ENVISIONING RIVER-BASED URBANISM IN BANGLADESH
A landscape-systems-informed approach for urban settlement pattern within a decolonized river terrain

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Abstract: Bangladesh was once a river-based artisan context where the locals co-existed with the ever-shifting land and water. But this transient context was transformed into a static land-based agrarian one, by the land policies during the colonial period. Consequently, inappropriate settlements took over the river terrain and the locals started conceiving natural riverine flood and erosion exclusively as calamities. Colonial river engineering mechanisms appeared to be faulty as they were devoid of awareness of the underlying landscape systems and failed to protect the local population from these riverine calamities. This research intends to find suitable landscape architectural strategies that can dismantle the colonized river domain and alleviate the adverse effects of flooding and land erosion while guiding the urban settlements within the transient river terrain. The Brahmaputra-Jamuna River system has been taken as a case-study site for the research by design. Through site analysis at multiple scales and investigation of native practices, precedent cases, and relevant toolboxes, the research demonstrates design schemes, applying a set of multi-scalar landscape architectural strategies and tactics that can promote resilience for the local settlements to deal with apparently adverse riverine landscape events so that they can be harnessed for the greater good of the community.

Keywords: *River colonization; flooding and land erosion; Brahmaputra-Jamuna River system; river-based urbanism; landscape systems-informed design.*

1. Introduction

Bangladesh is a small riverine country in Southeast Asia, where rivers define, shape, and play the most important role within the landscape system. Among the major rivers of Bangladesh, the dynamic braided river system of Brahmaputra-Jamuna has been the lifeline of large settlements generated over time along its flow zone. However, these settlements, sometimes insensitive and imposing on the river's natural flow, have also faced adversities related to riverine landscape events such as flooding and land erosion.

In this paper, we focus on the braided river system of Brahmaputra-Jamuna located in the north-western part of Bangladesh. Here, we will discuss how the imposing pattern of urban settlements, sometimes disregarding the river systems, increases the negative impact of the riverine landscape events and why current river engineering and management strategies are failing to address this. In the process, we will suggest an indigenous knowledge-informed landscape systems approach for envisioning a river-based urban settlement that can mitigate the adversities of the riverine calamities and harness their positive impacts to make the communities more resilient.

1.1. THE NATURAL RIVER DYNAMICS OF BANGLADESH

Bangladesh, a deltaic country, is located at the lower part of the basins of three mighty rivers—the Ganges, the Brahmaputra, and the Meghna (Rahman and Salehin, 2013). As rivers support the most rudimentary functions of life, such as drinking, washing, agriculture, and industrial production, the livelihood and culture of the local population, are closely linked with the Ganges-Brahmaputra-Meghna River basin system (Bosu and Ullah, 2020). These major rivers and their tributaries have their headwaters outside of Bangladesh (Brammer, 1990) and every year, the cross-border runoff drains into the deltaic plain of the country. Annually, 20.5% of the area of Bangladesh is flooded on average, and up to 70% of the country is inundated in extreme cases (Mirza, et al., 2003). Hence, flooding is a regular natural event here making the terrain of the country transient amidst the presence and absence of water.

Similar to floods, riverbank erosion is also a common phenomenon in braided river systems. Rivers constantly change their course, changing shape and depth, trying to find a balance between the sediment transport capacity of the water and the sediment supply (Islam and Rashid, 2011). While one bank of the river erodes, new land is accrued on the other side (Hasnat, et al., 2018). Global warming and climate change over the past few decades, have induced changes in rainfall

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patterns resulting in further increases in riverbank erosion, accretion, and bankline movement (Rahman, 2023).

From the above discussion, we can understand that flooding and erosion are part of natural river dynamics and they define the characteristic features of a braided river system. On the other hand, researches show that any fixed or permanent infrastructure on the inherent trajectory of the river can disrupt the natural river flow and ecosystem causing further adverse impacts of riverine calamities to the adjacent areas. Multiple cross-border dams in the Brahmaputra River basin, have aggravated floods and induced hazards for the riverine communities (Rahman, 2020). A study on the middle reach of the Ebro River in Spain reveals that flood and erosion protection measures have restricted the natural dynamics of the river and increased the adverse impacts of these calamities in some cases (Horacio, et al., 2019). Imposing infrastructural developments such as dam construction coupled with climate change can significantly reduce the flow variability and disrupt riverine ecosystems essential for the livelihood of the riverine communities (Mittal, et al., 2015). Hence, there needs to be an alternative nature-informed solution to address the adversities of these riverine calamities.

