URBAN WETLANDS IN PERIL

Uncovering Socio-economic, Governance and Legal Challenges in Bangladesh

edited by
ISHRAT ISLAM, MOHAMMAD SHAKIL AKTHER, TASLIMA ISLAM

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Preamble

Wetlands are one of the vital life support systems and important components of earth's ecosystem service. These have a diverse ecology in terms of habitat size, hydrology, and geomorphology both in spatial and temporal scales (Halls, 1997). It is defined as the *"areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters."* (UNESCO, 1971). In addition, riparian and coastal zones adjacent to the wetlands and islands or bodies of marine water deeper than six meters at low tide can be considered as wetland (UNESCO, 1971). Historically, wetlands have been viewed as places that have been drained and converted for more profitable uses, like agriculture (Matthews, 1993). Considering the tangible and intangible values of wetlands, the global community came forward with the commitment to ensure the sustainable conservation of wetlands. This vow is reflected in many global documents like the *Ramsar Convention's Strategic Plan 1997-2002* (UNESCO, 1996), *Brundtland Commission Report* (Brundtland Commission , 1987), *Agenda 21* (United Nations, 1992) and recently in *SDG (2016-30)* (United Nations, 2015). At a national level, many governments adopted policies, strategies, and acts to save the blue networks of the country. Considering the importance of wetlands, it is stated in the constitution of Bangladesh that *"The state shall endeavor to protect and improve the environment and to preserve and safeguard the natural resources, biodiversity, wetlands, forests and wildlife for the present and future citizens."* (Government of Bangladesh, 1972 as amended in 2011).

Wetlands are considered as among the Earth's most productive ecosystems, that support the livelihood of millions of people, and provide enormous goods and services (Barbier, Acreman, & Knowler, 1997). The vast wetlands in urban and rural areas of Bangladesh are considered a divine gift of nature, but fast disappearance of urban wetlands is considered a major threat from environmental and socio-economic perspectives. The research findings of Bangladesh Environmental Lawyers' Association (BELA), Bangladesh Institute of Planners (BIP), and Transparency International Bangladesh (TIB) revealed the alarming loss of 43,200 out of the total 187,958 acres of wetlands of Dhaka in between 2010-2018 (Hashim, 2019). Similar scenario is evident in Chittagong City (Hredoy, Naim, Sikdar, & Islam, 2018), and Rajshahi City (Kafy, Islam, Khan, Ferdous, & Hossain, 2019). The adverse impacts of such loss of wetlands are multifarious, which include deteriorating environment and biodiversity, adverse impact on livelihood of people, decreasing ground water table, causing urban flooding, and overall loss of tranquil natural environment for physical and mental well-being of people.

The coexistence of nature and development has always been a challenge, and keeping the balance is critical. The publication from Environmental Law Centre, IUCN rightly identified the complex relationship among different actors and the socio-economic and political factors that shape

the arena of wetland conservation and its wise use. This complex scenario related to urban wetland conservation has been independently researched from different disciplines. The loss of wetlands in urban areas and its impacts were studied from spatio-temporal perspectives. But factors behind the loss of wetland have not been yet studied in a comprehensive way as it involved knowledge from different backgrounds such as urban planning, environmental science, economics, sociology, law, and so on. Moreover, the eminent researchers contributing to this field never got an opportunity to exchange their views and ideas to conserve the wetlands of urban areas in a sustainable manner.

Against such a backdrop, a project was designed to understand the dynamics of wetland conservation from socio-economic, legal, and governance perspectives. Center for Regional Development Studies (CRDS), Bangladesh University of Engineering and Technology (BUET), and Bangladesh Environmental Lawyers Association (BELA) initiated the project, which was funded by the Tang Prize Foundation. The title of the project is "Disappearing Urban Wetlands in Bangladesh: Action Research on Socio-economic Governance and Legal Aspects," which had three objectives– (i) To initiate and support new research works on urban wetlands from various professionals and civil society members addressing the spatio-temporal, socio-economic, environmental, legislative, and institutional aspects; (ii) To train and support young researchers who are working on urban wetland and (iii) To formulate a guideline for mainstreaming wetland management in the planning process involving professionals from different disciplines through interactive workshops.

The eminent researchers of Bangladesh in the field of wetland management were invited to contribute in this project. Invited researchers from various disciplines, including planning, legal, journalism, as well as members from civil society contributed in four thematic areas. It is worth mentioning that young researchers were encouraged to contribute to this research project. The final output of the project is this book, where the research findings are presented in four thematic areas–Disappearing Blue Networks from Urbanscape; Wetlands Viewed through Socio-Economic, Political and Environmental Lens; Planning, Legislative and Institutional Framework; and Legal Battles, Civic Voice and Intellectual Discourse.

The project was launched with an introductory workshop to ensure interactions among the researchers and later the researchers shared their research findings with stakeholders in another daylong workshop. In the 2nd workshop, the participants also developed a guideline to conserve wetlands in urban areas of Bangladesh. The following chapter of this book presents the output of this workshop.

Overview of the Chapters

The first section of the book is titled "Disappearing Blue Networks from Urbanscape". Bengal is gifted with network of rivers and waterbodies and its beauty and abundance are extensively found in the literature, poetry and songs but scholarly works in the field of socio-economic and physical planning, ecological and environmental management on waterbodies are limited. The introductory article of this section provides the readers with a comprehensive understanding of the current state and issues associated with wetlands in Bangladesh by reviewing articles published in scientific journals and academic conferences and news articles from two of the most prominent newspapers, Prothom Alo and The Daily Star, from the year 2008. Next three chapters in this section

present spatio-temporal changes in the wetlands of Dhaka, Chattagram, and Rajshahi cities. All the researchers found that urban wetlands are transforming into built-up areas at an alarming rate. Among these cities, the rate of wetland loss is highest in Dhaka, where the encroachment of canals and rivers is a major concern. About 1,139 km of the blue network of Dhaka are proposed to be conserved in the Detailed Area Plan 2022–2035. Quddus *et al.* presented the current status of the proposed blue network and claimed that influential political individuals and entities are main protagonists of this encroachment. The wetland loss scenario of Rajshahi and Chattogram is no different from Dhaka. Hossain *et al.* and Raja *et al.* in Rajshahi and Chattogram found that cities are losing wetlands due to unplanned development caused by weak monitoring and enforcement of law. The authors are unanimous in their view that the decline in wetlands poses a significant threat to the local environment, including potential flooding risks and adverse impacts on aquatic ecosystems.

Section Two of this book, "Wetlands Viewed Through Socio-economic, Political and Environmental Lens," highlighted the socio-economic and environmental impacts of wetland loss in Dhaka. The researchers emphasize on the reasons and consequences of the ongoing encroachment of wetlands from the socio-economic and political point of view. Farha *et al.* identified economic interest, misuse of political and economic power, loopholes in regulatory frameworks, inappropriate approaches to development, and blame games among responsible agencies for the destruction of wetland in and around Dhaka. Again, Afroj and Anzum presented an in-depth analysis of how a marginal community is losing their livelihood and forced to be displaced due to the destruction of the wetland ecosystem. The key findings of Murshed and Rahman revealed that the loss of wetland not only reduces the livelihood of the people who are dependent on the wetland but also reduces land productivity, groundwater depletion, and the drastic loss of ecosystem services.

"Legislative and Institutional Framework", the third section of the book, focuses on policies, acts, and regulatory measures to protect urban wetlands. There are four chapters in this section. These chapters highlight that wetland loss is prevalent despite a considerable number of regulatory documents, as there are loopholes and poor implementation of the legal tools. According to Mehrin *et al.*, the problem of wetland disappearance has already been considered through various policy documents. Playground, Open Space, Park, and Natural Water Reservoir Conservation Act of 2000, National Water Policy 1999, and National Water Management Plan 2004 highlighted the importance of wetland conservation. Master Plans of different urban areas are the most appropriate arena where wetland-related strategies and regulations can be materialized. However, the authors identified that there is a lack of uniformity in defining waterbodies and wetlands. Furthermore, Hasan and Islam identified that the majority of the sectoral laws related to wetland protection are outdated and have not been amended. They also highlighted the need for comprehensive legislation with a proactive approach to eco-system protection. It is evident from the work of Ms. Islam that the High Court has supported the protection of wetlands through the verdict against various wetland filling and encroachment cases. But unfortunately, due to a lack of enforcement mechanisms, there is very limited compliance with the verdicts of the court. All three articles of this section provide a set of guidelines to address the challenges prevailing in the decision-making process of wetland management. Strong political will, strict enforcement of laws, updating the penalty for encroachers mentioned in the regulations, and solving the contradictions among various laws are mentioned as necessities by Farha et al.

"Legal Fights, Civic Voice and Intellectual Discourse", the concluding section of the book, highlights the contribution of the voices of civic societies and media in protecting wetlands. In general, the media played a significant role in raising awareness among citizens and policy makers regarding the invaluable importance of wetlands. A series of articles was published by popular print media highlighting the loss of urban wetlands. In addition, television media had dedicated programs showcasing the detrimental effects of the loss of wetland in the early 2010s. Maria *et al.* found that extreme waterlogging in the cities and decline in crop production due to unnecessary dam construction are two of the most evident impacts that were highlighted in the news articles. But interestingly, Mahmud explored the complex dynamics of media ownership and its linkage with wetland encroachers. He also drew attention to the politics of media personnel and showed how traditional media became enablers of those who are transforming the wetland into a so-called "Developed area". On the other hand, Azaz and Huq emphasized the crucial roles played by local people and social media in saving wetlands from time to time. These movements have stimulated many new conservation initiatives as well. They claimed that civil societies that intend to protect the wetlands hold the potential to be an important catalyst in the natural resources management process in this deltaic region.

This book provides a comprehensive understanding from identifying the factors behind and consequences of the excessive disappearance of the valued urban wetlands, the successes and failures of the legislative and policy bindings against the encroachment of wetlands to media and civic societies' continuous efforts in protecting their means of livelihood. The issues that are required to be prioritized for protecting wetlands were identified through the stakeholder workshop. Besides raising awareness, ensuring coordination among the stakeholders, updating and enforcing laws, and the eviction of illegal encroachments, the participants of the stakeholder workshop suggested developing an action plan for conserving wetlands. The participants also opined for formulating a committee to protect wetlands headed by DC, proper demarcation of wetlands according to the CS/ RS/ BS maps, making the data on wetlands widely available, and prioritization of research-based and bottom-up decision-making. It is expected that the chapters of this book will guide the policy makers to rethink the policies and wetland protection measures, keeping aligned with the national and global commitments and local vulnerable communities' needs.

Ishrat Islam, Mohammad Shakil Akther and Taslima Islam

Acknowledgement

The journey from concept to publication is rarely travelled alone, and this book is no exception. We owe a profound debt of gratitude to the many institutions and individuals whose support made this work possible. Our deepest thanks go to Ms Syeda Rizwana Hasan, an esteemed advisor to the Government of Bangladesh, who first envisioned this book while she was the Chief Executive of the Bangladesh Environmental Lawyers Association (BELA). Her initiative laid the foundation for this project. We are sincerely grateful to the Tang Prize Foundation for their generous financial support, without which the project could not have been launched. We also extend our appreciation to the Swedish International Development Cooperation Agency (Sida) for funding the workshops conducted under this initiative.

Special thanks are reserved for the contributors whose papers enrich our understanding of Bangladesh's urban wetlands. Their work bridges theoretical frameworks with real-world insights, and we have learned immensely from their contribution. We also recognise the many individuals who participated in surveys, focus group discussions, and interviews—their voices added depth and authenticity to our research.

We are grateful to our research assistants, Ms Maria Mehrin, Ms Fairuz Noshin, and Ms Sumaiya Tabassum. This book would not have come to fruition without the dedicated efforts of Ms Sumaiya Tabassum, who undertook the challenging task of communicating with all the contributors over the past year. Even after the end of her role as a research assistant in this project, she continues to be with us, tirelessly coordinating the publication process.

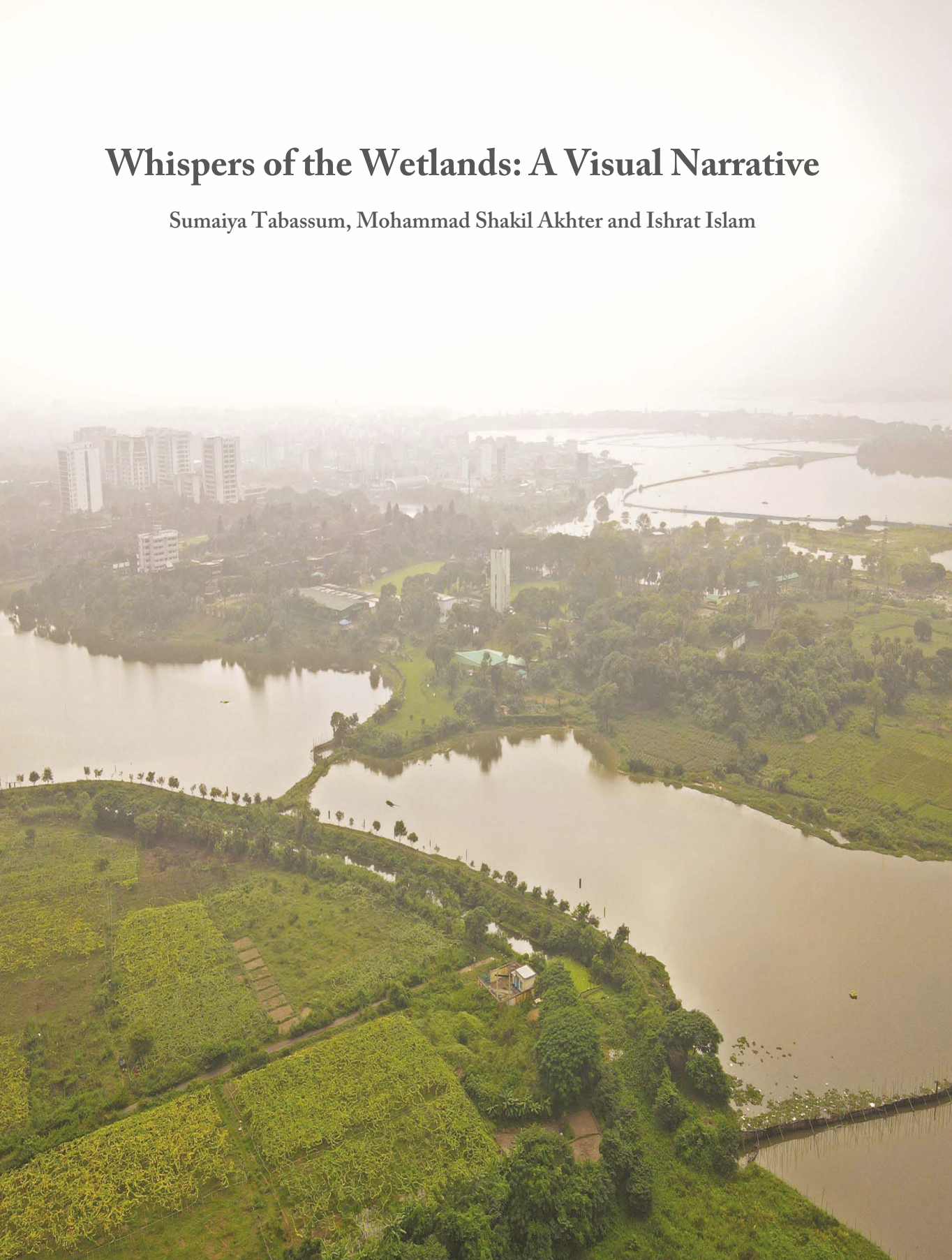
We extend our appreciation to Ms Mahrukh Mohiuddin, Managing Director of University Press Limited (UPL), for her early interest in publishing this book, and to her editorial team for their professional guidance and support throughout the process.

We would like to express our earnest appreciation to Mr Rakib Hasan, who has captured many of the recent photographs of the wetlands of Dhaka. In this opportunity we also like to thank Mr Md Waliullah for his support in retrieving the satellite images of wetlands of Dhaka over the years for the cover page. We express our gratitude to the authors for granting permission to publish their photographs. Despite our best efforts to trace and contact all copyright holders—particularly for images sourced from public domains such as newspapers and social media—we apologise for any unintentional omissions. In conclusion, we wish to express our deep gratitude to all those who contributed to this project, as your combined efforts and commitment have made this book a significant addition to the field of conservation of nature.

Ishrat Islam, Mohammad Shakil Akther
and Taslima Islam

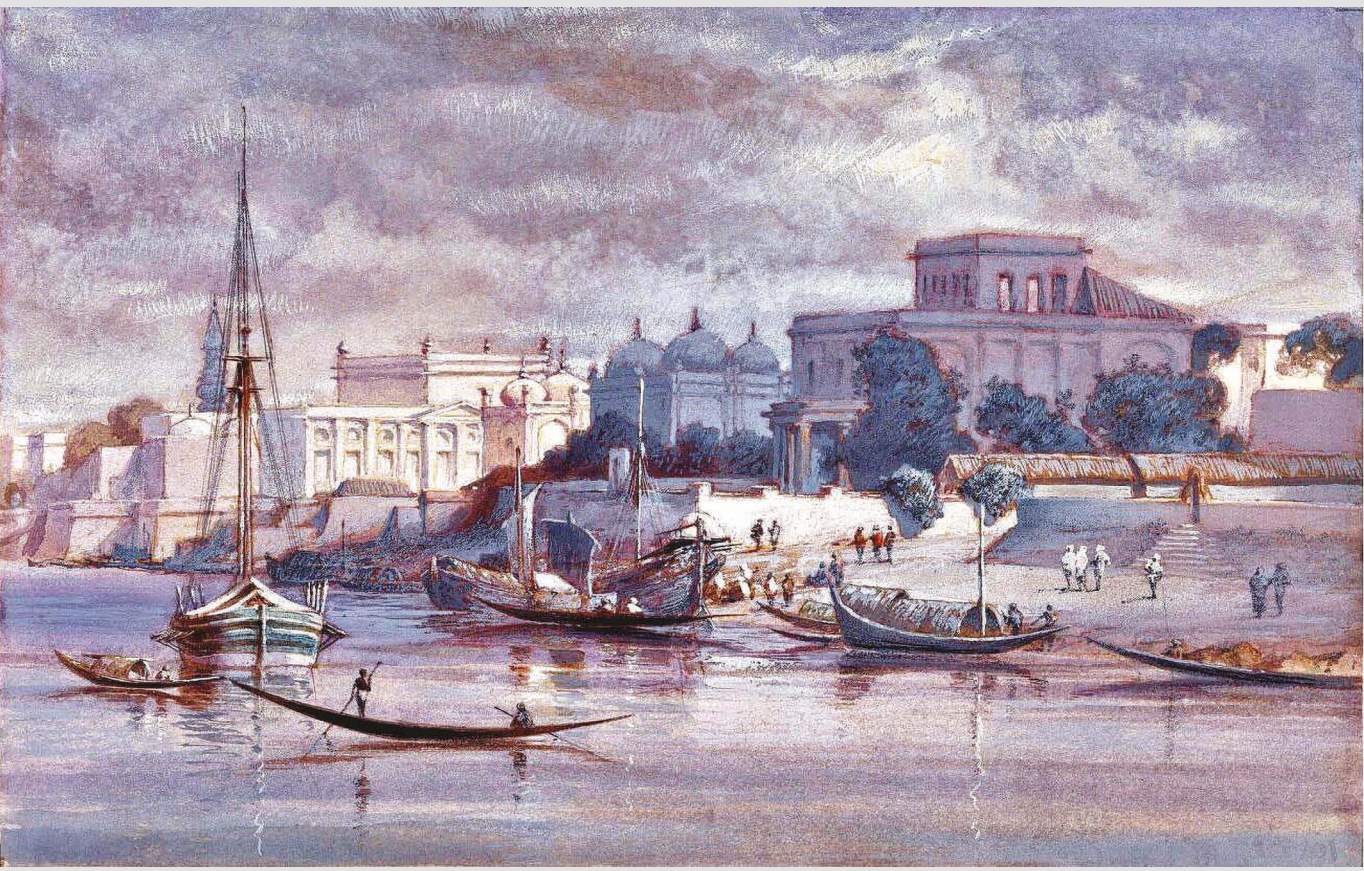
Whispers of the Wetlands: A Visual Narrative

Sumaiya Tabassum, Mohammad Shakil Akhter and Ishrat Islam



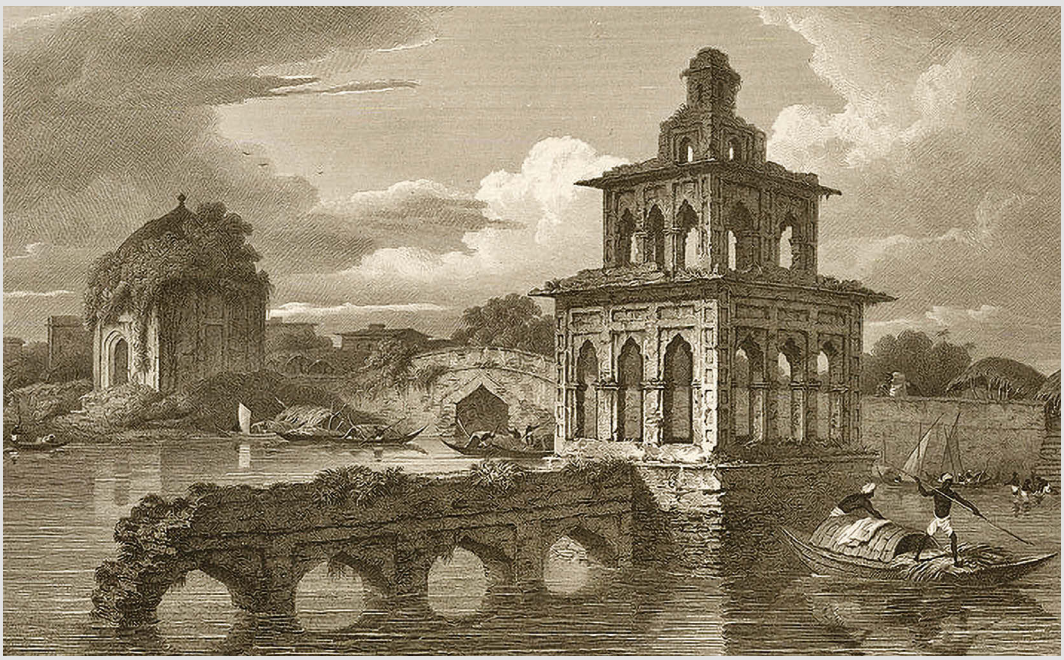
Living with Nature

The very fabric of Bangladesh's history, culture, and livelihoods is intricately woven with its rivers and waterbodies. Yet, as relentless Development Pressure'sweeps across the land, these invaluable resources are vanishing before our eyes. This chapter delves into the profound transformation of the wetlands in Dhaka and other urban landscapes, revealing their story through the fervent strokes of artists and the poignant imagery captured by photographers. Here, the essence of a vital ecosystem stands at the brink, as we confront the stark reality of loss and the urgent call for preservation.



