, adaptation to harsh climate, water filtration, flood prevention, adaptability with changing season and climate, resistance to heat, drought and pollution reduction, soil-salinity reduction, and the reduction of erosion and sedimentation.

Studies show that, after a three-step water filtration system, water that has WQI over 130 can come down to 31.0-51.9. As previously shown, the current WQI for Karnaphuli is 100.1-113.93 (Bakar et al., 2018); introducing a natural three step water filtration system will have a considerably positive impact on the ecological system of the river.

6.5 Multipurpose Community River parks

A successful riverbank restoration cannot be complete without community participation. As discussed in the national approach section, an interactive riverbank ensures a sustainable future as it is the users who are inclined to maintain the area for their own benefits. Therefore, through community collaboration, a multi-faceted approach using embankment restoration, water filtration, and storage should be considered. Multipurpose use, such as community gardens, waterbodies, and recreation spaces will encourage community engagement.

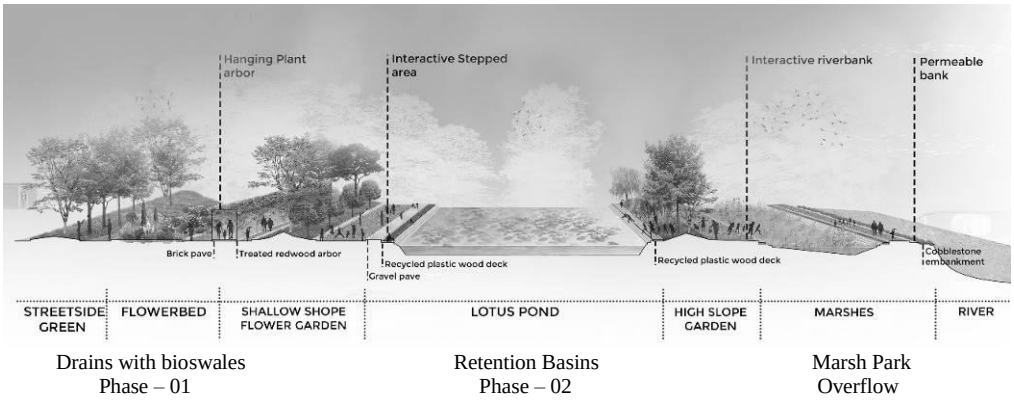

Figure 5. Visualisation of a riverfront park with bioswales, retention pond and marsh park

Figure 5 demonstrates how the concept of two-phase filtration with different types of retention ponds can be used to capacitate excessive surface run-off during the monsoon to prevent flooding and to filter water, while also being used for recreational space and community gardens to encourage community engagement and biodiversity.

For building any community facilities, soft permeable materials should be used so that the excess surface water can easily seep into the ground.
If we refer back to the national and international approach section, this methodology can be done in two phases. The first phase would focus on human activities such as fishing, fish markets, fish farming, water-based recreation, farming, water-based transportation, etc. The second phase would revolve around community based sustainable solutions, as previously mentioned in the methodology.

7 Conclusion

The Karnaphuli riverbank in Chattogram is one of the most significant riverbanks in Bangladesh. Despite being ripe with potential and historical significance, it is currently neglected in terms of lacking appropriate infrastructure to support the river eco-system and the community. Once used as an important port, the locality that was vibrant with cultural activities and diverse species has lost its identity and natural resources. These factors can be re-explored with modern sustainable solutions and critical thinking; this was attempted in this report with the two-phase water filtration system that addresses the environmental, ecological, and community issues. Recent environmental issues, such as water logging, flash floods, water pollution, effects of climate change, and loss of biodiversity were addressed and provided solutions that revolved around old-practices and community participation with consideration given towards climate adaptation.

Therefore, in a broader sense, the implementation of a climate appropriate sustainable method requires more focus, not just for the area discussed, but for all the important riverbanks in the country that have been victims of negligence. In order to achieve an appropriate solution, contextual understanding requires proper attention.

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