1.2. THE IMPACT OF COLONIZATION ON THE RIVERINE LANDSCAPE OF BANGLADESH

From time immemorial, the locals inherently negotiated with a dynamic river network for settling in the Bengal delta (Bosu and Ullah, 2020). The region inhabited a river-based artisan economy where agriculture was a secondary occupation and the rivers along with their innumerable waterways, supported the lifeline and economic growth of the local community. The major characteristic feature of the Bengal terrain was its fluidity, consisting of constantly shifting land and water. This very nature was altered during the colonial time through legal and infrastructural interventions aimed at stabilizing lands, taming mighty river forces, and creating permanent boundaries between them so that constant revenues could be generated from the agricultural landscape (Lahiri-Dutt, 2014). The main objectives of these authorities were to ensure maximum agricultural production and minimum damage caused by natural calamities (Bosu and Ullah, 2020). As a consequence of building embanked railway lines, embankments, dams, etc., exiting natural drainage and flow systems were gradually blocked. Thus, previously benign monsoon floods became destructive forces and were perceived as calamities by locals (Ghosh, 2018). This imposing approach transformed flood-dependent agrarian landscapes into flood-vulnerable ones, disrupting the native ecologies and balance between land and hydrology (D'souza, 2004).

Following the Colonial legacy, the later Pakistan regime and even the national water planning measures taken in independent Bangladesh almost solely resorted to structural flood control approaches that have had numerous negative impacts on the local community, and lessons from the failures have not been adequately learned (F. Rammelt, et al., 2018). Cunha (2018) states that the way colonials drew the map of rivers, as lines separating land from water, proves their misunderstanding of the native river systems and therefore, their actions, regarding river management were flawed. He further demonstrates that rivers are part of an intricate cycle of water, and wetness. Any line between land and water thus cannot be taken for granted as it is ever-changing.

1.3. PRESENT PROBLEMS WITH THE RIVER-MANAGEMENT PRACTICES

The unplanned infrastructural growth and enormous flood control measures in a floodplain environment like the Bengal Delta have resulted in flood disasters becoming larger and more frequent in recent times. Since the mid-1960s, embankments, drainage channels, sluices, and regulators have been built for flood management, but they have proven inappropriate mostly due to the lack of consideration of interdependence of land, water, ecosystems, and socio-economic development. Projects were mostly formulated with single objectives, aiming to solve immediate problems without giving adequate attention to undesirable long-term consequences (Rahman and Salehin, 2013). Flood-controlling fixed interventions such as roads and other transportation infrastructures tend to disconnect the floodplain area from the river dynamics, creating disturbance to river-floodplain connectivity and associated ecological balances (Blanton & Marcus, 2009). Consequently, river-edge resources like fish and riparian vegetation cannot be harnessed properly (Sultana & Thompson, 2017). Furthermore, embankments can fail due to overtopping, leading to flash floods, especially with increased frequency of high magnitude flood events (Powledge, et al., 1989). Figure 1 shows how the floodplain performs in a natural context and how the natural process is disrupted by the built embankment causing havoc to the imposed urban settlement.

While the presence of a flood plain helps the accretion process, the use of concrete embankment reduces natural accretion (Figure 2). Human-induced changes to the natural flow of the river, including bank protection, riparian vegetation removal, flow regulation, and flood control, have interrupted the natural equilibrium between erosion and deposition (Buer, et al., 1989). Figure 2 demonstrates that a concrete embankment along the urbanized river edge increases river current velocity and triggers more land erosion along the unprotected rural edge. In Bangladesh, over the last decade, it has been observed that in most cases, the affected people abandon their settlements in rural areas and move to towns and cities leading to chaotic urbanization without adequate planning and amenities (Ahsan, et al., 2011). This proves that the present protective measures must be taken under further scrutiny.

From the above discussion, it can be said that these expensive and imposing river-control systems are not appropriate for the fluid nature of the local landscape and are generating more problems than solutions. To deal with the land and river and their constant transience, the landscape system needs to be thoroughly understood and measures should be taken accordingly.