Painting of Buriganga by Frederick William Alexander de Fabeck in 1861
(Source: Victoria and Albert Museum, 2004)

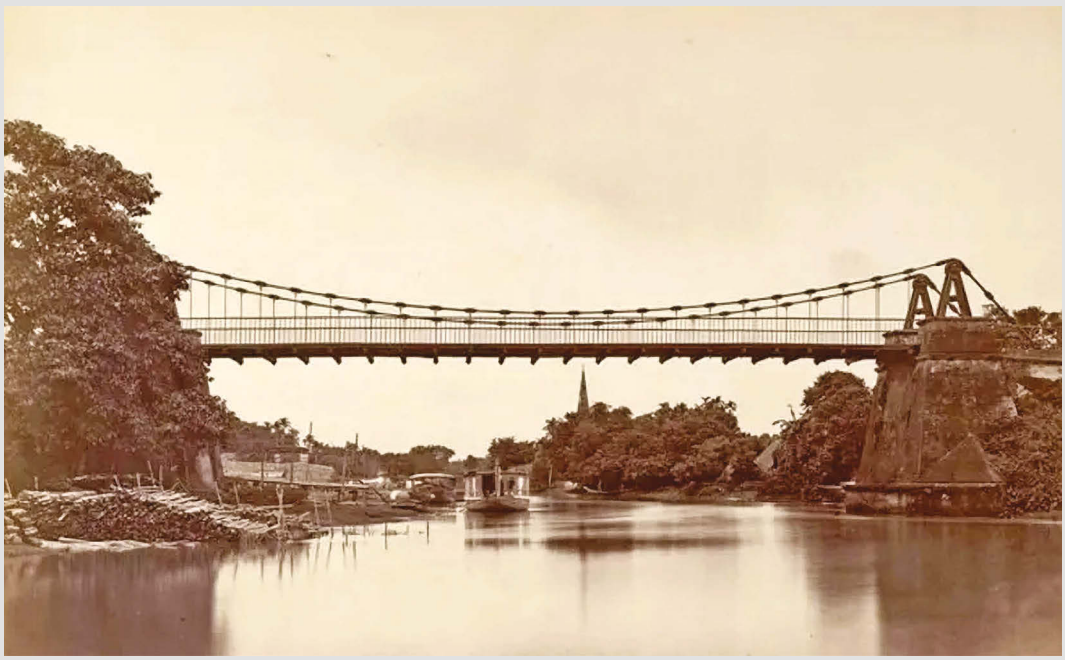
Living with Nature



Ruined part of Pagla bridge in 1814, as drawn by D'oyly (Source: The British Library)

Dholai Khal in 1870 (Source: The British Library)

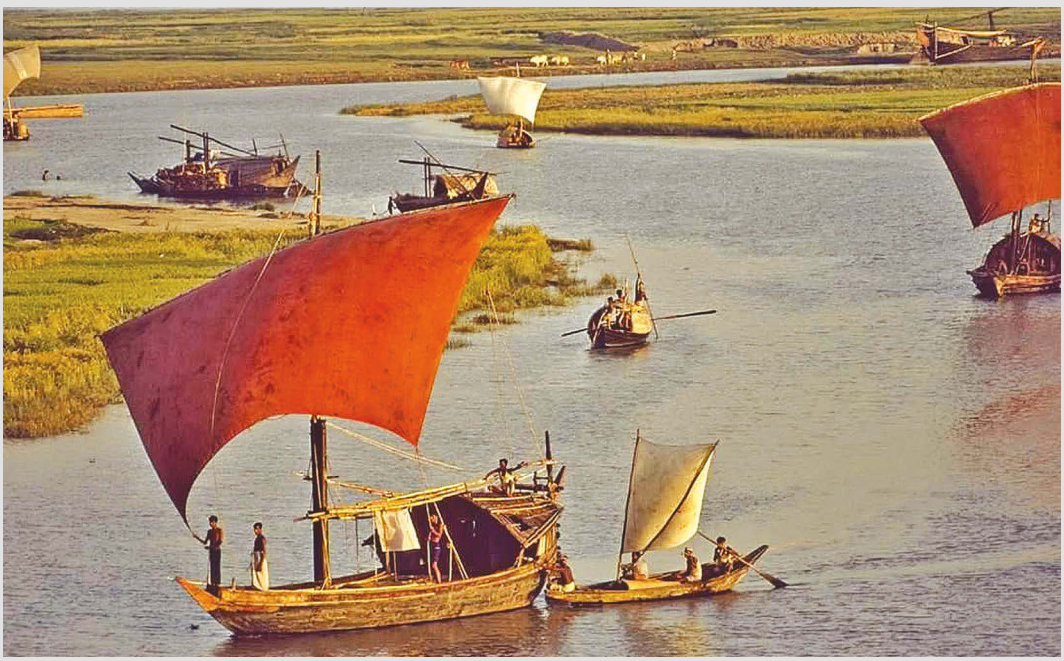
Wetland by the Mill building at Gandaria in 1870 (Source: The British Library)



Suspension bridge over a wetland at Dhaka in 1830 (Source: The British Library)

Living with Nature

Amiruddin Darogah's mosque by the Buriganga in 1912 (Source: Wikipedia)



Turag River in 1972 ©Dick Durrance II, National Geographic, 1972

Fishing in the wetland of Eastern fringe area, Dhaka (© Ishrat Islam, 2016)

Life, Livlihood and Wetland

Boatmen waiting for passengers at the bank of Buriganga © Nazifa Anzum, 2023

Fading Blues in Urban Maze

Sand filling in Eastern fringe of Dhaka © Ishrat Islam, 17.06.2005

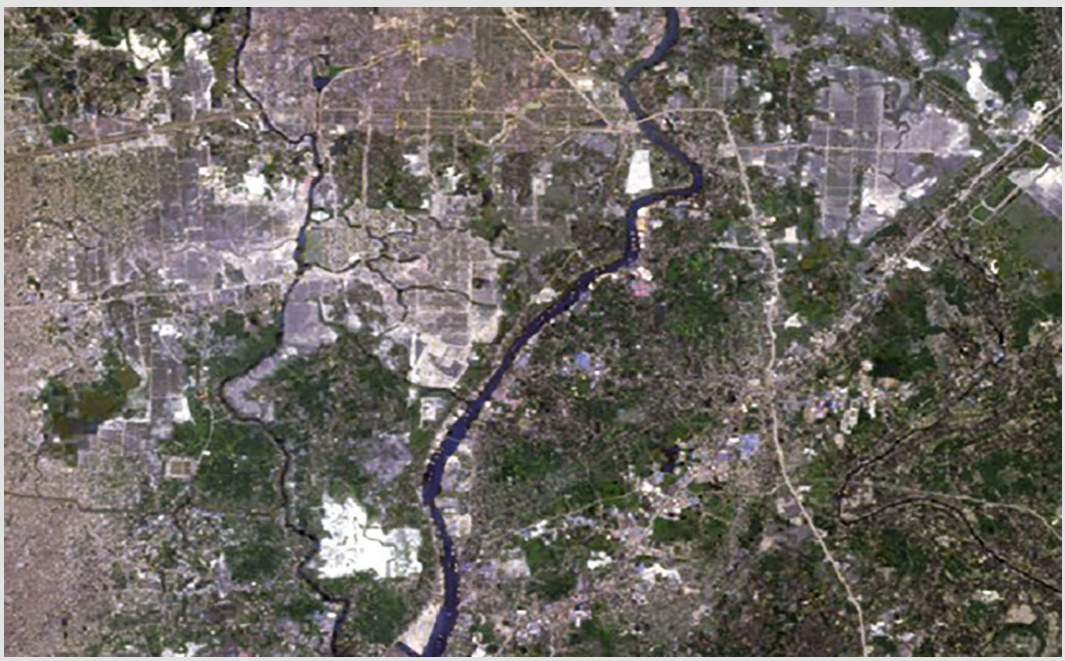
Fading Blues in Urban Maze

Google Image of Western Dhaka, 2000

Google Image of Western Dhaka, 2025

Fading Blues in Urban Maze

Google Image of Eastern Dhaka, 2000



Google Image of Eastern Dhaka, 2025

Fading Blues in Urban Maze

Eastern fringe area, Dhaka © Dr. Ishrat Islam, 2006

Dockyards within the Buriganga river's demarcation pillars. at Shubhadhya in Keraniganj
© Tanvir Ahammed, Prothom Alo, June, 2024

Fading Blues in Urban Maze

Encroachment of Balu river at Rupganj. © Daily Star Report, August 02, 2011

Encroachment of Turag at Kamarpara of Tongi © Daily Star Report, August 02, 2011

Fading Blues in Urban Maze

Sand filling in the Boro Beraid, Dhaka © Rakib Hasan, 2024

Fading Blues in Urban Maze

Pollution and encroachment in Buriganga river ©Rakib Hasan, 2024

Totail Beel of Keraniganj on the verge of encroachment © Daily Star September 16, 2023

Fading Blues in Urban Maze

Waste filled canal in Chottogram City © Mitoon Chowdhury, bdnews24.com, 2025

Informal settlement encroaching the River Padma, Rajshahi
© Sarjil Ahmed Khan, 2025

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বাংলাদেশ পরিবেশ আইনজীবি সমিতি (বেলা)

Saving Wetlands

Protest against grabber of Dhaleshwari river ©Motiur Rahman, Dhaka Tribune 2018

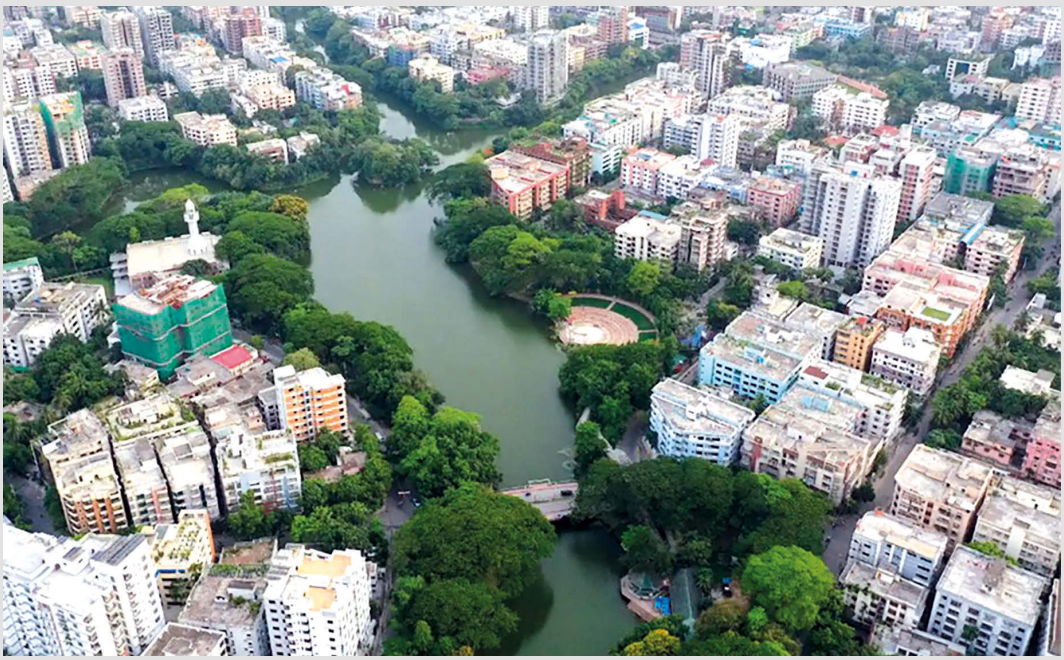
Protest to protect Khowai river bank © BAPA, 2020

Saving Wetlands

Waste removal from Baunia canal, Dhaka © Md Jahidul Islam, TBS, February 2025

Cleaned Mohammadpur canal, Dhaka © Bangla Tribune, TBS, September, 2023

Saving Wetlands



Restored Dhanmondi Lake, Dhaka ©VITTI Sthapati Brindo Ltd

Restoration and beautification of Padma river bank, Rajshahi © Sarjil Ahmed Khan, 2023

Restored Hatirjheel Lake Dhaka © Mr. Maruf Raihan

Section

1

Disappearing Blue Networks from Urbanscape

Chapter 1

A Comprehensive Review of Wetland Research of Bangladesh

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1. Introduction

Wetland is defined as "Natural or man-made, permanent or temporary, stagnant or flowing bodies of fresh, brackish or mixed water; swamps, marshes or wetlands; and deep marine areas where the depth at low tide does not exceed 6 meters." (The Ramsar Convention, 1971). These are vital natural resources for Bangladesh, covering the rivers, streams, freshwater lakes, marshes, and diverse ecosystems such as *haors, baors, beels*, water reservoirs, fishponds, flooded farmlands, and estuarine systems. This extensive network of wetlands supports biodiversity, provides water storage, cleanses the water, improves the water quality, stabilizes the shoreline and enhances the floral and faunal biodiversity (Vymazal, 2010; Kirk, 2004) and plays a significant role in the economy by reducing flood damage and erosion, adding recreational value and contributing to the transportation sector (Bergstrom et al, 1990; Schuyt and Luke, 2004). Despite playing a crucial role in preserving the ecological balance and augmenting the economy, the wetlands of Bangladesh are degrading due to encroachment and pollution. The degradation of wetlands in Bangladesh will reduce fish habitats, populations, and diversity, with the loss

of various wildlife species, such as birds and reptiles. The shift to high-yield crop varieties may lead to the extinction of indigenous rice types, while native aquatic plants, weeds, and shrubs remain at risk. Soil nutrient levels may decline, and the frequency of flash floods is likely to increase, worsening living conditions. Additionally, the loss of natural water reservoirs will diminish their associated benefits, and the degeneration of wetland-based ecosystems will disrupt traditional livelihoods, socio-economic structures, and cultural practices (Nishat, 1993).

Bangladesh is estimated to possess seven to eight million hectors of wetlands in the form of permanent rivers and streams, estuarine and mangrove swamps, shallow lakes and marshes, large reservoirs, small ponds and tanks, shrimp ponds and seasonally flooded flood plains (Khondoker et al, 2014; Haq, 2013). Being a country which has a quarter of its landmass less than seven feet above the sea level, the degradation could bring about severe consequences both ecologically and economically (Shalant, 2018).

Research on wetlands of Bangladesh is initiated in the early 1980s, but gained traction in the 1990s with increased funding from the IUCN and UN agencies. These studies highlighted the ecological and socio-economic value of the wetlands along with risks posed by infrastructure development, pollution, and intensive agriculture (Siddique and Hoque, 2011). This paper aims to present a comprehensive discussion focusing researches conducted on wetlands of Bangladesh since 2008.

2. Methodology

In order to gain a comprehensive understanding of the current state of wetlands in Bangladesh, peer-reviewed scientific journals and conference papers were considered, along with two of the most prominent newspapers, *Prothom Alo* and *The Daily Star*, to understand the role of media and civic societies. Research papers and articles those were published between 2008 to 2024 and are accessible online were included in the review.

The search was conducted using a list of keywords in Google Scholar. The search terms were developed to be sensitive enough to cover relevant articles while specific enough to limit the number of irrelevant search results. A combination of keywords, "wetlands," "*Haors*," "Bangladesh," was used as the search terms. The screening process involved reviewing the titles and abstracts of potentially relevant articles, and subsequently examining the full-text articles. To be included in the review, the studies had to meet two primary inclusion criteria. Firstly, the studies had to focus on wetlands in Bangladesh. Secondly, the research objectives needed to focus on understanding changes in land cover and related physical interventions in wetlands, ecosystem services, dependent livelihoods and valuation, management challenges, and the role of civic engagement and media in these issues.

After the screening process, a total of 70 research papers were selected for the review. Each of the selected papers was analyzed for its key findings and methodology. These papers were then categorized into five primary themes including; Socio-economic, political and environmental aspects

associated with wetland; Wetland loss across the country; Planning, and institutional dimensions; and legal fights; Media and civic voice. Additionally, two leading daily paper papers, including *The Daily Star* and the *Prothom Alo* were considered as data sources for understanding the role of media and civic society.

3. Socio-Economic, Political and Environmental Aspects Associated with Wetland

Wetlands have been instrumental to human civilizations and the support of socio-economic livelihoods beyond their contributions to environmental integrity and biodiversity. The existing research (Table A1, A2, A3) on the socio-economic and environmental impacts of the wetlands was reviewed through the following aspects—

- Wetland Livelihood
- Wetland Valuation
- Wetland Ecosystem Services

3.1 Wetland Livelihood

In Bangladesh, almost half of the people are directly dependent on wetlands (Khondoker et al, 2014). However, these communities face challenges like poverty, limited income options, declining fish stocks, and threats from natural disasters and resource overuse (Sunny et al., 2020). Climate change exacerbates these challenges (Rahman, et al., 2018), with Sunamganj district being the most susceptible in the northeastern region (Hoq, et al., 2018). Additionally, conflicts emerge from shifts in water and land availability, leading to temporal vulnerability in livelihoods (Islam, 2020).

The degradation of wetland natural resources poses a critical threat to local livelihoods. However, local communities have used their strengths to develop new livelihood strategies that sustain the link between ecosystem services and human wellbeing, despite ecological changes (Shahidullah et al., 2020). Diversifying livelihoods and crop rotations can enhance community resilience depending on wetlands (Sunny et al., 2020; Rahmana et al., 2018). The formation of Resource User Groups and micro-credit access has supported alternative livelihoods (Rahman & Begam, 2010). In Hakaluki Haor, communities built socio-economic networks for livelihood diversification, while in Tanguar *Haor*, efforts focused on improving resource use with government support (Rahman et al., 2018). Simultan-eously, agribusiness supports wetland livelihoods in Bangladesh through favorable conditions and enterprise links but faces challenges like poor marketing and limited credit. With improved technology and planning, it offers potential despite environmental threats and shrinking farmland (Dhar, Islam, Jannat, & Ahmed, 2018). Social capital, particularly "bridging," is identified as a critical factor in strengthening fishers' livelihood resilience (Rahman et al., 2014; Hossain & Banik, 2021). However, in wetland areas, community leaders often put their own interests first when connecting locals with government or NGOs, rather than prioritizing community welfare. Rahman et al., (2014) emphasized enhancing livelihood resilience through improved governance, recommending greater accountability of local leaders

and stronger communication between institutions and communities to foster policy learning and innovation. They further advocated for decentralizing resources and promoting democratic devolution of power to better support local livelihoods.

3.2 Wetland Valuation

The conservation of wetlands relies on proper economic assessment of wetlands, which includes both tangible and intangible benefits they offer. Various studies (Table A2 in the appendix) have analyzed the value of wetland from different perspectives, each employing their chosen approaches. The Contingent Valuation Method (CVM) and Market Price method have been widely used to measure both the use and nonuse value of wetlands over an extended period in the studies conducted in Bangladesh.

There are two studies on the assessment of wetland value in Dhaka city concentrated on particular locations for valuation. Rafiq, Alam, Rahman, and Islam (2014) evaluated the non-tangible benefits of wetlands in Goran Chatbari and Uttar Kaundia mouza, while Zinia and Shane (2018) evaluated the provisioning ecosystem services of *Jheel* in the densely developed zones of Mirpur-Pallabi. Results revealed the valuation of livelihoods and that diversifying income sources could be beneficial for this community (Sunny, et al., 2020).

Thompson (2008) examined four value types of Hail Haor wetlands including direct, indirect, optional, and existence. The annual value of wetland products in the year 2000 was approximately $650 per hectare, surpassing the net return from the alternative single rice crop. Tanguar Haor provides ecosystem services valued at approximately 17 crore BDT per year (Solaiman, Baten & Khan, 2018). These services are increasingly threatened by both natural and human-induced factors, where provisioning services are the most significantly affected. Studies have been conducted to evaluate the significance of beels. Ghosh and Mondal (2015) found that households were willing to pay Tk. 13.69 monthly for managing Chanda Beel, resulting in an annual non-use value of Tk. 33 million, mainly due to its bequest value. This indicates people's concern for the future environmental condition of the wetland. Ali and Wahood (2017) estimated Padma Beel's direct economic benefits at Tk. 253,443.8 per acre. The study found that the households' income from wetland cultivation does not have a significant impact on their food security. This may be because lower-income households have limited access to wetland areas for cultivation, restricting their ability to generate income from these resources and affecting their food security. Additionally, Dinnar and Islam (2019) showed that the annual average non-use value of Chalan Beel is approximately Tk. 12.15 million, while the average willingness-to-pay value is around Tk. 93.48 million. Rahman, Jiang, & Irvine (2018) and Mehvar, Filatova, Sarker, et al., (2019) studied coastal wetl-ands in Bangladesh. Rahman et al., (2018) focused on provisioning services, while Mehvar et al., (2019) examined how sea level rise (RSLR) by 2100, using IPCC scenarios (RCP2.6, RCP6.0, and RCP8.5), would affect Wetland Ecosystem Services (WES).

Al-Amin et al. (2021) studied how people respond to paying for wetland conservation, dividing responses into four types: certain, uncertain, protest, and zero. People who are

sure about paying are more likely to be part of organizations and have access to training or extension services. Those involved in farming or fishing, with access to credit and extension services, are less likely to reject conservation payments. Other important factors that affect willingness to pay include income, age, education (Ghosh & Mondal, 2015; Dinnar & Islam, 2019), and how far the household is from the beel (Dinnar & Islam, 2019).

3.3 Wetland Ecosystem Services

Following the influential publication of the Millennium Ecosystem Assessment, the study of ecosystem services has gained increased importance (Fisher, Turner, & Morling, 2009). Consequently, there has been a significant number of studies focused on evaluating the range of services offered by wetlands in different parts of Bangladesh (Table A3 in apendix). These studies collectively highlight the invaluable role of wetlands in providing provisioning, cultural, regulatory, and supporting services and demonstrate the influence of human activities on these crucial services.

The Sundarbans Mangrove Wetland provides vital ecosystem services, including provisioning (fisheries, forest products), regulatory (carbon sequestration, storm protection), cultural (tourism, religious value), and supporting services (soil formation, fish breeding) (Islam & Hossain, 2017; Rahman, Jiang, & Irvine, 2018). Communities particularly emphasized provisioning and cultural services due to their direct relevance to daily livelihoods (Islam, Sunny, Hossain, & Friess, 2018). Research by Akhter, Mia, & Panna (2018) unveiled changes in ecosystem services in Tanguar *Haor*, including reduced swamp forests, expanded agricultural land, disappearing migratory birds, decreased fish production, reduced river water-carrying capacity, and increased human settlements within the wetland area. Local residents highly valued provisioning services, while regulatory services were considered less important due to challenges in acceptance and understanding in Tanguar Haor (Solayman, et al., 2018). Mim and Ansari (2021) documented significant changes in key provisioning services in Aral Haor, Sylhet District, including increased rice cultivation, reduced fish farming, stable use of irrigation water, and a decline in bird nesting. Complementing this, Haque (2020) reported that although access to resources had improved in parts of northeastern Bangladesh, there was a notable deterioration in security, social cohesion, and overall community health.

Diverse factors those are responsible for changes in the wetland ecosystem services are unsustainable exploitation practices of land and water resources, shrimp farming, unplanned developments, reduction of freshwater flow, natural disasters, governance issues, unmanaged tourism and biodiversity mismanagement (Akhter, et al., 2018; Islam et al., 2018; Solayman, et al., 2018). Hossain, Hein, Rip, and Dearing (2015) also mentioned about Farakka Barrage, climate change and population growth as the drivers causing change in coastal wetland ecosystems.

3.4 Wetland Loss Across the Country

Several studies (Table B in the appendix) have been carried out in Bangladesh, concentrating on the changes in the land

cover of wetlands. The Dhaka Metropolitan Area and its surroundings have been the subject of numerous studies that consistently reveal alarming declines in wetland areas across various timeframes. For instance, the Dhaka North City Corporation lost 72.5% of its waterbodies between 1991 and 2014 (Arifeen and Faisal, 2018), while the eastern part of the city saw an 18.5% reduction in wetlands from 1995 to 2001 (Hossain et al., 2012). In Mirpur, Islam and Datta (2019) observed a drastic 78.69% decrease in wetland area.

Findings illustrate the anthropogenic impacts on wetland destruction and degradation (Dewan, & Yamaguchi, 2008; Sultana, Islam, & Islam, 2009; Mahmud, Habiba, Haider, Ishtiaque, & Masrur, 2011; Karim, 2014; Ishan & Intezar, 2019). The loss of wetlands in Dhaka has made the drainage system vulnerable, causing waterlogging and inundation in many parts of the city. Landfilling by various stakeholders, and unplanned urban development were identified as the main reasons for the wetland loss. Unregulated construction, both by government and private organizations, contributed to the deterioration of wetland ecosystems (Dewan, & Yamaguchi, 2008; Sultana, Islam, & Islam, 2009; Mahmud, Habiba, Haider, Ishtiaque, & Masrur, 2011; Karim, 2014; Ishan & Intezar, 2019). For instance, Modhumoti Model Town project in Savar led to a notable reduction of approximately 2.23 km2 in waterbodies out of the initial 10.54 km2 (Faisal et al., 2019). The surrounding upazilas of Dhaka also witnessed the impacts of unplanned urban expansion, as Dhamrai Paurashava experienced over 43% wetland loss (Mahmud et al., 2022).

Besides Dhaka, there are few studies which examined changes in wetland areas and their environmental impacts in different regions of Bangladesh. In Chittagong, Hredoy et al., (2018) noted a substantial 28.92% decline in wetlands, rivers, canals, and ponds over 38 years, attributed to indiscriminate encroachment. Shopan et al., (2013) observed a 25.25% reduction in wetlands from 1989 to 2010 in Northwest Bangladesh, particularly evident in Godagari Upazila, Rajshahi. The Haor areas of the Greater Sylhet Division are designated as ecologi-cally critical areas, which are also under threat, as Salaudin and Islam (2011) documented a 6.88% drop in waterbodies and an 8.35% rise in agricultural zones from 2000 to 2008. These findings show the alarming loss of wetlands across the country.

Consequently, researchers have assessed the vulnerability of wetland to mitigate the impacts of unforeseen events. Wetland vulnerability involves evaluating the extent to which wetlands are susceptible to adverse effects of climate change, land use changes, alterations in water regimes, and other stresses (Finlayson, 2006; Jiang et al., 2017). Physical interventions such as damming, dredging, and channelization contribute to the disappearance of the wetlands (Ekka, Pande, Jiang, & der Zaag, 2020; Pal & Saha, 2018). Studies have shown that damming in the Indo-Bangladesh River basins, such as the Atreyee and Punarbhaba, has significantly reduced wetland areas and attributed to factors like agricultural expansion, floodplain encroachment, and changes in flood frequency. For instance, Talukdar and Pal (2020) simulated wetland changes in Punarbhaba River Basin, and

anticipated 22.66% decrease by 2030, with decline in wetland depth. Hossain et al., (2021) found that in Rajshahi, man-made wetlands have increased while farmland has decreased, raising concerns about future land use.

4. Planning, and Institutional Aspects of Wetland Management

As demonstrated in the previous section, this invaluable resource is rapidly diminishing; therefore, it is imperative to develop comprehensive guidelines for the effective management of these vital natural areas. The researchers in Bangladesh have explored several aspects of the wetland management system in the light of administrative, legislative, and institutional perspectives (Table C in appendix). Although most of the studies have taken Dhaka as their study area, some studies attempted to explore the scenario in *Haor* and *Beel* area.

While conducting studies on the management of wetland ecosystems in Bangladesh, Islam (2010) identified various challenges faced in managing ecologically sensitive ecosystem services, including inadequate legal frameworks and institutional capacity, lack of awareness and education, and competing demands for natural resources. He proposed an integrated, adaptive approach. This approach would include institutional reform, participatory planning, biodiversity conservation, livelihood support, organizational development, and incorporation of indigenous knowledge (Islam, 2016). Jahan, et al., (2008) assessed the institutional weaknesses in the preservation of wetlands by examining the roles of different organizations. The study identified institutional weaknesses in wetland preservation, noting that local authorities often lacked account-ability, and communication gaps existed between agencies and communities. The preservation efforts were generally weaker than the forces causing wetland encroachment. Haq (2011) explored how government and non-government organizations work to prevent wetland shrinkage. The study also outlined major laws and policies supporting wetland protection, such as the Ramsar Convention (1971), the Tanks Improvement Act (1939), the Bangladesh Environmental Conservation Act (1995), the Environment Court Act (2010), and the Water Act (2013).

Rahman, Hickey, and Sarker (2015) proposed a wetland management structure based on local committees, highlighting the influence of political dynamics in the process. Similarly, Jahan et al. (2008) recommended an inclusive institutional framework led by the Dhaka Metropolitan Development Council (DMDC), involving all relevant stakeholders. Both studies stress the importance of multi-stakeholder collabo-ration to create urban strategies tailored to the needs of Dhaka's communities. Expanding beyond the scope of Dhaka, Byomkesh, Nakagoshi, and Shehdur (2015) offer a comprehensive assessment of the state and management of wetlands across Bangladesh. They propose a series of measures for improving wetland management, with a particular emphasis on integrating the Social Environmental Management System (SEMS) as a framework for sustainable management.

The interrelation of NGOs, I-NGOs, and government organizations in the wetland management process is elaborately explained by Ahsan, Delvals, and

Vasco (2009). Developed countries and international NGOs play a significant role in providing funding and technical support. National and local NGOs are crucial for implementing programs and reaching target communities. Lastly, charities can mobilize resources and can connect donors with beneficiaries.

5. Legal Battles

Unfortunately, legal battles regarding wetlands are not highlighted in published journal articles. To date, only the landmark judgment recognizing rivers as living entities with legal rights (Islam & O'Donnell, 2020) has been prominently discussed.

However, Hasan and Ullah (2024) evaluated the operation of environmental courts in Bangladesh, which handle this legal battle. Although environmental (wetlands as well) cases are managed by the Environment Courts and Special Magistrate Courts, only the Director General of the Department of Environment (DoE) or an authorized representative is permitted to file cases, and no case can proceed without a written report from a DoE Inspector. This requirement may limit judicial independence and responsiveness. According to the study, a comparison between the years 2003 and 2022 reveals a significant increase in the volume of cases handled by the Environment Court. In Chittagong, in 2003, there were only three pending cases from the previous year, five new cases were filed, making a total of eight cases, of which two were disposed, leaving six pending. In contrast, by 2022, the number of previously pending cases rose sharply to 250, with 41 new cases filed that year, totaling 291 cases. Out of these, 48 were disposed, yet 243 cases remained pending. This comparison illustrates a growing backlog over the years, indicating institutional inefficiencies. Access to justice for wetland-related concerns remains limited.

6. Media and Civic Voice

Wetland management is a multidimensional process that involves legal challe-nges, public participation, and expert knowledge. Legal battles often emerge in response to encroachments of wetlands and violations of acts and rules. While civic voices, through activism and grassroots movements, advocate for stronger conservation measures, semi-nars, national conferences, and press conferences are arranged to focus on wetlands to address the wetland issues by the civic society.

The newspapers and TV channels have always been vocal against illegal encroachments on the wetlands, exposing the encroachers to the general public. For example, they expressed concern about the excessive encroachment in Chalan Beel, which has shrunk from 1,085 km^2 to only 168 km^2 (*The Daily Star*, 2024a), and Arial Beel, a victim of forced occupation by the real estate (*The Daily Star*, 2023a). The reluctance of the local authority often fuels this encroachment. For example, a 200-year-old pond in Habiganj (*Prothom Alo*, 2025b), government ponds in Sirajganj, (*Prothom Alo*, 2016), in Shibchar (*Prothom Alo*, 2021b), pond in Dhaka, have all been affected (*Prothom Alo*, 2022a). Influential industrialists are grabbing rivers by establishing illegal brick kiln industries along them. The Dhaleshwari and Titas are prime victims of this (*Prothom Alo*, 2017a (*The

Daily Star, 2022e; *The Daily Star*, 2024c). Moreover, Chandpur Haor at Kishoreganj and Khanjar Haor are suffering from severe pollution from the battery industries and Bangladesh Small and Cottage Industries Corporation (BSCIC) respectively (*Prothom Alo*, 2022b; *The Daily Star*, 2022c). The flow of Kaladumur River in Comilla and Karnaphuli River in Chattogram is restricted due to the dumping of solid wastes (*Prothom Alo*, 2017b). Similarly, all of the 18 rivers in and around the capital, Buriganga, Turag, Shitalakshya, and Balu, are in a vulnerable condition because of severe pollution from industrial wastes (*Prothom Alo*, 2019c; *The Daily Star,* 2025a). *The Daily Star* also brought to attention that the plan of Hatirjheel was modified for constructing an expressway (*The Daily Star*, 2024c) and the Hajj Camp (*The Daily Star*, 2024c). The sand excavation in the Gumti River in Comilla was also highlighted (*Prothom Alo*, 2020b).

The harm to the wetlands is ultimately disrupting the regular lifestyle and livelihood of nearby people. Filling the Angaria-Burirhat canal in Shariatpur made boro cultivation on 2,000 acres of land uncertain, causing huge financial losses to the farmers living in that area (*Prothom Alo*, 2025a). Similar dam cons-truction at the Haor is causing a decline in rice production (*Prothom Alo*, 2025b). DND (Dhaka-Narayanganj-Demra) dam has become a cause of sorrow for about two million people living there (*The Daiy Star*, 2016).

These unplanned dams and illegal encroachments are causing waterlogging, especially in the cities. The sufferings of citizens of Chattogram City due to waterlogging caused by encroached canals and the loss of navigability of the Karnaphuli River has been highlighted in the dailies (*Prothom Alo*, 2025c; *The Daily Star*, 2022d). Ghior has also become a victim of artificial waterlogging due to redundant dam construction on a canal (*Prothom Alo*, 2022c). However, the scenario is worst in the capital Dhaka (Sarkar, 2009).

Although some legislative efforts were taken to protect some wetlands, but most of those attempts went in vain due to a lack of accountability. Example of such disappointment includes failure to implement the order from the High Court to protect the Buriganga, Shitalakshya, Turag, and Balu rivers by determining their boundaries according to the Cadastral Survey (CS), (Abbas, 2009). Even the National River Conservation Commission (NRCC) identified 21 grabbers of the Turag River and instructed the district administrators of Dhaka and Gazipur to take action against them. Unfortunately, no efforts were made by them (Independent TV, 2019). Bangladesh Inland Water Transport Authority (BIWTA) identified 131 encroachers of the Bakkhali River in Cox's Bazar in 2020. However, BIWTA never took any legal action against those listed entities (*The Daily Star*, 2023a). Moreover, the dailies are constantly exposing the corruption practices among elected politicians, government officials, and other implementers. For example, an accusation of corruption among the members of the Department of Fisheries was highlighted in an editorial. It was found that at Nabaganga River of Chuadanga, two to five feet of excavation was supposed to be done, however, it never happened. Moreover, many fake beneficiaries were included in the project cases (*Prothom*

Alo, 2017c). Although the collective scenario of wetlands is alarming, few good efforts to alter the situation by the government institutions can be noticed through the editorials as well. The project on five abandoned ponds in Sirajganj to make them suitable for fish farming by the Ministry of Fisheries and Livestock was well appreciated in the newspaper (*Prothom Alo*, 2019e). Another notable transformation was conducted by the Dhaka South City Corporation, as they revived a channel of Buriganga (*The Daily Star*, 2022a). Such articles help in suggesting future actions for the conservation of wetlands.

A series of articles was published in September 2009 in the *Prothom Alo*, urging people and responsible authorities to save the Kapotaksha River, which is associated with the famous poet Michael Madhusudan Dutta (Kanaidiya, 2009; Khan, 2009a; Khan, 2009b). Another series of articles was published in October 2009, as a call to save the lives and livelihoods of people living in Bangladesh, in the downstream area, from the Tipaimukh Dam (Kayes, 2009). Many objections and criticisms against the statistics and measures mentioned in the Detail Area Plan (DAP) for Dhaka were published in a series of news reports as well (*Prothom Alo*, 2010a; *Prothom Alo*, 2010b; *The Daily Star*, 2024a). Professionals and civic society joined together to highlight how the proposed DAP will endanger the livability of Dhaka by allowing the powerful people to grab the wetland. In this regard, the Bangladesh Institute of Planners published an opinion piece in December 2008 in *The Daily Star* (Bangladesh Institute of Planners, 2008). Bangladesh Institute of Planners (BIP), Institute of Architects, Bangladesh (IAB), Bangladesh Poribesh Andolon (BAPA), Bangladesh Environmental Lawyers Association (BELA) and Center for Urban Studies (CUS) joined together to oppose the Detailed Area Plan 2010-15 (DAP), as it did not follow the policies of the Structure Plan (1995-2015) and its proposals contradicted existing environmental laws and policies. For two months, professionals and civil society stakeholders urged the government and RAJUK to consider those issues through print and electronic media.

Key issues identified from the opinion columns published in these dailies since 2009 include the degradation of wetlands in Bangladesh (Titumir, 2023), filling up ponds and wetlands for brick field (Shabhan, 2024), and leasing rivers illegally by misclassifying them as beels (Wadud, 2025).

Additionally, scholars and commentators have emphasized the need for improved conservation and co-management strategies (Abbas, 2010; Khan, 2013; Bala, 2018), addressing plastic pollution and policy gaps in riverine and coastal areas (Chowdhury, 2023), and fostering sustainable, corruption-free development through public-private partnerships and research collaboration (Talukdar, 2019). Integrating Nature-based Solutions (NbS) into urban planning, as seen in the Hatirjheel project, has been highlighted as a way to enhance sustainability (Irfanullah, 2021b). However, weak inter-agency coordination remains a major challenge, underscoring the need for collaboration through initiatives like the Community of Interest on NbS (Irfanullah, 2024).

Recent discussions on wetlands are focused on the link among the destruction

of wetlands, water scarcity, and heatwaves (Chowdhury, 2019; Farid, 2019), combating fire incidents (Ahmed & Ahmed, 2023; Rabbi, 2024), emphasizing the urgent need for conservation as a climate adaptation strategy and questioning the transparency and accountability in community development projects driven by government agencies, donors, and NGOs (Irfanullah, 2020; Irfanullah, 2021a). With this in mind, Irfanullah (2023) pointed out that Bangladesh must advocate for wetland protection as a key component of its climate resilience efforts at COP28. Huq & Azaz (2025) further highlighted that the wetland restoration projects in Dhaka often take an exclusionary, top-down approach, displacing marginalized communities instead of integrating their ecological knowledge and practices. These communities often engage in informal lakeside farming, which supports both food security and environmental sustainability.

Scholars further pointed out that organizations have a greater capacity for river protection than individuals, as their collective strength enhances the effectiveness of protests. However, the government agencies are often the very ones facilitating the degradation. In this context, fostering strong social pressure is crucial to ensuring effective river conservation (Wadud, 2023).

Printed and online newspapers publish news on seminars, projects, and studies by scholars that highlight wetland and water-related research. One significant news coverage is done on the celebration of World Wetland Day, which is celebrated globally on 2 February to educate people and create awareness. On this specific occasion in 2022, Rtv published a news on how the historically important ponds, rivers and other waterbodies in Chattogram is being grabbed by real state companies (Rtv, 2022). The Centre for Natural Resource Studies (CNRS) ran a project, Biodiversity for Resilient Livelihood (B4RL), supported by the Swedish Embassy, to teach kids about the importance of wetlands. (Anika, 2024).