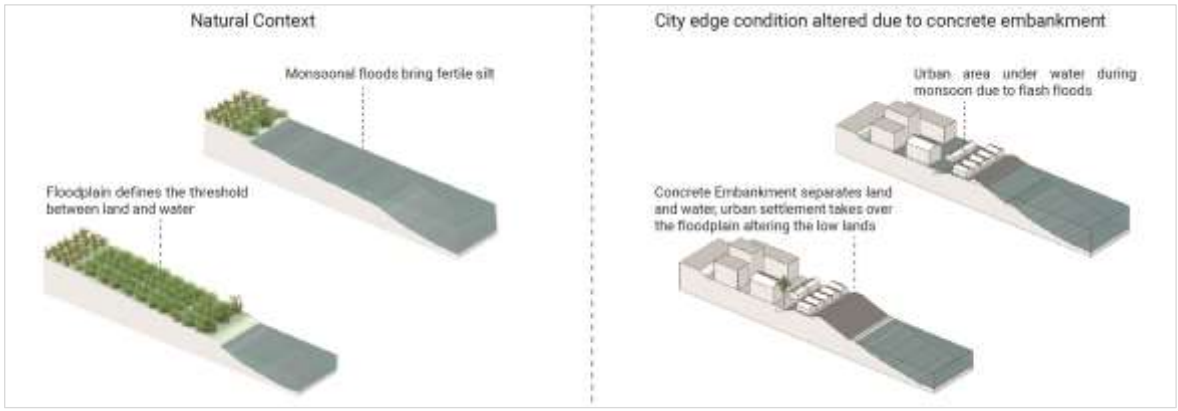

Figure 1: A study on the natural condition of a floodplain and altered condition of a floodplain in the presence of a concrete embankment road (*Source: Authors*)

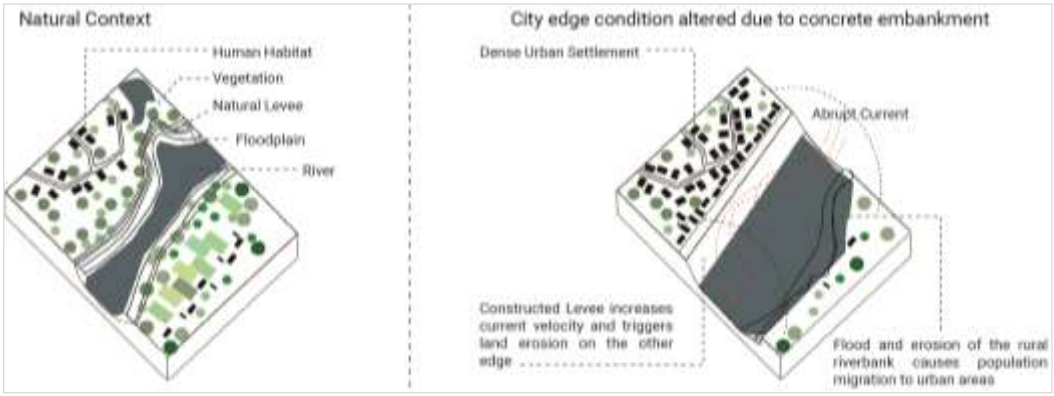

Figure 2: A study on the natural context of river erosion and the adverse impact of a concrete embankment road on river erosion (Source: Authors)

1.4. RESEARCH QUESTION

The research explores how an indigenous knowledge-informed landscape systems approach can dismantle colonial infrastructural impositions to control the river domain and mitigate adverse impacts of landscape events like flooding, and land erosion while guiding urban settlements within the dynamic river terrain.

2. Methodology

We adopted a research-by-design methodology, focusing on the Brahmaputra-Jamuna River System as our case study area as it is prone to extreme flooding and significant erosion along its bank line (Rahman, 2023). To comprehend the underlying landscape systems and existing challenges with the current river-controlling infrastructure and riverine calamities in the case study area, mapping was done in macro, intermediate, and micro scales addressing multiple issues such as hydrological systems, land use, infrastructural networks, past and present traces of the river and its tributaries, green spaces, vegetative covers, etc. Site visits and desk studies were conducted to attain further information on the prevailing challenges in different scales of the case study area.

To address the main objective of the research by design, i.e., to explore how the river system can be decolonized by employing a native wisdom-informed landscape system approach for a river-based urbanization process, a set of multi-scalar landscape design strategies and tactics were developed. Multiple design iterations in the macro, intermediate, and micro scales were done with feedback discussions on the pros and cons of each iteration phase to finalize the strategies and tactics and formulate the most appropriate design schemes envisioning river-based urbanism.

2.1. THE CASE STUDY AREA IN MACRO, INTERMEDIATE AND MICRO SCALES

The Brahmaputra River is one of the largest braided rivers in the world and it flows about 3848 km from its source in the Himalayas to its confluence with the Padma River in Bangladesh. The river is prone to heavy flooding when the snow melts in the Himalayan region. The lower part of this river within Bangladesh is called the Jamuna River, the largest sand-bed braided river in Bangladesh (Rahman, 2023). Mapping of Brahmaputra Basin and greater geological context (Figure 3) reveals significant insights regarding river dynamics and associated geological context. Brahmaputra River generates

numerous tributary rivers and the position of two geological plates, namely, Barind and Modhupur tracts, create a unique alluvial and low land through which Brahmaputra traverses. The presence of tectonic plates causes the river bank along with the river course to shift towards either side of the bank within the Jamuna River basin.

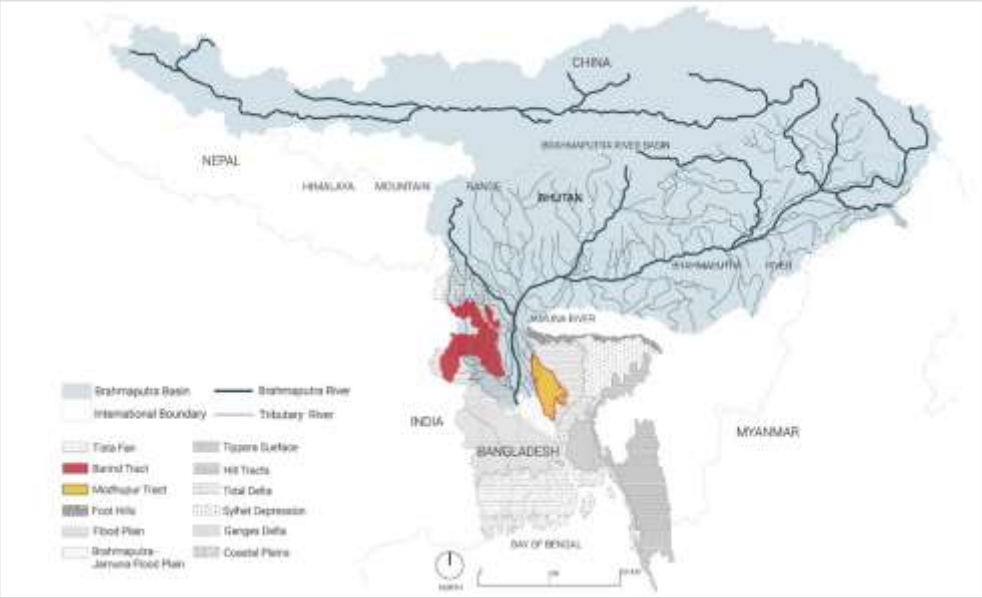

Figure 3: The geological and hydrological context of the Jamuna-Brahmaputra River System
(Source: Fischer, et al., 2017)

At the divisional scale (macro-scale) of the Jamuna-Brahmaputra River System (Figure 4), there are a few pressing problems induced by river colonization. Mapping reveals that the tributary rivers entering the adjacent areas have been marginalized due to insensitive road and embankment construction. These imposing roads and embankments have detached the natural floodplain from the flow zone of the river course. In addition, mapping and site analysis show a lack of vegetation and tree cover along the unprotected river banks. This is due to mass deforestation and a lack of native wisdom in planting trees to protect the river's edge. These problems have a great impact on the dynamics of the entire stretch of the river. In the absence of connection to natural floodplains and tributaries and protective green buffers, more adversities are caused to the adjacent urban and rural settlements related to flood and erosion.

On the city scale (intermediate scale), we focus on the urban context of Sirajganj town (district headquarters area) along the bank of the dynamic braided river system of Brahmaputra-Jamuna within the Rajshahi Division of Bangladesh (Figure 4). Since the inception of Sirajganj town in the late nineteenth century, the urban area has been under almost constant threat of riverbank erosion and annual flooding (Hutton & Haque, 2004). Riverbank erosion has caused substantial land loss and population displacement in the Sirajganj riverine area of Bangladesh in the past years (Rabbi, et al., 2013). Site analysis shows that this urban context consists of colonial idea-driven protective embankments encouraging urban encroachment over the floodplain. A study on the Jamuna River floodplain revealed that structural flood protection can paradoxically increase population density and flood mortality in Bangladesh (Ferdous, et al., 2020).