Research published in newspapers highlights critical concerns regarding wetland encroachment, institutional corruption, and necessary interventions. Transparency International Bangladesh (TIB) identified the water resource sector as one of the most corrupt in the country, with an annual loss of BDT 4,623 crore (*Prothom Alo*, 2010). Similarly, weak institutional oversight has led to the leasing of 18 haors, designated as sanctuaries, to public representatives under the Ministry of Land (*Prothom Alo*, 2013). Another pressing issue is water pollution in wetlands. The Bangladesh Haor and Wetland Development Board found that dissolved oxygen (DO) levels dropped to 0 mg/L in parts of the Buriganga, Turag, Balu, and Tongi rivers, raising concerns about aquatic life and ecosystem health (*The Daily Star*, 2009). In addition, research under the Fisheries Management Project in Haor Areas revealed that rivers connected to Hakaluki Haor, such as Juri and Kanthinala, are heavily silted, causing extreme water shortages during the dry season and necessitating dredging (*Prothom Alo*, 2013).

In 2000, the Bangladesh Environment Network (BEN) first organized the International Conference on Bangladesh Environment (ICBEN). In all the conferences so far arranged, one of the focus areas was rivers, floodplains, and wetlands.

Bangladesh Environmental Lawyers Association (BELA) is another strong voice in the conservation of wetlands. They fought many legal battles and organized discussion forums, press conferences, and dialogue sessions nationwide. For instance, in 2019, a Press conference in Dhaka city was jointly arranged by TIB (Transparency International, Bangladesh), Association for Land Reform and Development (ALRD), and Bangladesh Environmental Lawyers Association (BELA) about wetland filling in the capital and its surroundings violating DAP (The *Prothom Alo*, 2019). Events like the Fifth International Seminar on Water and Flood Management and Dhaka South City Corporation's seminar on urban waterlogging provided insights into ongoing research and policy reco-mmendations (*Prothom Alo*, 2015). A seminar organized by the Bangladesh Center for Environment and Geographical Information Services (CEGIS) emphasized restoring canal connections as a solution to Dhaka's waterlogging crisis, proposing a detailed interconnection plan for 26 canals (*Prothom Alo*, 2017). Additionally, the National River Conservation Commission (NRCC) classified and documented Bangladesh's rivers, recognizing Padma as the longest (*Prothom Alo*, 2023a). The findings shared in these seminars not only inform the public about ongoing conservation efforts but also inspire scholars to conduct further research on wetlands, contributing to long-term environmental sustainability.

Another way for civic society to express its concerns is through protest rallies. Local communities, along with the environment-based NGOs, form a human chain and rally in protest against the filling of the ponds. For instance, in 2024, the historic ponds of Barishal, which have existed for centuries and hold deep cultural and communal significance, faced the threat of being filled. In response, outraged residents, along with the Bangladesh Environmental Lawyers Association (BELA), organized a human chain and rally to protest the destruction of these heritage waterbodies (*Prothom Alo*, 2024). Moreover, open letters are written to the prime minister asking for intervention in protecting wetlands against filling. One of the noteworthy activities of BAPA is "Buriganga Bachao Andolon". As a part of this protest, they organized a boat rally on the Buriganga River and seminars, workshops and human chains, so that they could make people aware of the poor situation of the river (Ahsan , DelValls, & Blasco, 2009).

Saha and Tasnim (2025) concluded that civil society's involvement in environmental issues is more vivid at the grassroots and media levels than at the policy levels, resulting weak influence on political decisions.

7. Conclusion

Though wetland-related research started in Bangladesh in the early 1980s, they were mainly funded works to associate wetlands with infrastructure development, pollution, and intensive agriculture. Scholars started to focus on the diverse issues of wetlands around the year 2008 when the impact of development activi-ties on wetlands started to become visible among mass people. As the wetland area reduction was the most prominent to notice, the majority of the studies were conducted on this theme. Specifically, Dhaka being the political, economic, and administrative center of

Bangladesh, more attention was given to assessing the change of wetland area in Dhaka Metropolitan area. All the studies provided evidence of the loss of wetland by conver-ting them into built-up area. Since 2015, researchers intended to understand the services provided by this ecosystem to provide supportive evidence to protect them. Studies were focused on coastal and *Haor* wetlands as they are well-known to support the livelihood of rural communities. The communities identified fishery resources, fuel energy, storm protection, and fish breeding as highly valued services provided by the wetlands.

To emphasize the conservation of wetlands, the proper economic assessment of the value of the natural resources has been given importance. The Contingent Valuation Method (CVM) and Market Price method have been widely used to measure. In contrast to the research on wetland area loss, only two research has been found on the valuation of wetland services in Dhaka. This implies that wetlands in rural areas are thought to be more valuable in monetary terms. Therefore, there is a scope to evaluate the wetlands of Dhaka in recent times. The key outcome from the theme, wetland livelihood, is that enhancing resilience and sustainable livelihoods in Bangladesh's wetland communities requires livelihood diversification, accountability in local leadership, improved resource access, and strategic planning to address environmental and socio-economic vulnerabilities. Similarly, the key findings from wetland management are that effective wetland management in Bangladesh requires a cohesive institutional frame-work involving accountable local authorities, improved communication among stakeholders, and adherence to legal protections to counter institutional weaknesses and protect these vulnerable ecosystems. Moreover, though previous studies identified NGOs as weak entities regarding wetland management, in recent times, many NGOs have been in strong positions and on good terms with local people to collaborate on management activities. Lastly, there is a research scope regarding the all-weather road constructed in the Haor region under the theme of physical intervention. The research scope can focus on assessing the environmental, social, and economic impacts of all-weather road construction in *Haor* regions, examining how such infrastructure influences wetland hydrology, ecosystem stability, local livelihoods, and accessibility, while evaluating potential trade-offs between development needs and wetland conservation.

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Appendix

Table A1: A list of studies that addressed wetland livelihood

Reference	Key Points of the Study
Nurullah, A B M. (2024).	**Title:** Assessment of Livelihood Challenges Due to Wetland Ecological Changes: A Case from Chalan Beel, the Largest Wetland of Bangladesh. • **Issues Considered:** To explore the complex connection between ecological changes and the challenges affecting the livelihoods of the local community. • **Location:** Chalan Bill • **Method:** 12 Focus Group Discussions, 7 Key Informant Interviews and Participant Observations • **Types of Capital:** Natural and financial • **Major Findings:** Ecological changes, driven by road construction, the Farakka Dam, and Mirjapur Canal closure, led to declining fish and aquatic resources and rising farming costs, harming community livelihoods.
Hossain, M. A., & Banik, A. K. (2022).	**Title:** What drives the resilience of wetland-dependent fishermen? Social determinants of co-management in Bangladesh • **Issues Considered:** To measure the resilience of a wetland-dependent fishing community • **Location:** A fishery in Sunamganj District • **Method:** AHP Method; Data collected through FGD and KII • **Types of Capital:** Social Capital • **Major Findings:** Collective action, community facility, and social capital are found to be the most important factors in building fishers' resilience.
Hoq, M. S., Raha, S. K., & Hossain, M. I. (2021).	**Title:** Livelihood vulnerability to flood hazard: understanding from the flood-prone haor ecosystem of Bangladesh. • **Issues Considered:** To assess the vulnerability of households in the haor ecosystem in the face of frequent floods • **Location:** Haor Area • **Method:** Livelihood Vulnerability Index (LVI) based on the Intergovernmental Panel on Climate Change framework • **Major Findings:** Sunamganj district is more vulnerable to floods, especially in terms of food, water, and health access, indicating low adaptive capacity and high sensitivity and exposure
Islam, M. N. (2020).	**Title:** Seasonal Livelihood Variation and Socio-economic Conflict of the Chalan beel Wetland Area: A Case of Beel Chiroil at Pabna District in Bangladesh. • **Issues Considered:** To understand the livelihood pattern aligning with seasonality and socio-economic conflict • **Location:** Chalan Beel Wetland • **Method:** Household Surveys, PRA Tools, FGDs and KIIs • **Types of Capital:** Social and Natural Capital • **Major Findings:** Seasonal shifts in water and land availability in the Beel area lead to livelihood changes, increased conflicts between farmers and fishers, and declining crop production due to water scarcity, poor siltation, and drainage issues.

Reference	Key Points of the Study
Huq, N., Pedroso, R., Bruns, A., Ribbe, L., & Huq, S. (2020).	**Title:** Changing dynamics of livelihood dependence on ecosystem services at temporal and spatial scales: an assessment in the southern wetland areas of Bangladesh • **Issues Considered:** To explore the dynamics of the social-ecological system (SES) in terms of climate change and ecosystem degradation • **Location:** The beel areas of the central south and south-west regions • **Method:** Developing two dependency indexes, including the Dependency Index of Ecosystem Services (DIES) and the Dependency Index of Socio-Economic Activities (DISE) • **Types of Capital:** Financial, Human and Natural Capital • **Major Findings:** An increasing number of households are diversifying into various socio-economic activities for financial stability, leading to a growing income gap between those dependent on ecosystem services and those engaged in alternative livelihoods.
Sunny, A. R., Masum, K. M., Islam, N., Rahman, M., Rahman, A., Islam, J., ... & Prodhan, S. H. (2020).	**Title:** Analyzing livelihood sustainability of climate vulnerable fishers: Insight from Bangladesh. • **Issues Considered:** To know about the livelihood strategy, strengths, weaknesses, opportunities and threats of fishing communities • **Location:** Haor Area • **Method:** Sustainable livelihoods Approach (SLA) • **Types of Capital:** Physical, Natural, Financial, Human, and Social Capital • Major Findings: Strengths: Physical strength and a strong work ethic, enabling them to engage in continuous work throughout the year,; Weaknesses: Acute poverty, economic hardships, limited alternative income opportunities, and decreasing fish availability; Threats: Natural Calamities, Overexploitation, Dependency on Natural Resources
Rahman, H. T., Mia, M. E., Ford, J. D., Robinson, B. E., & Hickey, G. M. (2018).	**Title:** Livelihood exposure to climatic stresses in the north-eastern floodplains of Bangladesh • **Issues Considered:** To explore the temporal and spatial aspects of climatic stress on local resource production systems from the perspectives of resource-dependent communities • **Location:** Hakaluki haor and Tanguar haor • **Method:** FGDs, KIIs and Household Surveys • **Types of Capital:** Social and Natural Capital • **Major Findings:** Agriculture remains the primary livelihood, but is increasingly vulnerable to climatic stresses such as flash floods, droughts, and seasonal flooding; Resource management practices and the social-natural environment play crucial roles in shaping stress impacts beyond just climate and economic factors; Communities adapt their perceptions of climatic stress through learning and innovation, with livelihood diversification, crop variety changes, and multiple crop rotations helping to reduce perceived stress intensity.

Reference	Key Points of the Study
Rahman, H. T., Robinson, B. E., Ford, J. D., & Hickey, G. M. (2018).	**Title:** How do capital asset interactions affect livelihood sensitivity to climatic stresses? Insights from the northeastern floodplains of Bangladesh. • **Issues Considered:** To examine how various forms of capital assets can be strategically employed and modified to mitigate the impact of climatic stresses on livelihoods • **Location:** Haor Area • **Method:** Comparative Case Study • **Types of Capital:** Physical, Natural, Financial, Human, and Social Capital • **Major Findings:** Two major strategies were commonly used- Communities in Hakaluki haor were mobilizing their networks with sub-national, national and, international socio-economic systems in order to generate alternative livelihood activities; Communities in Tanguar haor were intensifying natural resource use with the help of government interventions
Dhar, A. R., Islam, M. M., Jannat, A., & Ahmed, J. U. (2018).	**Title:** Wetland agribusiness aspects and potential in Bangladesh. • **Issues Considered:** To explore the farmers' livelihood aspects and agribusiness potentials in the wetland areas of Bangladesh • **Location:** Haor area • **Method:** Direct interview method using a structured questionnaire. • **Types of Capital:** Financial and Human Capital • **Major Findings:** The SWOT analysis of agribusiness prospects- Strength: Favorable farm environment, Enterprise Interdependence; Weakness: Weak Marketing System, Lack of Agricultural Credit Access; Opportunity: Improvement in Agricultural Technologies, Proper Utilization of Agricultural Resources; Threat: Environmental Vulnerability, Declining Amount of Cultivable Land
Rahman, H. T., Hickey, G. M., & Sarker, S. K. (2015).	**Title:** Examining the role of social capital in community collective action for sustainable wetland fisheries in Bangladesh. • **Issues Considered:** To identify the prerequisites for developing a community-based fisher organization by assessing the relationships between collective action and social capitals • **Location:** North-eastern district of Sylhet Local Level Institution (LLI) study technique • **Types of Capital:** Social capital • **Major Findings:** Successful wetland resource decentralization relies on significant social capital, encompassing bonding, linking, and bridging. Though community leaders bridged the gap between community members and external agents through linking and bridging social capital, leaders sometimes exerted disproportionate influence over decisions due to their opportunistic behavior.

Reference	Key Points of the Study
Rahman, M. M., & Begum, A. (2010).	**Title:** The strategy of empowering poor for wetland resources conservation in Bangladesh • **Issues Considered:** How the poor community mobilizes their resources to develop alternative livelihoods and adapt their way of life through enhanced management of fisheries resources • **Location:** Three major wetlands: Hail Haor, Turag-Bongshi river basin, Kangsha-Malijhee river basin • **Method:** Resource User Groups • **Time Frame Considered:** 1999- 2008 • **Types of Capital:** Financial and Social Capital • **Major Findings:** Group formation and activities enhance comprehension of the community's roles in wetland resource management.; Resource user group (RUGs) and Micro-credit offered a strong foundation for alternative livelihoods; Financial capital is enhanced through RUGs, fostering savings and income generation, and reducing reliance on exploitative lending.

Table A2: A list of studies that addressed wetland valuation

Reference	Key Points of the Study
Al-Amin, A. K. M., Alam, K., Shrestha, U. B., Prodhan, M. H., Hossain, M. A., Sattar, N., ... & Akhter, T. (2021).	**Title:** Ecosystems, livelihood assets and willingness to pay for wetland conservation in Bangladesh • **Issues Considered:** To examine the willingness to pay attitudes and to examine the effect of livelihood assets on their WTP. • **Location:** Dingapota Haor • **Data Collection and Valuation Method:** Focus group discussion and Contingent Value Method • **Major Finding:** Households' responses to conservation payments vary: those with organizational ties and extension services are more willing to pay (certain), while older and wealthier households show reduced willingness (uncertain). Farming and fishing households with access to credit and extension services are less likely to protest payments.
Mehvar, S., Filatova, T., Sarker, M. H., Dastgheib, A., & Ranasinghe, R. (2019).	**Title:** Climate change-driven losses in ecosystem services of coastal wetlands: A case study in the West coast of Bangladesh • **Issues Considered:** To quantify potential climate change-driven losses in the value of wetland ecosystem services due to relative sea-level rise induced inundation • **Location:** Western coastal area of Bangladesh • **Data Collection and Valuation Method:** Valuation of WES: Standard economic techniques (i.e. contingent valuation, market price and net factor income • **Major Findings:** The study finds that relative sea-level rise (RSLR) alone is projected to cause limited inundation and modest economic losses (up to US$ 20 million) in wetland ecosystem services along the western coast of Bangladesh by 2100 under various IPCC climate scenarios. However, the results suggest that other climate change impacts—like coastal erosion, cyclones, and rising sea temperature—are likely to pose greater threats to these ecosystems.

Reference	Key Points of the Study
Dinnar, S. H., & Islam, S. (2019).	**Title:** Economic Valuation of a Wetland by Using Statistical Method: A Case Study on Chalan Billabong, North-Bengal, Bangladesh • **Issues Addressed:** To estimate the total economic value of non-use attributes of the Chalan Beel • **Location:** Chalan Beel • **Data Collection and Valuation Method:** Questionnaire survey, key informant interview and focus group discussion; Contingent valuation method (CVM) • **Major Findings:** The annual average non-use value of the Chalan Billabong at Tk. 12.15 million, with households' average willingness to pay (WTP) totaling around Tk. 93.48 million. Socio-economic factors such as income, age, education, and proximity to the beel significantly influence WTP.
Rahman, M. M., Jiang, Y., & Irvine, K. (2018).	**Title:** Assessing wetland services for improved development decision-making: a case study of mangroves in coastal Bangladesh • **Issues Considered:** To examine the ecosystem services provided by Sundarban mangroves as perceived by local coastal communities and their monetary value • **Location:** Coastal wetland • **Data Collection and Valuation Method:** Questionnaire Survey-providing 20 different options for annual monetary contribution under a hypothetical market scenario • **Major Findings:** The annual economic value of wetland provisioning services at US$ 976/ha for capture fishery, US$ 80/ha for fuel, US$ 53/ha for honey, and US$ 26/ha for fodder. Additionally, the average annual willingness to pay for regulating and habitat services was US$ 13/ha for storm protection, US$ 2/ha for erosion control, and US$ 9/ha for fish breeding and nursery services.
Zinia, N. J., & McShane, P. (2018).	**Title:** Significance of urban green and blue spaces: Identifying and valuing provisioning ecosystem services in Dhaka City • **Issues Considered:** To quantify provisioning services provided by urban ecosystems including rooftop gardens, parks, and waterbodies in Dhaka • **Location:** Mirpur-Pallabi Zone • **Data Collection and Valuation Method:** Not Specified • **Major Findings:** The value of Fish was estimated at BDT 1,080,000/year, and Fodder at BDT 144,000/year.
Solayman, H. M., Baten, M. A., & Khan, M. B. (2018).	**Title:** Status and Economic Valuation of Ecosystem Services of Tanguar Haor: A Wetland of Bangladesh. • **Issues Considered:** To identify the ecosystem services utilized by communities, their economic valuation and the basic reasons for depletion of ecosystem services • **Location:** Tanguar Haor • **Data Collection and Valuation Method:** Valuation by Market Value Method (MVM) and Contingent Value Method, Impacts by natural and anthropogenic causes through DPSIR framework and Impact Matrix (IM) • **Major Findings:** The total annual economic value of ecosystem services was estimated at BDT 1,740,39,980, with provisioning services showing the highest influence (impact factor 4.85). The overall impact factor—reflecting both natural and human-induced pressures—was calculated at 4.16, indicating substantial stress on ecosystem functions.

Reference	Key Points of the Study
Ali, A., & Wadood, S. N. (2017).	**Title:** Economic Valuation of Rural Wetlands in Bangladesh: A Case Study of the Padma Beel of Pabna • **Issues Addressed:** To estimate the valuation of the Padma Beel in the rural context • **Location:** Padma Beel, Pabna • **Data Collection and Valuation Method:** Market price method • **Major Findings:** The estimated annual net benefit from wetland cultivation was Tk. 8,829,220, while the overall direct economic benefit of wetlands was valued at Tk. 73 million. However, the share of household income from wetland cultivation unrelated to food security suggests limited access to cultivation opportunities, particularly for lower-income populations.
Rafiq, R., Alam, M. S., Rahman, M. M., & Islam, I. (2014).	**Title:** Conserving wetlands: Valuation of indirect use benefits of a Wetland of Dhaka. • **Issues Considered:** Assessing the intangible benefits of the wetlands of Dhaka • **Location:** Western floodplain of Dhaka • **Data Collection and Valuation Method:** Flood Control Function: Damage Cost Avoided method; Ground Water Recharge Function: 'Chaturvedi Formula' to estimate the quantity of recharged groundwater and then value the quantity • **Major Findings:** The total economic loss due to flooding was estimated at BDT 60,621,519, while the value of recharged groundwater was BDT 5,08,03,967. The total economic value in 2010 was estimated at 111.43 million BDT, with an average value of 10.53 million BDT per square kilometer annually.
Ghosh, P. K., & Mondal, M. S. (2013).	**Title:** Economic valuation of the non-use attributes of a south-western coastal wetland in Bangladesh • **Issues Considered:** To estimate the non-use values of the wetland to realize its hidden values • **Location:** Chanda Beel, coastal freshwater wetland • **Data Collection and Valuation Method:** CV survey and Contingent Valuation Method (CVM) • **Major Findings:** Households are willing to contribute Tk. 13.69 per month for a hypothetical freshwater wetland management program, amounting to an annual non-use value of Tk. 33.24 million. Key socio-economic factors influencing willingness to pay (WTP) include age (with younger individuals more willing to contribute), education (higher education leads to higher WTP), and income (higher income increases WTP). The bequest value, highlighting concerns about the future environmental condition of the wetland, was the most significant non-use value.

Reference	Key Points of the Study
Thompson, P. M. (2008, July).	**Title:** Conserving and restoring the benefits from Bangladesh wetlands • **Issues Considered:** A detailed valuation of the uses of Hail Haor with assessment of the benefits from conserving and restoring it through MACH project • **Location:** Hail Haor located in north-east Bangladesh • **Data Collection and Valuation Method:** Mapping of land uses, surveys and detailed monitoring of all main uses. • Four types of values measured- Direct value (Fisheries, Non fish products, Tea estate vegetation use, Pasture, Boro rice, Transportation, Recreation; Indirect: Flood Control (DCA), Water quality, Aquifer charge; Optional: Value of maintaining the ecosystem for potential future uses and Existence values: Existence Values, Biodiversity (KI) • **Major Findings:** In 2000, the annual value of wetland products in Hail Haor was approximately US$650 per hectare, double the net return from cultivating a single rice crop in the same area, with the haor generating nearly US$8 million annually. Following restoration efforts, fish catches increased by 36% by 2005-06, significantly improving the overall value of the wetland, with the net present value (NPV) of benefits over 15 years reaching US$79.7 million.

Table A3: A list of studies that addressed wetland ecosystem services

Reference	Key Points of the Study
Baishakhy, S. D., Islam, M. A., & Kamruzzaman, M. (2023).	**Title:** Overcoming barriers to adapt rice farming to recurring flash floods in haor wetlands of Bangladesh. • **Issues Considered:** To identify the challenges faced in adapting rice farming to recurring flash floods in the haor wetlands of Bangladesh • **Location:** Sunamganj District • **Method:** Data collected through survey, FGD and KII and analyzed with Problem Confrontation Index (PCI) method and statistical analysis • **Major Findings:** The most significant barrier is found to be the unavailability of submergence-tolerant rice varieties, and socio economic factors as annual family income, media exposure, and perception of climate change play crucial roles in the adaptation of the flash flood challenges by the farmers.
Mim, T. S., & Ansari, M. N. A. (2021).	**Title:** Community Based Assessment of the Changes of Provisioning Ecosystem Services of Aral Haor of Sylhet District. • **Issues Addressed:** Changes in provisioning ecosystem services of Aral Haor, Sylhet District from 1990 to 2020 • **Study Area:** Aral Haor • **Data Collection Method and Year:** Observation, FGD, Community Mapping and interview with experts, 2020 • **Result:** Diversified provisioning services as both land and wetland ecosystems; Change in four key provisioning ecosystem services: Rice cultivation- Increased; Fish cultivation- Decreased; Water for irrigation- No change; Bird nesting- Decreased

Reference	Key Points of the Study
Shahidullah, A. K. M., Choudhury, M. U. I., & Emdad Haque, C. (2020).	**Title:** Ecosystem changes and community wellbeing: social-ecological innovations in enhancing resilience of wetlands communities in Bangladesh. • **Issues Addressed:** The impact of ecosystem changes on community wellbeing • **Study Area:** Northeastern region • **Data Collection Method and Year:** Participatory Land Use Survey, household surveys, focus group discussions, workshops, direct observation 2014-2015 • **Result:** The drivers that lead to the decline of ecosystem services include land use, climate change, and governance. Negative trend in security, good social relations and general health
Rahman, M. M., Jiang, Y., & Irvine, K. (2018).	**Title:** Assessing wetland services for improved development decision-making: a case study of mangroves in coastal Bangladesh. • **Issues Addressed:** The ecosystem services of Sundarban mangroves as perceived by local communities • **Study Area:** Sundarbans Mangrove Wetland • **Data Collection Method and Year:** Focus group discussions and household surveys; November 2014 to January 2015 • **Result: Highly important**- Provisioning services: Capture fishery and fuel energy; Regulating services: Storm protection; Cultural service: Aesthetic features; Supporting services: the habitat for fish breeding
Akhter, H., Mia, C., & Panna, S. A. (2018).	**Title:** Understanding the Changes of the Wetland Ecosystem and Its Impact on the Biodiversity of Tanguar Haor in Sunamganj, Bangladesh. • **Issues Addressed:** Changes in the ecosystem of Tanguar Haor from 1955 to 2015 • **Study Area:** Tanguar Haor • **Data Collection Method and Year:** Secondary source (Published international journals, government reports, project reports of international organizations) • **Result:** Changes: Swamp forests becoming very rare, Increasing percentage of agricultural land, Migratory birds disappearing, Reduction in fish production, losing water carrying capacity of the adjacent rivers, and an increase in human localities
Islam, M. M., Sunny, A. R., Hossain, M. M., & Friess, D. A. (2018).	**Title:** Drivers of mangrove ecosystem service change in the Sundarbans of Bangladesh. • **Issues Addressed:** Factors contributing to the degradation of ecosystem services of Mangrove wetland • **Study Area:** Sundarbans Mangrove Wetland • **Data Collection Method and Year:** Individual interviews, focus group discussions, key informant interviews; July to December 2015 • **Result:** The provisioning and cultural services of the Sundarbans having a direct impact on the daily lives • Anthropogenic factors responsible for change: Unsustainable exploitation practices, Shrimp farming and land use change, Coastal development activities, Reduction of freshwater flow, Cyclones, Governance issues, Markets and globalization, Tourism

Reference	Key Points of the Study
Islam, M. M., & Hossain, M. M. (2017).	**Title:** Community dependency on the ecosystem services from the Sundarbans mangrove wetland in Bangladesh. • **Issues Addressed:** Identifying Ecosystem Services of the Sundarbans Mangrove Wetland • **Study Area:** Sundarbans Mangrove Wetland • **Data Collection Method and Year:** Not Mentioned • **Result:** Provisioning services: Fishery Production (Fish, Shrimp, Crab, Oyster, Dry Fish), Forest Production (Timber, Nipa Palm, Woods, Wax, etc.)**;** Regulatory Services: Carbon sequestration; Supporting services: Soil formation; Cultural Services: Mangrove tourism, religious value
Islam, S. N. (2016).	**Title:** Deltaic floodplains development and wetland ecosystems management in the Ganges–Brahmaputra–Meghna Rivers Delta in Bangladesh. • **Issues Addressed:** The management of wetland ecosystem functions within the deltaic floodplain • **Study Area:** Ganges–Brahmaputra–Meghna Rivers Delta • **Data Collection Method and Year:** Focus Group Discussion and Participatory Rural Appraisal • **Result:** Emphasized an integrated and adaptive management approach involving institutional support, planning and policy support, biodiversity support, livelihood support, organizations support and indigenous support
Hossain, M. S., Hein, L., Rip, F. I., & Dearing, J. A. (2015).	**Title:** Integrating ecosystem services and climate change responses in coastal wetlands development plans for Bangladesh. • **Issues Addressed:** The plausible impact of future climate change on coastal ecosystem services and adaptation response for it • **Study Area:** Narail District • **Data Collection Method and Year:** Focus group discussion and secondary data • **Result:** Provisioning services: Reduction of rice and wheat production, Reduction of fresh water Regulatory • **Services:** Increase of flood, Low water flow, Increase of salinity, River erosion Supporting services: Inhibition of primary production, Decrease of soil organic matter • **Cultural Services:** Extinction of Nouka Baich, Nobanno for reduction in local crops
Islam, S. N. (2010)	**Title:** Threatened wetlands and ecologically sensitive ecosystems management in Bangladesh. • **Issues Addressed:** To understand the issues in the management of environmentally sensitive ecosystems • **Study Area:** Wetlands in Bangladesh • **Data Collection Method and Year:** Not Mentioned • **Result:** The challenges of the management of threatened wetlands and ecologically sensitive ecosystems in Bangladesh include Inadequate legal frameworks and institutional capacity, Lack of awareness and education, and competing demands for natural resources.

Table B: A list of studies that addressed land cover change of wetlands

Reference	Key Points of the Study
Siddique A. B., Rayhan, E., Sobhan, F., Das, N., Fazal M, A., Riya,S,C and Sarker, S. (2024).	**Title:** Spatio-temporal analysis of land use and land cover changes in a wetland ecosystem of Bangladesh using a machine-learning approach. • **Location and Time Frame:** Hakaluki Haor • **Wetland Typology:** Freshwater wetland designated as a RAMSAR site and Ecologically Critical Area (ECA). • **Time Frame Considered with season:** Rainy season (May to October) and dry season (November to April) • **Technique Used:** Landsat 5, Landsat 7, Landsat 8, and Landsat 9; Algorithm used is Classification and Regression Tree (CART) for LULC classification and change detection through Google Earth Engine (GEE) and ArcGIS 10.8 • **Findings:** Waterbodies are decreased by approximately 51%, vegetation is decreased by around 71%, settlement areas are increased by about 353% and agricultural land demonstrated fluctuations throughout the study period
Hossain, F., Rana, M. M. P., & Moniruzzaman, M. (2021).	**Title:** Modelling agricultural transformation: A remote sensing-based analysis of wetlands changes in Rajshahi, Bangladesh. • **Issues Considered:** Evaluation of the conversion of agricultural land into man-made wetlands • **Time Frame Considered:** 1990-2020 • **Technique Used:** Normalized Difference Water Index; Binary Logistic Model • **Major Findings:** A reduction in the area covered by agricultural land and vegetation, while the area occupied by settlements and wetlands has increased and predicted growth in wetlands area is 3.62%
Talukdar, S., & Pal, S. (2020).	**Title:** Modeling flood plain wetland transformation in consequences of flow alteration in Punarbhaba river in India and Bangladesh. • **Issues Considered:** Analyze and predict the impact of the construction of dam (flow alteration) • **Location:** Wetlands in the Punarbhaba river basin in India and Bangladesh • **Time Frame Considered:** Pre dam:1978- 1992; Post dam: 1993-2001 • **Technique Used:** Method of modeling flow alteration: Artificial Neural Network**,** Wetland delineation: Calculation of NDWI**,** Methods of wetland area simulation: Combined cellular automata-Markov chain • **Major Findings:** Decline in river flow leading to a reduction in the wetland area by 34.52% in the post-dam phase; Predicted to decrease by 22.66% by 2030**;** Decline in the depth of wetland**;** 10.56% of highly consistent wetland has been transformed into inconsistent wetland
Mahmud, H., Rahman, M. M., & Sharmin, S. (2020).	**Title:** Urbanization Impact on Wetlands: A Case Study on Dhamrai Paurashava. • **Location:** Dhamrai Paurashava, Dhaka • **Wetland Typology:** Waterbodies including ponds, rivers, khals, lakes, and low-lying areas • **Time Frame Considered:** 2004-2017 (Dry season) • **Satellite Image and Analysis Technique Used:** Land use maps of 2004, 2010 and 2017 derived from Google Earth Satellite images; digitizing to prepare land use map • **Change in Area:** Around 43.49% of wetland was lost

Reference	Key Points of the Study
Ishan, R. B., Intezar, T. M. (2019).	**Title:** An Analysis on Chronological Conversion of Urban Wetlands of Dhaka Metropolitan Area from 1990 to 2018 • **Location:** Dhaka Metropolitan Area • **Wetland Typology:** Wetlands subdivided into two categories (Total wetland, Permanent wetland) • **Time Frame Considered:** 1995-2015 • **Satellite Image and Analysis Technique Used:** Landsat images of 1995 and 2015 from USGS; Doing supervised classification • **Change in Area:** Total wetland area reduced by 44%, permanent wetland area reduced by 27%.
Faisal, A. A., Hossain, M. A., Hoque, S., Shaunak, M. F., & Kafy, A. A. (2019).	**Title:** Remote sensing approach in wetland and land degradation assessment: a scenario of Modhumoti Model Town, Savar, Bangladesh. • **Location:** Modhumoti Model Town, Savar, Dhaka (Focused on the impact of a housing project at the river zone) • **Wetland Typology:** Floodplain area as per Master Plan 1997 • **Time Frame Considered:** 1998-2019 • **Satellite Image and Analysis Technique Used:** Images of 1998, 2004, 2010, 2014 and 2019 from Landsat TM 4-5 and OLI 8; Calculating NDVI, SAVI, NDWI, NDBI • **Change in Area:** Water body reduced by around 2.23 km^2 from 10.54 km^2
Islam, M. R., & Datta, N. (2019, March).	**Title:** Remote Sensing and GIS Analysis of Changing Wetlands and Drainage Network System in Mirpur Zone. • **Location:** Mirpur Zone, Dhaka • **Wetland Typology:** Two categories: Wetland, Water Body (River and Khals/ Canals) • **Time Frame Considered:** 1972-2017 • **Satellite Image and Analysis Technique Used:** The land-sat images of the years 1972, 1989, 20000, 2010 and 2017; Technique not mentioned • **Change in Area:** Wetland decreased by 78.69%
Saha, T. K., & Pal, S. (2019).	**Title:** Exploring physical wetland vulnerability of Atreyee River basin in India and Bangladesh using logistic regression and fuzzy logic approaches. • **Issues Considered:** The nature of the physical vulnerability of wetland for pre- and post-dam periods • **Time Frame Considered:** Pre dam: 1987- 2010**;** Post dam: 2013- 2016 • **Technique Used:** Logistic regression and fuzzy logic approaches • **Major Findings:** 9.97% and 8.99% of wetland areas were highly or very highly vulnerable which increased to 23.35% and 12.52% in the post-dam period; An increase in the very highly vulnerable wetland habitat from 9.93% to 25.28%**;** Reasons for growing wetland vulnerability flow reduction, squeezing of active flood-prone zone, and agricultural extensions

Reference	Key Points of the Study
Pal, S., & Talukdar, S. (2018).	**Title:** Application of frequency ratio and logistic regression models for assessing physical wetland vulnerability in Punarbhaba river basin of Indo-Bangladesh. • **Issues Considered:** Physical vulnerability of the wetlands • **Location:** Punarbhaba river basin of Indo-Bangladesh • **Time Frame Considered:** Pre dam: 1988- 1992; Post dam: 1993- 2016 • Technique Used: Frequency Ratio and Logistic Regression • **Major Findings:** Vulnerability of the wetland area significantly increased in the post-dam period, with FR and LR models showing a rise from around 6–9% to over 50% in high and very high vulnerability zones. This rise is attributed to agricultural expansion, floodplain encroachment, and changes in flood frequency.
Pal, S., & Saha, T. K. (2018). .	**Title:** Identifying dam-induced wetland changes using an inundation frequency approach: the case of the Atreyee River basin of Indo-Bangladesh • **Issues Considered:** The impact of dams • **Location:** Wetlands in the Atreyee River basin of Indo-Bangladesh • **Time Frame Considered:** Pre dam: 1987- 2011; Post dam: 2012- 2016 • **Technique Used:** Wetland delineation: Calculation of NDWI; Inundation frequency Water presence frequency approach • **Major Findings:** A reduction in the wetland area from approximately 1280 km^2 to 629 km^2 in the post-monsoon season and 78% reduction in the stable part of the wetland in the post-dam period
Arifeen, H. M., & Faisal, A. S. M. (2018).	**Title:** A Geospatial Approach to Identify the Changes in Waterbodies and its Consequences in Dhaka North City Corporation, Bangladesh**.** • **Location:** Dhaka North City Corporation • **Wetland Typology:** Khals • **Time Frame Considered:** 1991-2014 • **Satellite Image and Analysis Technique Used:** Landsat images of 1991, 2005, and 2014; Doing supervised classification • **Change in Area:** Around 72.5% khals were lost
Hredoy, M. S. N., Naim, M. N. H., Sikdar, M. S., & Islam, M. K. (2018, December).	**Title:** Spatio-temporal change analysis of Wetland in Chittagong City Corporation by Remote Sensing and GIS Technique. • **Location:** Chittagong City Corporation • **Wetland Typology:** Lake, ponds, lagoon, river, aqua fishing, and vast seawater • **Time Frame Considered:** 1990-2018 (Rainy season) • **Satellite Image and Technique:** Landsat images of 1990 (TM), 2005 (TM), 2018 (OLI-TRS); Calculating Normalized Difference Water Index (NDWI) along with post-classification change detection • **Change in Area:** About 28.92% wetland decreased
Talukdar, S., & Pal, S. (2017). .	**Title**: Impact of dam on inundation regime of flood plain wetland of punarbhaba river basin of barind tract of Indo-Bangladesh • **Issues Considered:** Analyzing the loss and alteration of wetlands due to damming and water diversion • **Location:** Punarbhaba River basin • **Time Frame Considered:** 1978- 2015 pre-monsoon (March to May) and post-monsoon (October to December) seasons • **Technique Used:** Detecting seasonal flow regime: Seasonal flow instability • **Major Findings:** Pre-monsoon wetland area decreased from 42.2 km^2 to 27.87 km^2, the post-monsoon wetland area decreased from 277.85 km^2 to 220.90 km^2.

Reference	Key Points of the Study
Karim, K. R. (2014).	**Title:** Trends of Permanent Wetland Change in Detailed Area Plan of Dhaka • **Location:** Dhaka Metropolitan Area • **Wetland Typology:** Permanent Wetland • **Time Frame Considered:** 1967-2010 (Dry season) • **Satellite Image and Analysis Technique Used:** Corona Space photo of 1967, Landsat MSS image of 1977, 1988 and Landsat TM image of 1989, 1999, 2010; Applying unsupervised classification method • **Change in Area:** Reduced from 14% to 4%
Hossain, M. W., Feerdaus, J., Saha, P. K., & Saifullah, A. (2014).	**Title:** Temporal and spatial changes of wetlands in selected areas of Dhaka city and its impact on the surrounding environment • **Location:** Eastern part of Dhaka city • **Wetland Typology:** Divided into two categories (waterbodies and lowlands) • **Tim e Frame Considered:** 1995-2001 • **Satellite Image and Analysis Technique Used:** Two topographic maps of 1995 and 2001 from the Survey of Bangladesh • **Change in Area:** 18.5% reduction in wetlands
Shopan, A. A., Islam, A. K. M. S., Dey, N. C., & Bala, S. K. (2013, March).	**Title:** Estimation of the changes of wetlands in the northwest region of Bangladesh using Landsat images • **Location:** Northwest Region of Bangladesh • **Wetland Typology:** Not Specified • **Time Frame Considered:** 1989-2010 (Dry season) • **Satellite Image and Analysis Technique Used:** Landsat images of 1989, 2000 and 2010; Calculating Normalized Difference Vegetation Index (NDVI) • **Change in Area:** Around 29.27% of the wetland was lost
Mahmud, M. S., Masrur, A., Ishtiaque, A., Haider, F., & Habiba, U. (2011).	**Title:** Remote sensing & GIS-based spatio-temporal change analysis of wetland in Dhaka city, Bangladesh. • **Location:** Dhaka Metropolitan Area • **Wetland Typology:** Identified wetland into two Categories (Wetland and Rivers, Khals) • **Time Frame Considered:** 1978-2009 (Rainy season) • **Satellite Image and Analysis Technique Used:** Landsat MSS image of 1978, 1988 and Landsat TM image of 1998, 2009; Supervised classification with the post-classification change detection • **Change in Area:** Reduced by- Wetland: 76.67%, Rivers & Khals: 18.72%
Salauddin, M., & Islam, A. K. M. S. (2011, January).	**Title:** Identification of land cover changes of the haor area of Bangladesh using MODIS images. • **Location:** Northeastern Region of Bangladesh • **Wetland Typology:** Haor basin • **Time Frame Considered:** 2000-2008 (Dry season & Rainy season) • **Satellite Image and Analysis Technique Used:** MODIS satellite images; Calculating Normalized Difference Vegetation Index (NDVI) • **Change in Area:** Haor area reduced by around 6.88%

Reference	Key Points of the Study
Islam, M. S., Rahman, M. R., Shahabuddin, A. K. M., & Ahmed, R. (2010).	**Title:** Changes in wetlands in Dhaka city: trends and physio-environmental consequences. • **Location:** Dhaka Metropolitan Area • **Wetland Typology:** Divided into two categories (waterbodies and lowlands) • **Time Frame Considered:** 1960-2008 • **Satellite Image and Analysis Technique Used:** Topographic map of 1960, Landsat TM image of 1988, ALOS-VNIR satellite image of 2008; Supervised image processing over false color composite • **Change in Area:** Reduced by- Waterbodies: 32.57%, Lowlands: 52.58%
Sultana, M. S., Islam, G. T., & Islam, Z. (2009).	**Title:** Pre-and post-urban wetland area in Dhaka City, Bangladesh: a remote sensing and GIS analysis. • **Location:** Dhaka Metropolitan Area • **Wetland Typology:** Subdivided into two categories (Open water body, Inland water body) • **Time Frame Considered with season:** 1968-2001 (Dry season) • **Satellite Image and Analysis Technique Used:** Aerial photo of 1968 and SPOT satellite image of 2001; Generating composite data layers by ArcGIS • **Change in Area:** Reduced by- Open water body: 50.96%, Inland water body: 64.7 %
Dewan, A. M., & Yamaguchi, Y. (2008)	**Title:** Effect of Land Cover Changes on Flooding: Example from Greater Dhaka of Bangladesh. • **Location of the considered wetland:** Dhaka Metropolitan Area • **Wetland Typology in Analysis:** Identified wetlands as lowlands • **Time Frame Considered with season:** 1960-2005 (post-monsoon) • **Satellite Image and Analysis Technique Used:** Topographic map of 1960, Landsat TM image of 1988, IRS-1D data 2008; Post-classification change detection • **Change in Area:** Reduced from 32.5% to 17.2%

Table C: A list of studies that addressed the Planning, Legislative and Institutional Framework of Wetlands

Reference	Key Points of the Study
Khondoker, S., Hossain, M. L., & Moni, K. A. H. (2014).	**Title:** Wetland management in Bangladesh: A study on Beel Bakar • **Issue addressed:** To assess the present water management system, • **Data Collection Method:** Mix group discussion, focus group discussion, key informants interview, direct observation • **Findings:** excessive gher culture practice and possession of non-fishermen over the water body are the main constraints of the beel

Reference	Key Points of the Study
Haq, T. (2013).	**Title:** A violent threat to conservation of wetlands and the existing laws of Bangladesh: A critical analysis • **Issue considered:** Broad discussion of current laws regarding the conservation of wetlands • **Findings:** Environmental Policies related to wetlands: 1971 Ramsar Convention, the Tanks Improvement Act, 1939, the Bangladesh Environmental Conservation Act (1995), the Environment Court Act, 2010, the Water Act, 2013 • Institutes associated with conservation of wetlands: the Ministry of Land, Ministry of Environment and Forests, Govt. Forest Dept. and Fisheries Dept., BD Water Development Board (BWDB), Flood Plain Co-ordination Organization (FPCO), The Space Research and Remote Sensing Organization
Byomkesh, T., Nakagoshi, N., & Md. Shahedur, R. (2009).	**Title:** State and management of wetlands in Bangladesh. • **Issue Considered:** Investigating the present management and conservation approach • **Data Collection:** Primary data through participatory rural appraisal (PRA), field survey, observation, and interview • with experts. Critical perusals of secondary data included relevant books, articles, reports, unpublished theses, maps, • relevant documents, newspaper cuttings, and in situ personal experiences • **Findings:** Lacking in policy documents, participatory approach is practiced in limited wetlands • Proposed SEMS Framework: The Social Environmental Management System (SEMS) from Hiroshima University involves government, citizens, and corporations in wetlands management, fostering collaborative, multi-level environmental management, with emphasis on building local capacity and coordination at national and community levels.
Ahsan, D.A., Delvalls, T.A., & Blasco, J. (2009).	**Title:** The Relationship Of National And International Environmental Ngos in Bangladesh And Their Role in Wetland Conservation. • **Issue Considered:** To explore the role of environmental NGOs to protect the wetlands of Bangladesh their relation with governmental agencies, donor agencies and international ENGOs. • **Data Collection:** Semi-structured interview technique • **Findings:** Environmental NGOs (ENGOs) primarily rely on foreign donor funding, which tends to favor larger NGOs. While NGOs maintain generally positive relationships, they compete for attention in campaigns, media, and sponsorship. • ENGOs report strong public support but experience limited engagement from government officials, who often skip meetings and exclude ENGOs from development and environmental protection projects.