From the mapping in Figure 4, it can be seen that an embankment road along the river edge, divides the floodplain from the river dynamics and this induces flash floods in the urban area during monsoon. The tributary river connections that once had access to the inner city and were a mode to minimize flood and erosion forces of the river are also lost due to the colonial practice of building roads across the water channels. Due to the construction of inner roads, the inner-city waterway got further fragmented and stagnant. Eventually, it became a dumping zone for the city. Moreover, the construction of an imposing road network has diminished the traditional means of water transport which was cheap, vernacular, and more resilient with the transient landscape. Although the concrete embankment mitigates river erosion to some extent, it prevents any sort of accretion and adversely impacts the erosion scenario on the adjacent peri-urban and rural edges. Also, the area lacks open green spaces for public activities catering to a lower livability context, which could be ameliorated by harnessing a healthy and resilient relationship with the river system and its transient edge.

In the case of the neighborhood scale (micro-scale) of Sirajganj Municipal context, the mapping is focused on the site where a tributary river got disconnected from the main Brahmaputra-Jamuna River system due to the embankment road construction (Figure 4). The embankment road has disconnected the settlement from the river. Moreover, the existing urban settlement does not leave necessary space for water retention and drainage measures or refuge spaces to be used during flooding events. Hence, the settlement suffers from flash floods and waterlogging issues.

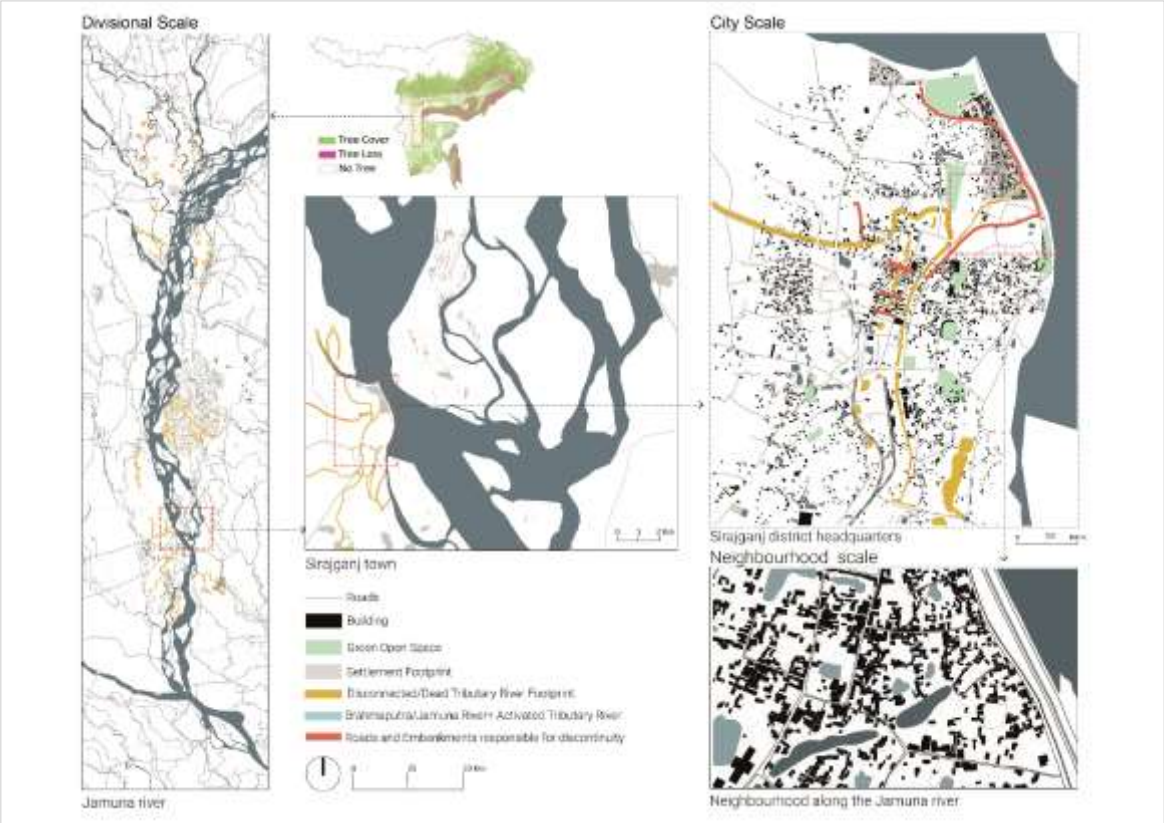

Figure 4: The case study area of the Brahmaputra Jamuna River system on macro, intermediate, and micro scales (*Source: Authors*)

Considering the consequences of river colonization in the case study area at different scales mentioned above, we can realize the importance of decolonizing the river edge by understanding the landscape systems to determine an appropriate urban settlement pattern within the area.