Reference	Key Points of the Study
Jahan, S., Islam, I., Takao, K., & Kanegae, H. (2008).	**Title:** Shrinkage of the Wetlands of Dhaka: A Study from an Institutional Perspective. • **Issue addressed:** Institutional shortcomings and weaknesses in protecting wetland loss and level of coordination among different institutions both at public and private sector • **Data Collection Method and year:** Questionnaire survey to households living in floodplains in 2005 and 2006, interviews with professionals • **Findings:** Wetland owners often sell land unwillingly due to surrounding land-filling.; Local administration (UP) favors land developers and lacks accountability; Land-owning companies are highly influential and threatening organizations are more organized and influential than protective ones; Rural landowners' limited administrative knowledge benefits land developers.
Ahmed, I., Deaton, B. J., Sarker, R., & Virani, T. (2008).	**Title:** Wetland ownership and management in a common property resource setting: A case study of Hakaluki Haor in Bangladesh • **Issue Addressed:** To examine how variations in ownership positions within a common property resource setting impact villagers' incentives for long-term maintenance and conservation efforts. The research is based on Schlager and Ostrom's theoretical framework, which links ownership positions to conservation motivations. • **Study area:** Hakaluki Haor wetland • **Data collection method:** Questionnaire Survey • **Findings:** Ownership positions differ among villagers, where villagers who viewed themselves as having management rights were more likely to participate in conservation activities. Notably, women indicated support for wetland conservation despite generally not perceiving themselves as having formal management rights.

Chapter 2

Changing Dynamics of Wetland in Dhaka City

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1. Background of the Study

Wetlands, often termed as Green Blue Infrastructures (GBI) of a city, are important elements of ecological systems of cities and regions for ensuring sustainability and livability. Wetland covers some 29.83 million km^2 (5% to 8%) of the world's land surface among which largest portion (9.2 million km^2) is distributed in Asia followed by South America (7.95 million km^2), North America (5.65 million km^2), and Africa (5.6 million km^2) (Mitsch, & Mander, 2018 and Xu et al, 2019). Wetlands are critical ecological resources providing a range of ecosystem as well as socioeconomic services that play a vital role in human wellbeing directly or indirectly (Danso et al., 2021). They contribute around 40.6% of the global ecosystem service value (Ramsar Convention on Wetlands, 2018). Wildlife habitat, carbon sequestration, water supply and purification, agricultural pollution filtration, flood mitigation, coastline protection are some significant functions of wetlands (Owers, Rogers, Woodroffe, 2018; & Sica et al., 2016). Besides, they produce food, supply raw materials, genetic resources, medicine, and used in recreational and tourism purposes (Gallant et al., 2020). Furthermore, through

CO2 sequestration they capture and store carbon either naturally or by man-made sink and thereby contributing to climate change mitigation (Were et al., 2019). Some wetlands are used for hydropower and trans-port, while others hold cultural and spiritual values and serve as a source of inspirations (Ramsar Convention on Wetlands, 2018).

Despite these wide ranges of benefits, disappearance and degradation of wetland occur globally due to rapid population growth, unplanned agriculture, aquaculture, industrial and economic activities (Ballut-Dajud et al., 2022). The scenario in urban areas of Bangladesh is not so different in this regard. Dhaka, the capital of Bangladesh, is one of the fastest growing cities in the world. The city faces challenges in coping with rapidly changing situation augmented by inappropriate management and resource constraints. Being a city of a deltaic country, the civilization of Dhaka is highly blessed by the rivers like Buriganga, Turag, Shitalakkha, Balu, Dhaleswari and their tributaries. The vast network of wetlands in the form of rivers, lakes, ponds, canals, flood flow zones, has been an integral part of the natural drainage system of Dhaka city and its adjacent areas, helping to prevent floods and waterlogging while maintaining environmental balance. However, flood flow zones and water retention areas in metro Dhaka have been facing constant threats of encroachment or land use changes over the past decades. A study was conducted employing topographic map of 1960 and a satellite image of 2008 (ALOS VNIR 2008) through GIS and remote sensing technique. The results show that in 1960 total areas of wetland and lowland were 2952.02 and 13527.58 hectares, respectively. In 2008 total areas of wetlands and lowland found were 1990.71 and 6414.57 hectares, respectively. These indicate that wetland and lowland areas were decreased 32.57% and 52.58%, respectively that means more than 49% of the wetland areas decreased over the period 1960 to 2008 (Islam et al., 2012).

Various Physical plans for Dhaka city have proposed different strategies in the past to retain these important water infrastructures. However many of these water zones have been encroached and grabbed due to lack of enforcement of the physical plans and associated laws. Recently approved Dhaka Detailed Area Plan (2022-35) has also made profound changes relating the regulations and management of wetlands for Dhaka city. On these contexts, this study analyzes the changes of wetlands of Dhaka city in the past few decades. Changing dynamics of wetlands for Dhaka South City Corporation (DSCC) and Dhaka North City Corporation (DNCC) area has been analyzed as well. Based on the findings, some strategies and actions have been suggested to protect wetlands for ensuring sustainability and well-functioning of Dhaka city in the changing urban dynamics.

2. Methodology

Literature review was carried out to understand the multifunctional values of wetland. Suitable image processing methods were selected to detect the change in wetland area. Existing policies, acts, rules, and plans related to wetland conservation

were reviewed to identify the challenges in this regard. Finally, some suggestions were proposed to make the wetland conservation process more sustainable.

2.1 Methods of Wetland Change Detection and Map Preparation

ArcGIS 10.8 and "Google Earth-pro" were used to analyze the data. A classification scheme for Supervised-Maximum Likelihood Classification (SMLC) of images was created after reference data for proper boundary delineation was collected. The classification of satellite images was established by collecting various spectral signatures from Landsat images. The band color composite selection was the most crucial step after the images were acquired for the various land classes. It can recognize a variety of terrain observations quickly. Following classification, the raster images were transformed into polygons, and the features of the polygons were combined to create a single category of landuse types. The initial land cover map was produced along with an accuracy assessment of the map. The map was created to show the locations of settlements (including built-up urban areas), waterbodies, and areas covered by vegetation.

2.2 Data Sources

The amount of vegetation cover in the DSCC was determined using satellite data from the USGS server (https://earthexplorer.usgs.gov/). To avoid issues such as cloud coverage, satellite sensor errors, and other problems, only high resolution and visibly clear images were chosen. For this study, satellite images from 1990 to 2023 are used because of their high image quality. All of the images were chosen to represent the pre-monsoon season in Bangladesh. Each satellite image is separated by a five-year interval. Path 137 and row 043; Path 137 and row 044 were used to select the images covering the study area. Preprocessing, classification, and map generation were all done with ArcGIS software. Table 2.1 displays all of the other details of the satellite image data.

Table 2.1: Specification of Satellite Data for the Study Area

Data period	Time frame	Landsat	Sensor	Cloud Coverage
1990	29 April, 1990	Landsat 05	TM	3%
1995	01 January, 1995	Landsat 05	TM	0%
2000	28 February, 2000	Landsat 07	ETM+	3%
2005	25 February,2005	Landsat 07	ETM+	3%
2010	11 March,2010	Landsat 07	ETM+	0%
2015	28 January, 2015	Landsat 07	ETM+	0%
2020	11 February, 2020	Landsat 08	**OL**	7%
2023	27 February, 2023	Landsat 09	**OL**	3%

Source: Developed by authors, 2023

2.3 Landsat Band Value

For Bands 1–7 and 9, the images from the Landsat 8 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS) have a spatial resolution of 30 meters. Panchromatic Band 8 has a resolution of 15 meters. Thermal bands 10 and 11 provide more precise surface temperatures and are collected at 100 meters 1. (Acharya & Yang, 2015). Landsat 7 Enhanced Thematic Mapper Plus (ETM+) images are made up of eight spectral bands, each

with a spatial resolution of 30 meters. Panchromatic Band 8 has a resolution of 15 meters. For greater radiometric sensitivity and dynamic range, Band 6 collects both high and low gain for all scenes, whereas the other bands can only collect one of the two gain settings (high or low) (Rajeshwari & Mani, 2014). Thematic Mapper (TM) images from Landsat 4-5 are composed of seven spectral bands, each with a spatial resolution of 30 meters for Bands 1-5 and 7. The spatial resolution of thermal infrared Band 6 is 120 meters, but it is resampled to 30-meter pixels.

2.4 Normalized Difference Vegetation Index (NDVI) Calculation

The Normalized Difference Vegetation Index (NDVI) is used to quantify vegetation greenness and is useful in understanding vegetation density and assessing changes in plant health. This index is calculated using spectral reflectance in the red and near infrared bands. The NDVI value range is -1 to 1. Low NDVI values (typically between 0 and 0.2) indicate light or dark soils, whereas high NDVI values indicate dense vegetation (Barbieri et al., 2018). The following equation is used to calculate NDVI:

$$NDVI = \frac{(\text{NIR} - \text{Red})}{(\text{NIR} + \text{RED})}$$

In Landsat 4-7,

$$NVDI = \frac{(\text{Band } 4 - \text{Band } 3)}{(\text{Band } 4 + \text{Band } 3)}$$

In Landsat 8-9,

$$NVDI = \frac{(\text{Band } 5 - \text{Band } 4)}{(\text{Band } 5 + \text{Band } 4)}$$

Table 2.2 states the suitable normalized difference vegetation index (NDVI) ranges identified for the land cover classes (Akbar et al., 2019).

Table 2.2: NDVI-based LULC classification

Sl. No	Class	NDVI Range
1	Water	–0.28–0.015
2	Settlement	0.015–0.14
3	Barren Land	0.14–0.18
4	Vegetation	0.18-0.30
5	Dense Vegetation	0.30-0.74

Source: Akbar et al., 2019

2.5 Kappa Coefficient

The accuracy assessment method demonstrates the consistency between a surface feature of the earth and the classification's outcomes. It is critical to classify satellite images from different years in order to determine changes in land use with absolute precision. The kappa statistic is frequently used to evaluate interdependence. The kappa values are a matrix that compares actual and expected accuracy as well as random change. The importance of inter-rater reliability is determined by how accurately it reflects the variables being measured in the study's data. Kappa values will always be between 0 and 1. (Rwanga & Ndambuki, 2017). A value of 1 indicates perfect agreement, while values less than 1 indicate less than perfect agreement. Table 2.3 shows the interpretation scale for Kappa (k) values (Ismail et al., 2020).

Table 2.3: Kappa Coefficient Scale

Sl. No	K Value	Strength of Agreement
1	0	No agreement
2	0.01 - 0.20	Slight agreement
3	0.20 - 0.40	Fair agreement
4	0.40 - 0.60	Moderate agreement
5	0.60 - 0.80	Substantial agreement
6	0.81 - 1.00	Very good agreement

Source: Akbar et al., 2019

Table 2.4 states the estimated Kappa coefficient (k) values for image analysis in different years of DMDP, DNCC and DSCC area. In DMDP area the calculated Kappa coefficient (k) values represent "Very Good Agreement" in 2000, 2005, 2010 and 2023, while "Substantial Agreement" was found in 1990, 1995, 2015 and 2020. In the DNCC area, the computed Kappa coefficient (k) values demonstrate a consistently high level of agreement, classified as 'Very Good Agreement' for the years 2000, 2010, 2015, 2020, and 2023. In contrast, the agreement was deemed 'Substantial Agreement' for the years 1990, 1995, and 2005. Moving to the DSCC area, Kappa coefficient (k) values indicate 'Very Good Agreement' in 1990, 2005, and 2023, while 'Substantial Agreement' was observed in 1995, 2000, 2010, 2015, and 2020. According to the result, image analysis for LULC change detection demonstrates high levels of precision.

Table 2.4: Calculated Kappa Coefficient Values of Different Year

Year	DMDP	DNCC	DSCC
1990	77.5%	75%	80%
1995	72.5%	77.5%	75%
2000	82.5%	80%	75%
2005	80%	77.5%	80%
2010	80%	82.5%	77.5%
2015	75%	80%	75%
2020	77.5%	80%	77.5%
2023	80%	82.5%	80%

Source: Developed by authors, 2023

3. Policies and Plans for Wetland Conservation

To conserve the wetlands and sustainable utilization of water resources, government of Bangladesh adopted a number of policies, acts, and plans in different periods. The provisions of these policies and plans have been summarized in Table 2.5 and Table 2.6.

The provisions under different policy, act, and rules clearly emphasize on the conservation of wetlands throughout the country. Among those, Wetland Conservation Act 2000 specifically mention that the use of wetlands marked in the master plan cannot be altered. Though this is a very explicit provision, the wetland grabbing and conversion cannot be prevented successfully due to lack of proper implementation. The other policies, acts, and rules also focus on the conservation and precluding degradation of wetland.

Table 2.5: Wetland Conservation Related Laws and Policies

Policy/Act/Rules	Provision
National water policy, 1999	Protection against degradation and resuscitate natural water-bodies such as lakes, ponds, beels, khals, tanks, etc. affected by man-made interventions or other causes.
Wetland conservation act, 2000	Wetlands should be conserved in city corporation, municipality area as demarcated in the Master Plan. Use/class of wetland cannot be changed.
Bangladesh water act, 2013	Emphasize on conservation of water resources, ensure water right.
Bangladesh water rules, 2018	Flood flow area and wetland development projects. Technical Committee to conserve wetland and examine the pollution.

Source: Compiled by authors, 2023

Table 2.6: Wetland Conservations in Various Plans for Dhaka City

Plan	Provisions
Pattrick Geddes Master Plan, 1917	Recognize the role of wetlands in the city's organization. Emphasize on wetland conservation and its regular monitoring. Focus on wetland sensitive planning. Utilitarian perception of canal and waterbodies Proposal of water parks.
Dhaka Metropolitan Development Plan (DMDP), 1995	Demarcate flood flow zones, water retention ponds.
Detailed Area Plan (DAP), 2010	Protection of flood flow zone from encroachment.
Dhaka Structure Plan, 2016	Protection of flood flow zones, canals, rivers, and flood water retention areas by restricting construction and development.
Detailed Area Plan (DAP), 2022	Demarcation and conservation of flood flow areas, water retention areas, wetlands. Water based parks. Conservation of canal as urban lifeline.

Source: Compiled by authors, 2023

Since 1917, a number of plans have been proposed to guide the development of Dhaka city considering the significant role of wetlands. The Dacca Master Plan prepared by Sir Pattrick Geddes recognized the substantial impacts of wetland on the residents' life. Thus, conservation of wetland was the prime focus of that master plan. The other plans emphasized on the demarcation and protection of wetlands and flood flow areas.

4. Land Use Change in Dhaka Metropolitan Development Plan (DMDP) Area

The land use dynamics within the Dhaka Metropolitan Development Plan (DMDP) Area have changed significantly over time, reflecting the changing needs of urban development. From the year 1990 to 2023, the area has experienced substantial shifts

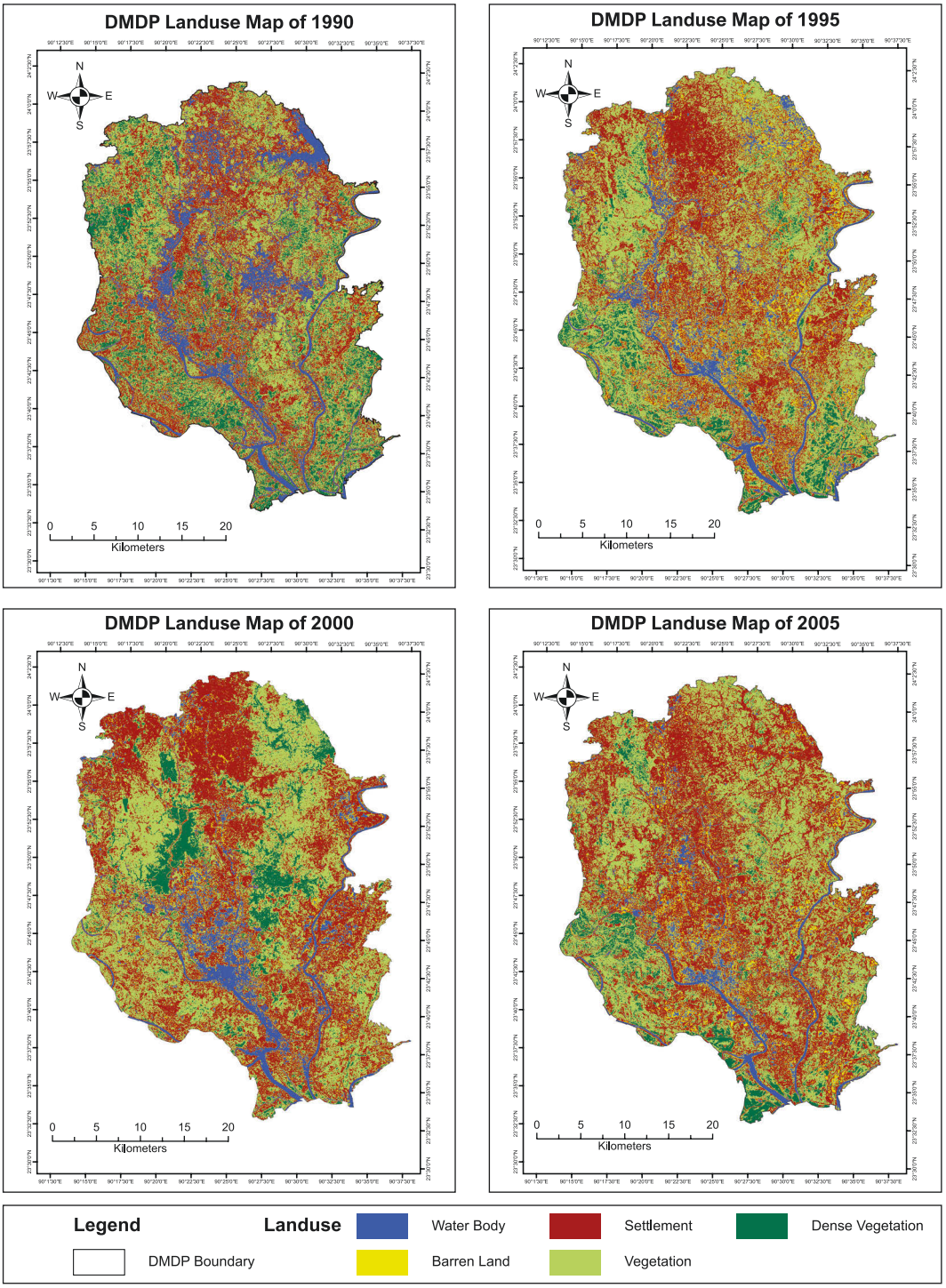
in its land utilization (Figure 2.1). This period witnessed significant urbanization and development activities, leading to changes in the spatial distribution of land for residential, commercial, and industrial purposes. The expansion of infrastructure, such as roads and transportation networks, has facilitated these changes, reshaping the spatial configuration of the area. The establishment of new residential complexes, commercial hubs, and industrial zones reflects the city's response to the demands of a burgeoning population and a growing economy.

Between 1990 and 2023, DMDP's land use has undergone an accelerated rate of change (Table 2.7). During this 33-years period, the amount of vegetation land cover has consistently decreased at an alarming rate which was from 36.36% to 17.55%. Although some lowlands and wetlands were under vegetation land cover, after 2002, due to rapid urbanization and development, these lands were filled with sand and turned into settlement and barren land. Almost the same scenario is observed in the case of change in waterbodies, but it is not as pronounced as the change in agricultural land. Between 1990 and 2023, the highest amount of waterbodies was seen at 12.81% in 1990. However, although the amount of barren land has decreased, the change in barren land has not been as consistent. The main reason for this is that waterbodies and agricultural land turn into barren land within a short period of time and become build-up areas for settlement and development purposes. On the contrary, the settlement of the DMDP area increased from 30.90% to 73.25%. Mainly, agricultural land and waterbodies are changed into build-up areas due to the housing demand for the large population of the area in this time period.

Table 2.7: Land use Land cover (LULC) Change in DMDP Area (In percent)

LULC Types	1990	1995	2000	2005	2010	2015	2020	2023
Water Body	12.81	9.59	8.55	6.35	5.16	4.30	3.62	2.02
Settlement	30.90	33.21	37.92	40.02	47.97	54.20	58.66	73.25
Barren Land	4.86	12.02	6.53	8.34	9.20	7.48	8.21	2.08
Vegetation	36.36	37.02	37.59	37.46	30.27	27.36	23.26	17.55
Dense Vegetation	15.06	8.16	9.42	7.83	7.40	6.66	6.25	5.10

Source: Developed by authors, 2023


DMDP Landuse Map of 1990
DMDP Landuse Map of 1995
DMDP Landuse Map of 2000
DMDP Landuse Map of 2005
N
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Kilometers
Legend
Landuse
Water Body
Settlement
Dense Vegetation
DMDP Boundary
Barren Land
Vegetation

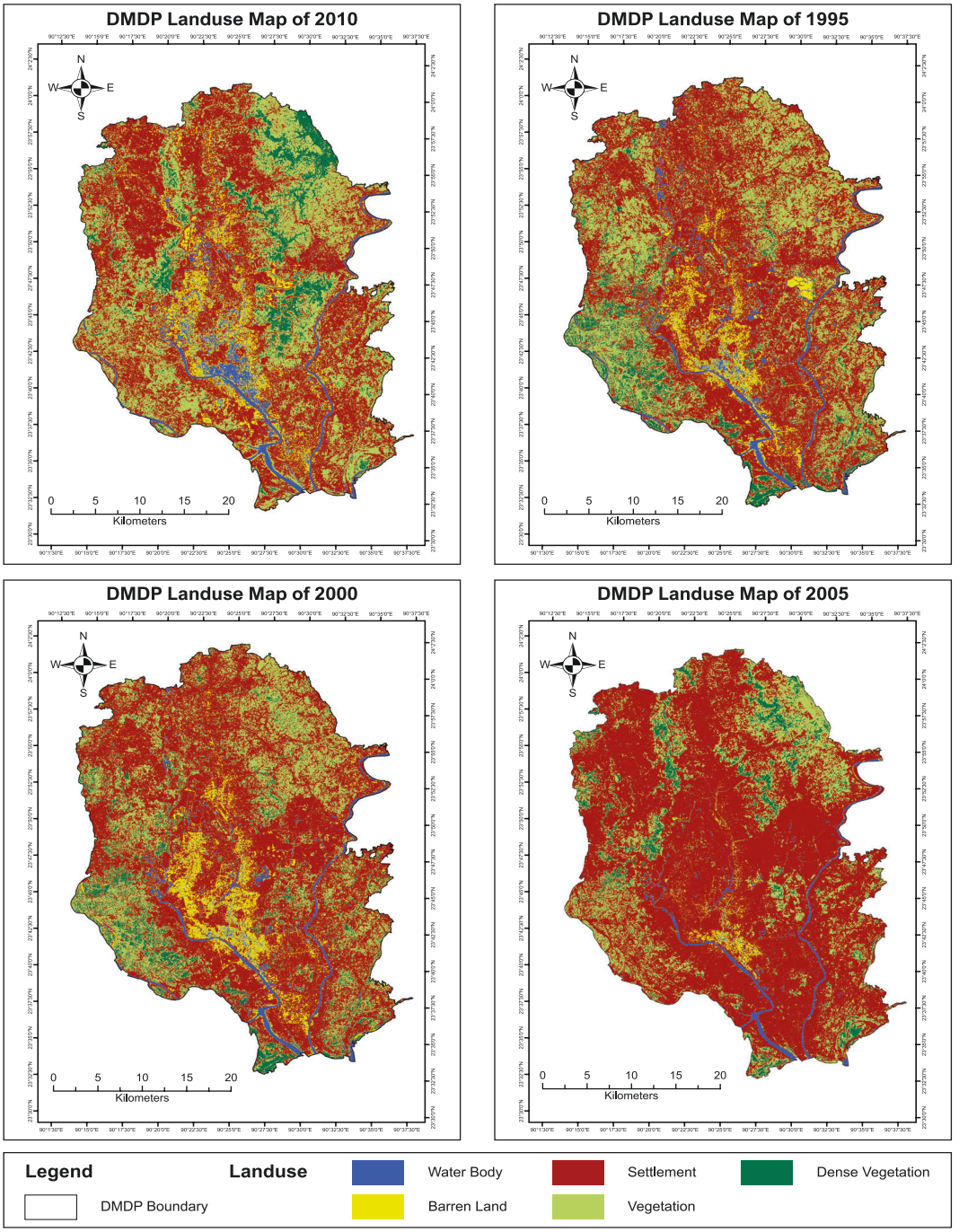


Figure 2.1: LULC Change within DMDP within DMDP Boundary (1990-2023)

Source: Developed by authors, 2023

5. Land Use Change in Dhaka North City Corporation (DNCC) Area

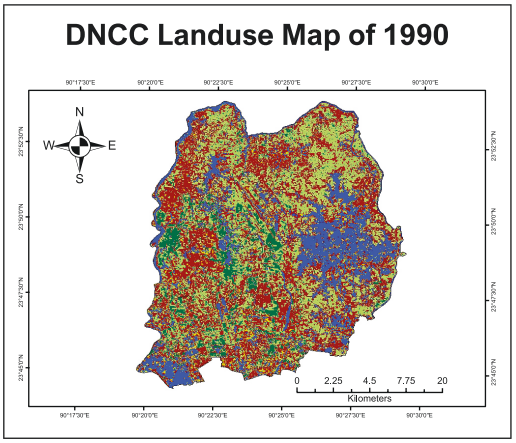
From 1990 to 2023, DNCC's land use has undergone through a rapid change (Table 2.8). During this 33-year period, the amount of vegetation land cover has consistently decreased at an alarming rate which was from 28.19% to 5.76%. But after 2002, due to rapid urbanization and development, these lands were filled with sand and turned into settlement and barren land. Almost the same scenario is observed in the case of change in water bodies, but it is not as pronounced as the change in agricultural land.

Between 1990 and 2023, the largest coverage (18.25%) of wetland was seen in 1990 (Figure 2.2). A number of wetlands were found in Badda, Tejgaon, Mohammadpur, Hazaribagh, Khilkhet, and Turag area during this period. However, the wetland of these areas was converted into other land uses between 1995 and 2023. In recent time few wetlands are found in Badda and Turag area. Although the coverage of barren land has decreased, the change in barren land has not been as consistent. The main reason for this is that water bodies and agricultural land turn into barren land within a short period of time and become build-up areas for settlement and development purposes. On contrary, the settlement coverage within the DNCC area increased from 37.22% to 88.22%.

Table 2.8: Land use Land cover (LULC) Change in DNCC Area (In percent)

Types	1990	1995	2000	2005	2010	2015	2020	2023
Water Body	18.25	9.56	12.21	8.64	8.27	5.33	4.51	1.84
Built-up Area	37.22	41.92	31.62	47.75	44.70	63.28	62.99	86.26
Barren Land	7.40	14.25	10.77	14.46	24.51	16.69	20.91	4.54
Vegetation	28.19	32.45	26.07	23.23	15.81	12.07	8.94	5.20
Dense Vegetation	8.94	1.81	19.34	5.93	6.70	2.63	2.64	2.15

Source: Developed by authors, 2023


DNCC Landuse Map of 1990
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W
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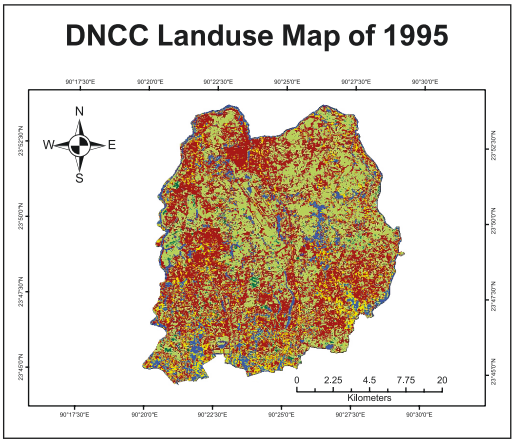
0 2.25 4.5 7.75 20
Kilometers


DNCC Landuse Map of 1995
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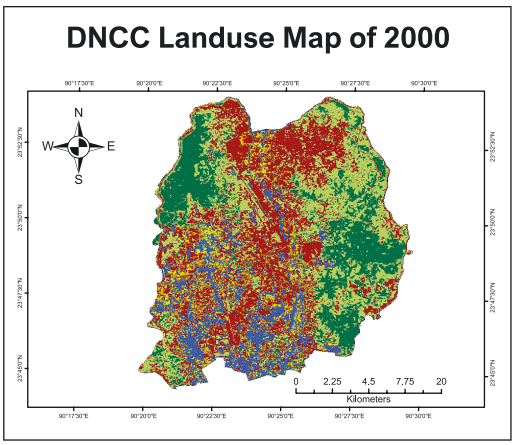
0 2.25 4.5 7.75 20
Kilometers


DNCC Landuse Map of 2000
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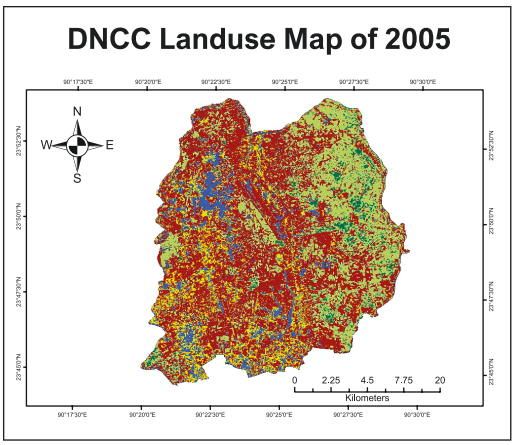
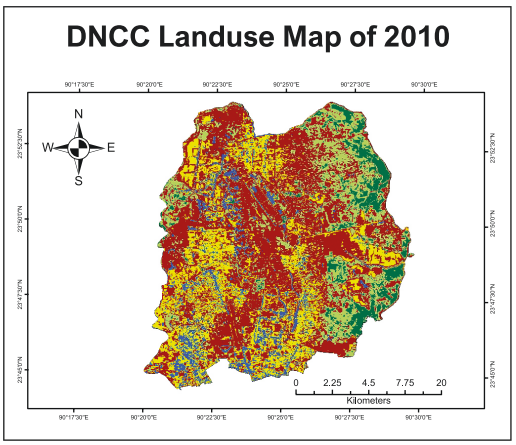
S
0 2.25 4.5 7.75 20
Kilometers


DNCC Landuse Map of 2005
N
W
E
S
0 2.25 4.5 7.75 20
Kilometers


DNCC Landuse Map of 2010
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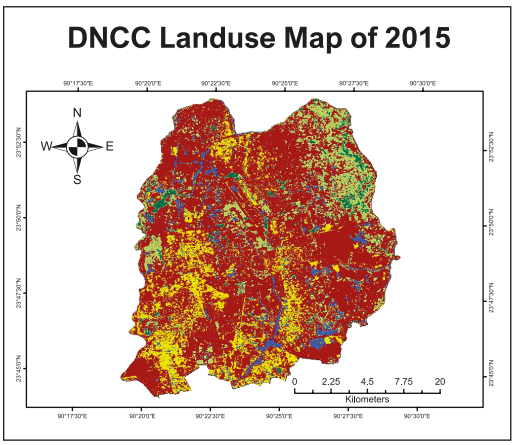
Kilometers


DNCC Landuse Map of 2015
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W
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S
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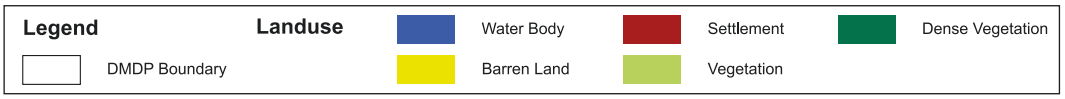
Kilometers


Legend
Landuse
Water Body
Settlement
Dense Vegetation
DMDP Boundary
Barren Land
Vegetation

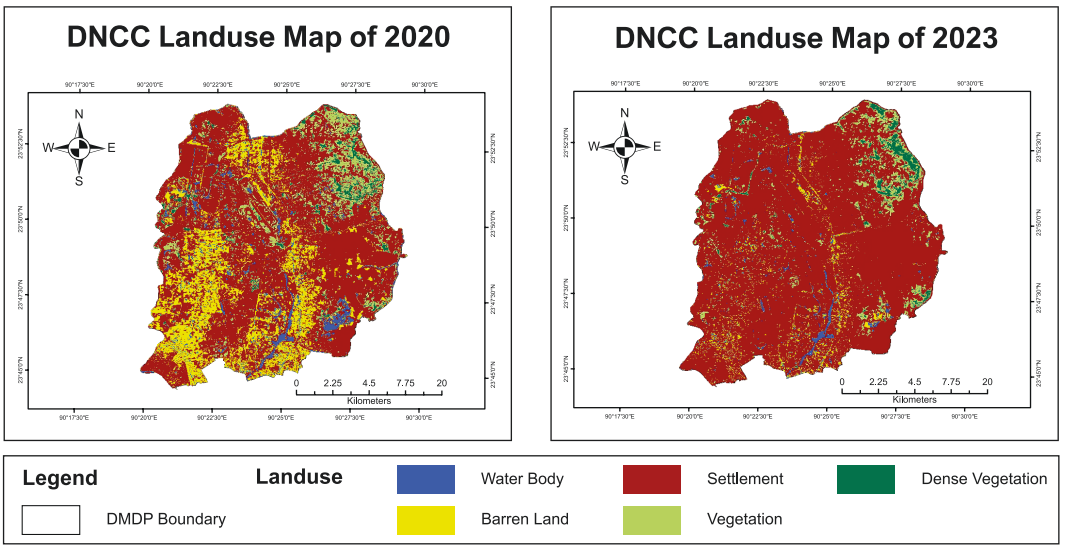


Figure 2.2: LULC Change in DNCC Area (1990-2023)

Source: Developed by authors, 2023

6. Land Use Change Analysis of DSCC

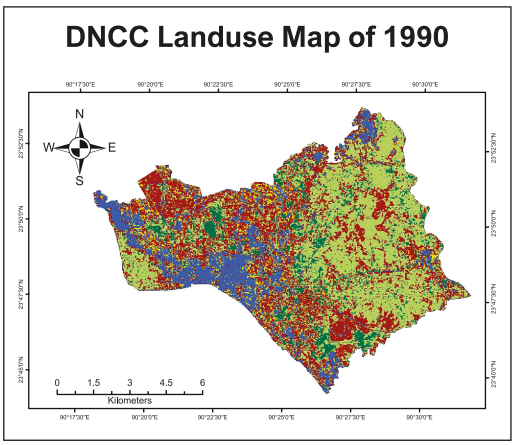
Waterbodies have decreased from around 15% in 1990 to around 3.04% in 2023 (Table 2.9). In 1990, aZ notable number of waterbodies were found in Kadamtoli, Khilgaon, Lalbagh, Chawkbazar, Shutrapur, Kotwali, Gendaria, Bangshal, Motijheel areas (Figure 2.3). At present, only a few wetlands exist in Kadamtoli and Chawkbazar area. Built-up area has increased from 32.23% in 1990 to 57.69% in 2023.

Vegetation coverage has been reduced up to 5.97% which was about 35.75% in 1990. Moreover, dense vegetation cover was around 10% in 1990 which has been reduced to only 1.42%. By and large, the land cover balance among waterbody, vegetation and built-up area has drastically impaired in last three decades for Dhaka South City Corporation.

Table 2.9: Land use Land cover (LULC) Change in DSCC Area (In percent)

Types	1990	1995	2000	2005	2010	2015	2020	2023
Water Body	14.36	15.71	24.64	14.79	17.06	8.46	6.99	3.04
Built-up Area	32.23	36.20	30.48	39.35	35.45	56.06	52.19	75.69
Barren Land	7.68	20.81	12.00	19.08	22.40	25.03	31.00	13.87
Vegetation	35.73	23.37	25.16	21.30	17.98	8.29	7.10	5.97
Dense Vegetation	10.00	3.92	7.72	5.48	7.11	2.16	2.71	1.42

Source: Developed by authors, 2023


DNCC Landuse Map of 1990
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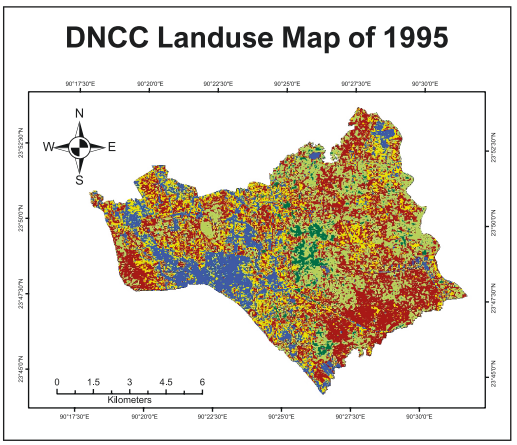
Kilometers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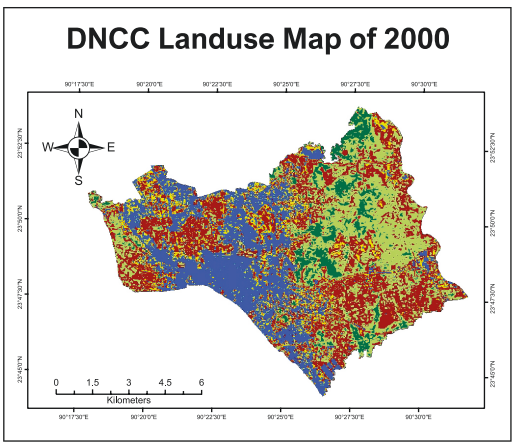
DNCC Landuse Map of 2000
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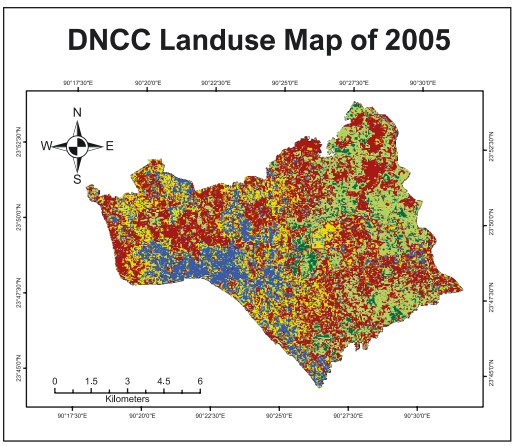
Kilometers


DNCC Landuse Map of 2005
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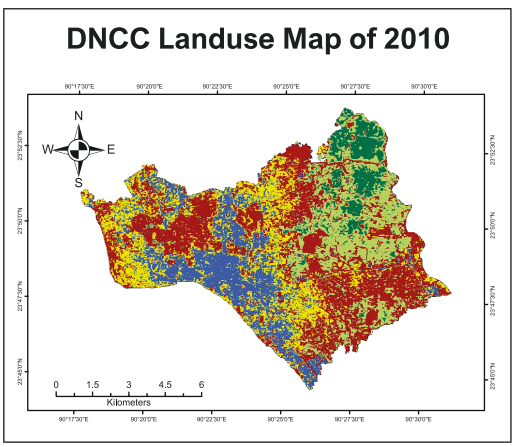
DNCC Landuse Map of 2010
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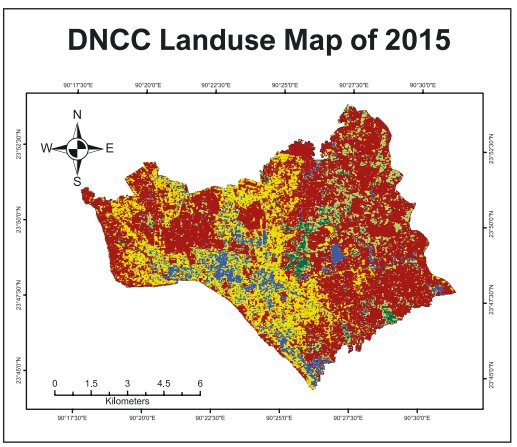
DNCC Landuse Map of 2015
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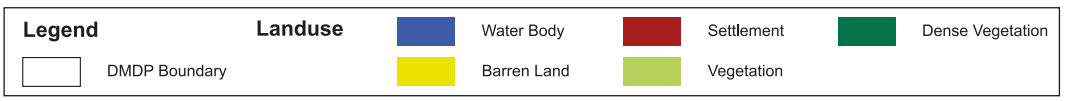
Legend
Landuse
Water Body
Settlement
Dense Vegetation
DMDP Boundary
Barren Land
Vegetation

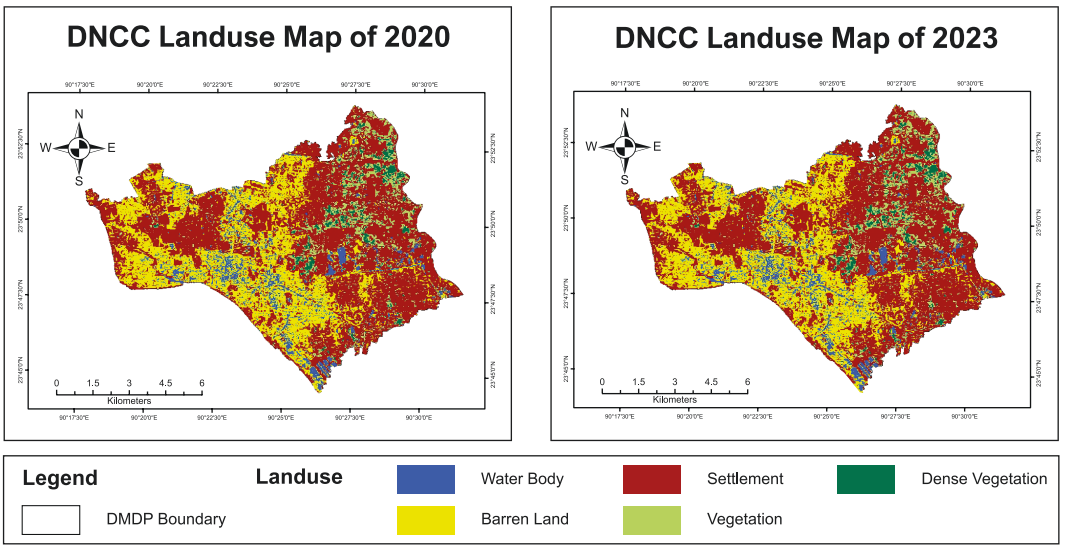

Figure 2.3: LULC Change in DSCC Area (1990-2023)

Source: Developed by authors, 2023

7. Conversion of Wetland during 1990-2023

The wetland conversion status of the DNCC, DSCC, and DMDP areas has been presented in Table 2.10 and Figure 2.4. It is evident that, largest portion of waterbodies were transformed into settlement in the DNCC (84.3%) area, followed by DSCC (52.2%) and DMDP (49.7%) area due to rapid urbanization. A notable segment (34.5%) of wetland were converted into barren land in the DSCC area with an aim to develop housing projects.