3. Result

Based on the issues found in the site discussed earlier, the research-by-design explored landscape architectural design iterations on multiple scales of the braided river system (divisional scale). Taking an indigenous knowledge-informed landscape systems approach the design iterations comprised a set of landscape design strategies and tactics. Based on the fact that they meet four criteria, namely, ecological awareness, economic returns, social engagement, and a sense of resilience; precedent cases, relevant literature, historical references of local wisdom-informed native practices, and landscape design toolboxes, were studied. These, along with the analysis of the landscape systems of the site and learnings from initial design iterations, aided the formulation of the strategies and tactics employed in the resulting design schemes.

3.1. MACRO SCALE DESIGN SCHEME

The proposed design scheme on the divisional scale went through two prior iteration phases. The first two design iterations majorly focused on protecting river courses along with river banks of the main and tributary rivers. These iterations only partially addressed the research question as they did not consider the existing colonial river controlling infrastructures in the process. Eventually, the proposed macro-scale design scheme was built upon decolonizing the entire river basin system by implementing a set of landscape systems-informed design strategies (Figure 5). The strategies are as follows:

- The tributary rivers will be reconnected with the main river course by dismantling all the fixed colonial river engineering infrastructures and encroachments. The reconnection with tributary rivers will create more space for the river to flow and reduce pressure on the river bank to lessen the impact of flood and erosion. It will create appropriate space for riparian vegetation and fish breeding.

- Protective green belts will be planted along the river edge to stabilize the river bank against river erosion. This will also help to create a continuous ecological network and multiple ecosystem services like urban heat reduction, mitigating air pollution, food source, urban recreation etc. as co-benefits.

- The floodplain would be reconnected with the river system for flood water inundation and siltation process. This will, in turn, increase land fertility and better river navigability.

Figure 5: Landscape systems-informed design strategies for landscape architectural intervention on the macro scale (*Source: Authors*)

The proposed large-scale design scheme (Figure 6) may be implemented in multiple phases over a considerable period within the entire stretch of the Brahmaputra-Jamuna River basin of Bangladesh. The design scheme would regenerate a river-based lifestyle within the region through harnessing floodplains, and green belts to complement the river dynamics absent in the river-controlling infrastructures at present. Water transportation, one of the cheapest conveyance mechanisms, would be revived to cater to the river-based lifestyle. In the process, a novel water-based human settlement could be incorporated.

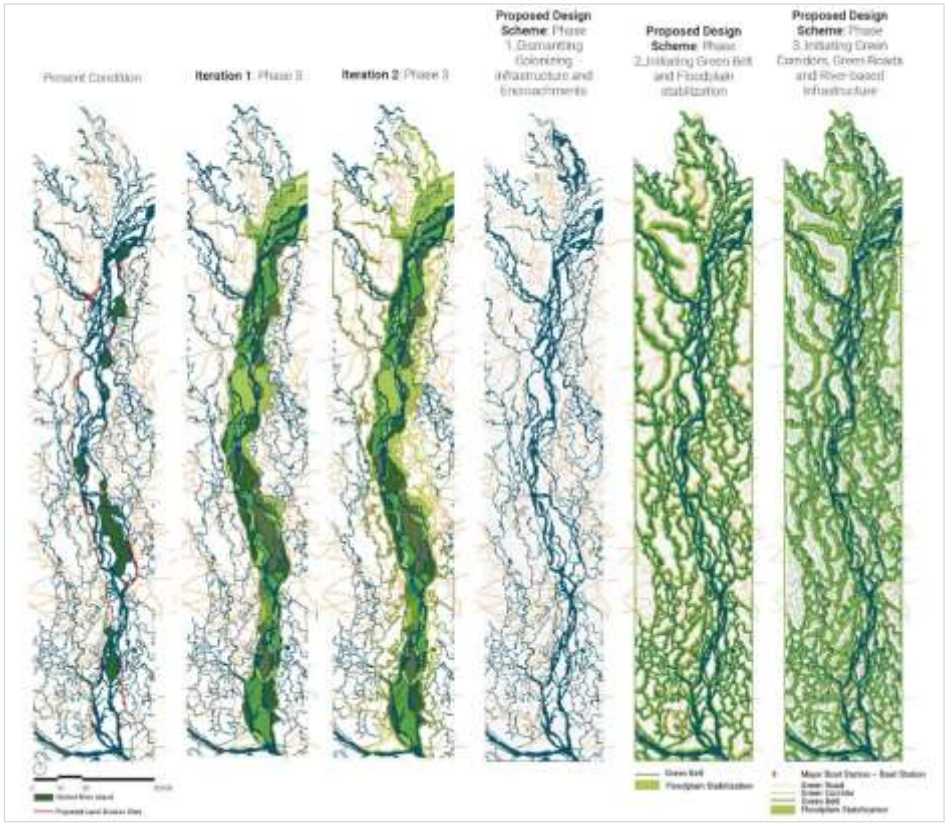

Figure 6: The proposed landscape design scheme on the macro scale (*Source: Authors*)

3.2. INTERMEDIATE SCALE DESIGN SCHEME

In the case of the scale of Sirajganj city, similar landscape architectural strategies as mentioned above, have been followed to create a future vision of the decolonized river-based urbanism (Figure 7). The first design iteration following the larger scale, entailed massive alterations in the site to accommodate the river dynamics within the existing urban fabric and hence more difficult to execute or realize. Therefore, the proposed landscape design scheme has tried to carry the idea of decolonizing the entire river domain but keeping the existing urban morphology. By dismantling the concrete road embankment along the river edge and relocating illegal encroachments from the river floodplain area, the floodplain will be reconnected with the main river flow and function as a transient urban green space with various public amenities. The dying river tributaries in and around the urban area will also be reconnected to the main river course to ensure a constant flow of water within these tributaries. These urban waterways along with riparian vegetation, will work as urban green-blue corridors and create active urban public realms. The main river and its tributary lines will form a water transportation network for the city resonating with the historical and vernacular practice of the riverine community. A green buffer will replace the concrete embankment along the main river edge.

Figure 7: The proposed landscape design scheme on the intermediate scale (Source: Authors)

3.3. MICRO SCALE DESIGN SCHEME

In the case of the micro-scale selected site, the first design iteration harnessed existing open spaces and vegetation cover to generate river-based urbanism. This scheme would be easy to implement but through feedback discussions, it was pointed out that the scheme lacks resilience during extreme landscape events such as floods. Hence, the proposed landscape design scheme has adapted four neighbourhood-scale spatial design tactics in the selected micro-scale site (Figure 8). They are:

- Pond and flood mound: Following the local vernacular practice, if ponds and flood mounds are introduced within the river-based settlement, they can be harnessed for urban productive and recreational activities such as fish and duck cultivation, water harvesting, playing, and gathering. The ponds can also work as a buffer zone to prevent urban water-logging during the monsoon. During extreme flood scenarios, the mounds can be refuge spaces for the community.
- Urban green corridors and open spaces: Introducing an urban green belt by the riverbank of the main and tributary rivers will ensure shoreline stability and provide resilience against erosion. They can also perform as urban ecological corridors and recreational spaces. These forested areas and tree lines will also reduce urban heat.
- Permeable semi-green secondary roads: While there could be some major roads still co-existing with the proposed river-based urban settlements, the secondary roads can be lined with grass pavers creating a permeable semi-green surface for non-motorized vehicles and pedestrian movement.
- Raised plinth of buildings and homestead: The age-old native technique of simply raising the plinth of the house can be a resilient and protective measure to address flooding events. The raised plinth space and its surroundings can become productive surfaces for the household to practice urban agriculture.

The rationale behind these land-based design tactics to guide the proposed river-based urban settlement in the final iteration of the design is that, land is an inseparable component of the water systems within the Brahmaputra River basin; where river edge, floodplain, land terrain, vegetation, pond, and other water-bodies play equally important roles as the river bed and river course. The micro-scale landscape design scheme through implementing developed design tactics, acts as a flexible living infrastructure within the transient rive terrain.

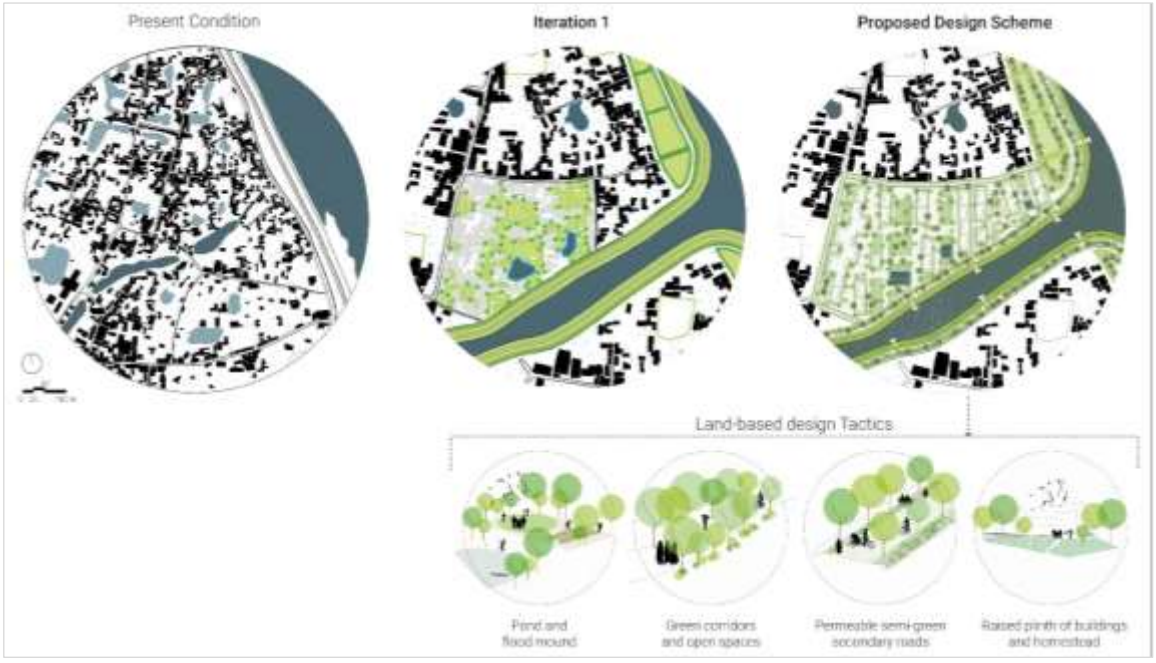

Figure 8: The proposed landscape design scheme on the micro-scale (*Source: Authors*)

3.4. WORKING ACROSS SCALES

The learnings from applying the landscape architectural strategies in different scales and in multiple design iterations can be further employed to interpret tentative working phases to achieve resilience and co-exist with riverine landscape events. Of course, long-term planning and policy changes may be required to attain such a river-based urban settlement pattern at the scale of the entire river system. However, the city and neighborhood scale strategies could be implemented gradually by local governing bodies in collaboration with government agencies ensuring active collaboration with the stakeholders. These pilot projects and living laboratories may inspire other similar urban areas gradually. Landscape design visions similar to the above-mentioned ones can be demonstrated to the stakeholders to make them realize the adversities of river colonization and break away from the colonial lens of viewing natural riverine landscape events as calamities.

4. Conclusion

Every year during monsoon, Bangladesh is blessed with fresh water from the Himalayan range traversing through the land to the Bay of Bengal. Unfortunately, in the presence of colonial river-controlling infrastructures and due to the lack of native knowledge in practice and awareness of local natural processes, we translate this invaluable resource into apparently adverse landscape events of flooding and land erosion. While economically challenged and marginalized people are the worst sufferers of these calamities, floods, and erosion cause damage to valuable resources and hinder the living quality of the entire urban fabric, which, in most cases, is densely populated and inappropriately planned.

To change the above-mentioned insensitive river management practices, the conducted landscape architectural design research aims at achieving means to disengage colonial river-controlling mechanisms and alleviate the adverse impacts of riverine landscape events such as flooding and erosion. In the process, the expected research outcome was to employ appropriate landscape architectural strategies and tactics to arrive at a multi-scalar design scheme for a phase-by-phase decolonization process and shift towards a river-based urban settlement that can harness the positive impacts of the riverine natural processes. The awareness of underlying landscape systems along with the historical study of native wisdom to co-exist within this transient riverine terrain, have guided the search for the appropriate strategies and tactics.

The proposed landscape design schemes resulting from the multiple iterations of the research, work as living infrastructures within the city and address the issue of social cohesion, offer space for local economic activities, foster ecology and biodiversity within the urbanity, and empower settlements with resilience against severe riverine landscape events.

Although our research demonstrates the theoretical outcome of river decolonization and the process of establishing a new river-based urbanization pattern, the Government and local stakeholders are expected to establish meaningful partnerships over a considerable period to attain the desired result. The first step to this would be to decolonize the negative mindset of the local populace against the natural riverine landscape processes and inspire them to co-exist within a balanced urban settlement in the dynamic river terrain.

To conclude, it can be said that this landscape design research opens up a new scope for further research in related fields. Climate change-induced riverine natural calamities are a global concern and this research addresses that by a local example. The outcomes can be further simulated or tested on the real site and context through an action research process to enrich the adapted research framework and accommodate improvements. Multidisciplinary action research would offer more details about architecture, urban design, agriculture, transportation, and other aspects of the newly proposed river-based urbanity and inspire more related design research regarding urban settlements within the dynamic river terrain.

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