Wetland covered some 185 sqkm of the DMDP area in 1990. In 2023, the wetland coverage has declined into 24 sqkm. The conversion of wetland into other land use in DMDP is presented in Table 10. More than 92 sqkm (around 50%) of the wetland was converted into settlement because of rapid urbanization. Around 19% of the wetland was turned into vegetation. In some low laying areas land filling were carried out initially. Then some vegetation and grass coverage were introduced. About 9% of wetland was transformed into dense vegetation. Trees like Mehegoni (Swietenia macrophylla), Shegun (Tectona grandis) were planted along the edge of filled up areas of flood flow zone. These trees gradually constitute the dense vegetation coverage.

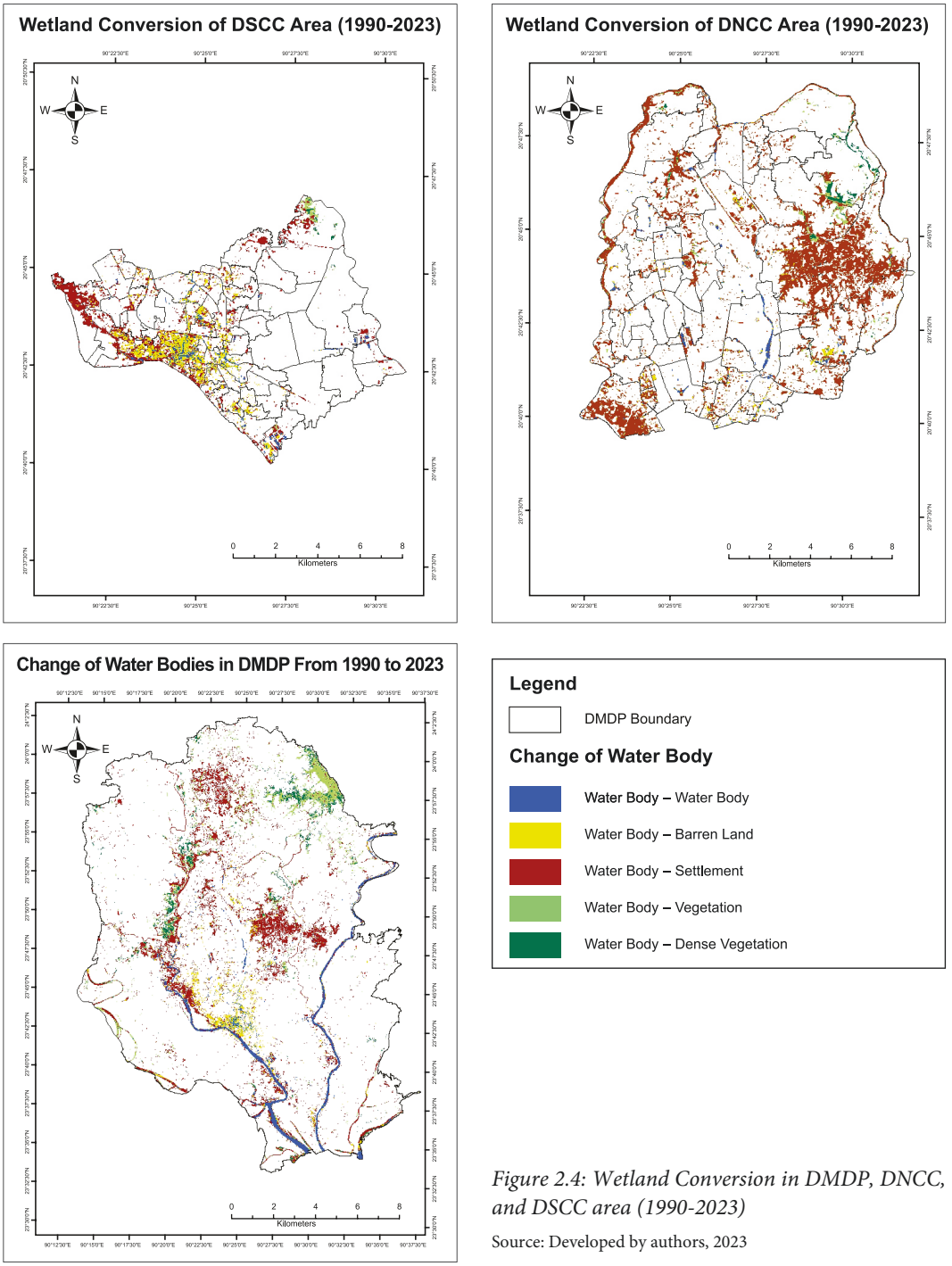

Figure 2.4: Wetland Conversion in DMDP, DNCC, and DSCC area (1990-2023)

Source: Developed by authors, 2023

Table 2.10: Wetland Conversion during 1990-2023

Change of Water Body	DNCC		DSCC		DMDP	
	Change of Area (sq.km)	Percentage	Change of Area (sq.km)	Percentage	Change of Area (sq.km)	Percentage
Water Body - Water Body	1.33	3.53	1.37	9.50	23.95	12.89
Water Body - Barren Land	1.84	4.87	4.96	34.46	18.23	9.81
Water Body - Settlement	31.86	84.29	7.52	52.21	92.28	49.68
Water Body - Vegetation	1.70	4.49	0.40	2.78	34.93	18.80
Water Body - Dense Vegetation	1.07	2.82	0.15	1.06	16.37	8.81

Source: Developed by authors, 2023

8. Development by Sacrificing Wetland

A number of development activities have been carried out by converting wetlands across the country, especially in and around Dhaka city. Most of these development projects were taken without considering proper planning and apposite site analysis. As a result, a number of consequences have been invited. Salient features of such two development projects are discussed here.

8.1 Jhilmil Residential Park

The Capital Development Authority (RAJUK) initiated the Jhilmil Residential Park project (Figure 2.5) under a public-private partnership arrangement in 2017 (Nandy, 2022). Jhilmil residential area covers some 381.11 acres land (Javed et al., 2016). Total 85 high rise buildings of which 60 buildings of 20 stories, and 25 building of 25 stories have been proposed to construct. The flat size ranges between 130 and 204 sq m. Besides, park, playground, school, college, hospital, mosque, market, lake, and community were proposed in the project area (Nandy, 2022). This housing project was developed in low laying flood flow area by sand filling (Javed et al., 2016). Before 1995, the project area was found as flood flow area. Initially, wetlands were found in the area in 2004 (Figure 2.6, a). But after 2005 the wetland re filled with sand (Figure 2.6, b) and the land development activities were started in full swing. The transformation of the Jhilmil Residential area from 2004 to 2024 is shown in the Figure 2.6.

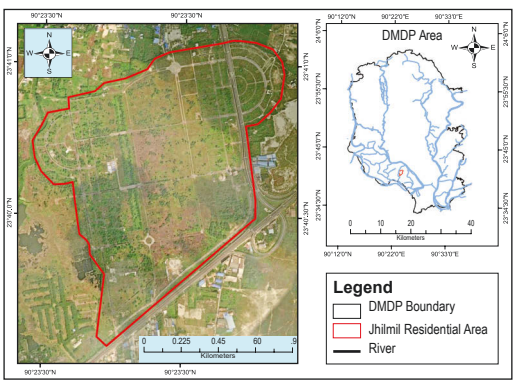

Figure 2.5: Location of Jhilmil Residential Project

Source: Developed by authors, 2023

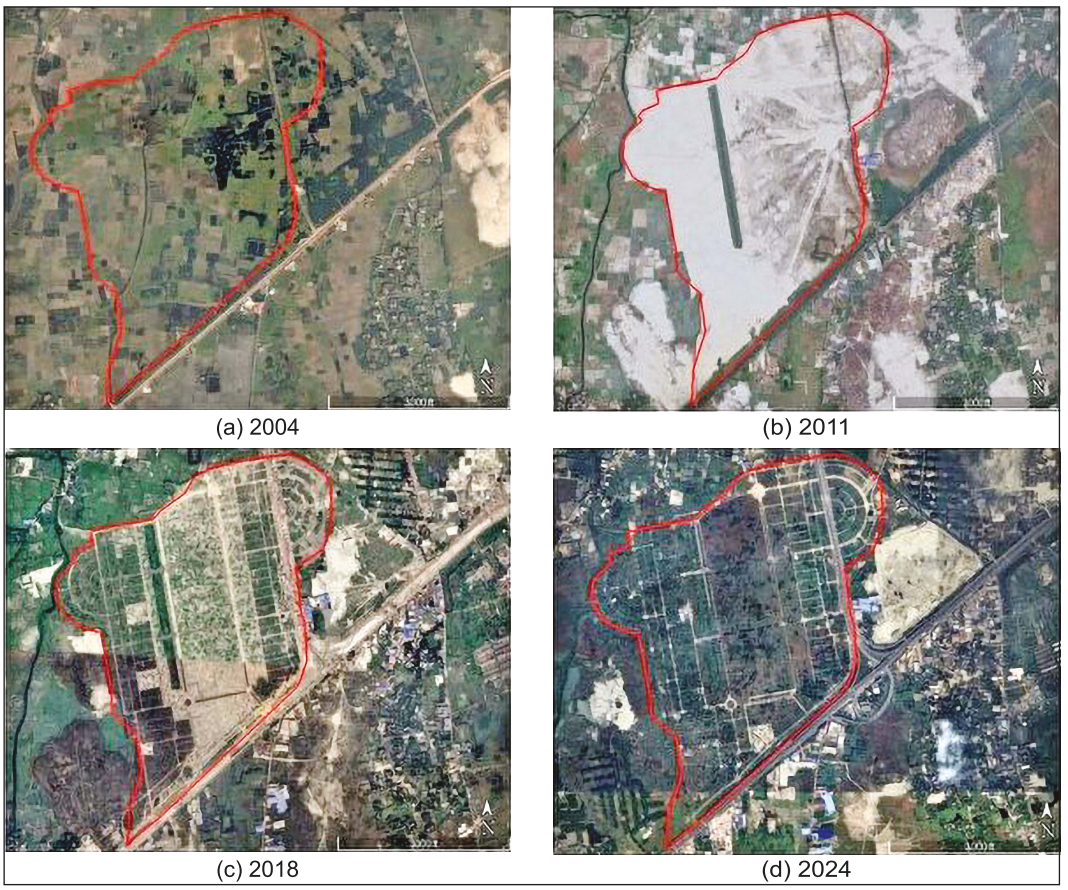

Figure 2.6: Evolution of Jhilmil Residential Project Area

Source: Developed by authors, 2024

8.2 Modhumoti Model Town

Modhumoti Model Town established in 1990 was the first housing project of Metro Makers and Developers Ltd. In 1991, the company started buying land and after ten years, in 2001, they started sellingBy filling in about 550 acres of wetlands at Bilamalia and Baliarpur the company had developed this housing project (Figure 2.7). This project area was demarcated as floodplain area in the Dhaka Metropolitan Development Plan (DMDP),

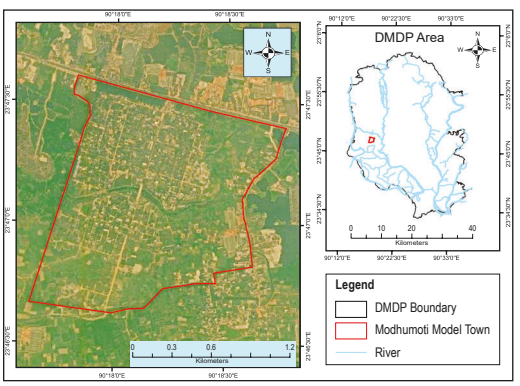

Figure 2.7: Location of Modhumoti Model Town

Source: Developed by authors, 2024

1995. The development of this project was started without the approval of the Capital Development Authority (RAJUK) and a clearance certificate from the Department of Environment (DoE) (Siddiqui, 2020). The project comprises 6,000 plots of 4,000 owners where 20 duplex houses, 8 resorts. 300 one-storey buildings, and 150 tin-shed houses have already been constructed (Alam, 2021). Besides, several picnic and film shooting spots named as "Chayabithi", "Kallol Kutir" and "Rajmohol" along with grocery shops and mini restaurants are also exist in the housing project. There is also a madrasa (religious school) with 20 students and a mosque in the area (Siddiqui, 2020).

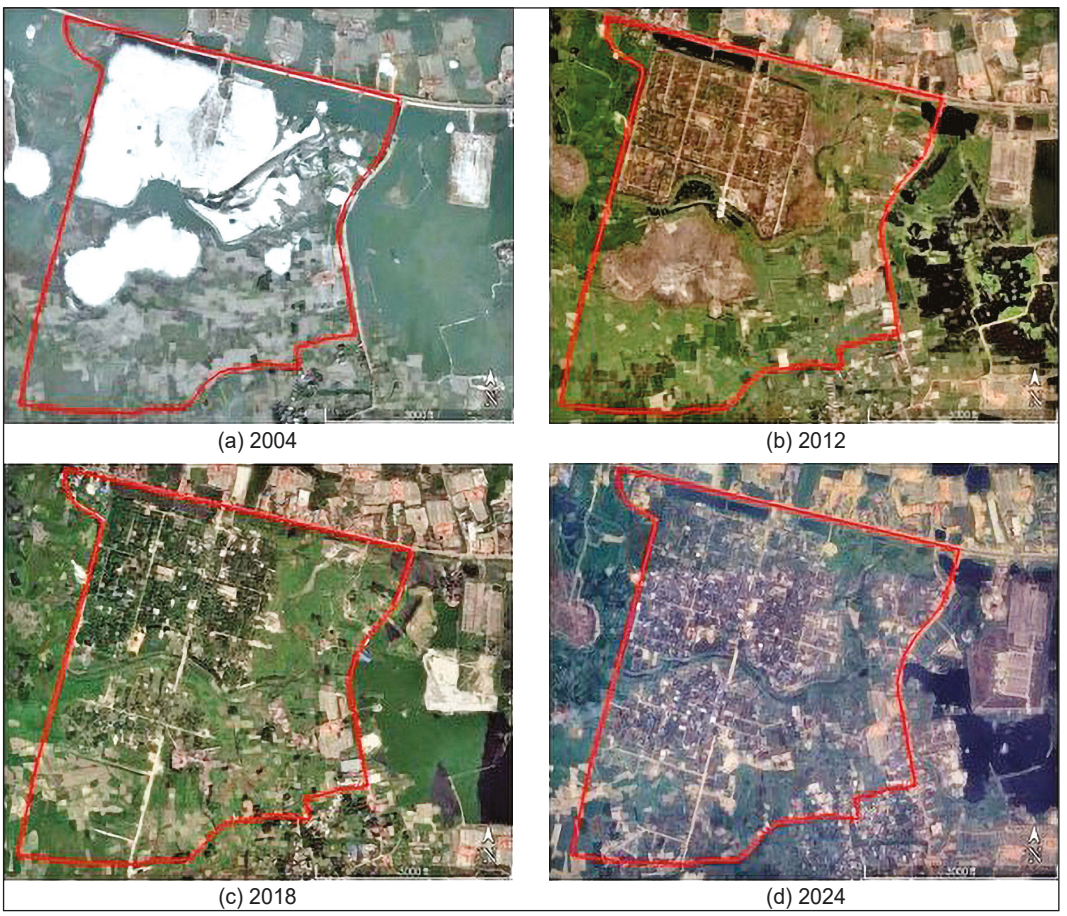

Figure 2.8: Evolution of Modhumoti Model Town

Source: Developed by authors, 2024

The housing project area previously existed as a water body with the catchment of the Turag River. The river had a free flow of water towards the model town project area before its establishment. However, after the project began the river channel was blocked

and the natural flow of water was disrupted. Consequently, waterlogging, floodding, and degradation of soil and vegetation occurred frequently in the surrounding area (Faisal, et al, 2019). The project was declared illegal on July 27, 2005. In 2019, this illegal project was renamed as 'Nandonik Housing' and further development activities were carried out (Siddiqui, 2020). In 2004, the wetlands were filled with sand (Figure 2.8, a) and land development activities started in full swing. The conversion of the Modhumoti Model Town from 2004 to 2024 is shown in the Figure 2.8.

9. Recommendations

The above sections indicate that the wetlands of Dhaka are declining over the period which causes multiple consequences to the city's entire environment. Following strategies and actions should be adopted to conserve the wetland of Dhaka.

- Wetlands provide multiple ecosystem services such as provisioning, regulating, cultural services. A comprehensive valuation is essential for each type of ecosystem service offered by the wetlands of Dhaka. Then people can realize the genuine values of the wetlands and thereby will be more cautious on protecting wetlands.
- Policies, acts, rules, and plans should be upgraded periodically. The term 'Wetland' and its typologies should be defined clearly and uniformly to avoid ambiguity in plans and policies. Additionally, 'Class Alteration' of wetland should be prohibited strictly in any acts, rules, and plans.
- Though wetland grabbing is a serious crime, the punishment for the land grabber mentioned in the Wetland Conservation Act 2000 is marginal compared to its degree of offence. There should be provisions of exemplary punishment, both in terms of fine and imprisonment, to prevent the land grabbers from wetland encroachment.
- This study indicates that wetlands within and around Dhaka city are mostly converted to housing projects. Therefore, a comprehensive site suitability analysis should be conducted in the housing project approval process. Without site suitability certificate no housing project should be approved.
- The environmental values of wetlands should be considered properly while formulating any physical plan. Specific strategies and actions to conserve the wetlands should be incorporated in the Structure Plan, Detail Area Plan, and Ward Action Plan.
- Wetland conservation requires involvement of multiple stakeholders, like concerned government departments, development authorities, NGOs, INGOs, CBOs, researchers, civil society, and academic personnels. Strong collaboration and partnership among these stakeholders are a prerequisite to wetland conservation of Dhaka.
- This is evident from different cases around the world that active engagement of the local community makes the wetland conservation process successful. Active participation

of the local people should be ensured in the conservation, management, and maintenance of wetlands of Dhaka. The opinion and suggestions of the local people should be acknowledged and incorporated in the formulation and upgradation of relevant policy, plan, program and projects.

- Incentives and rewards should be offered for those who will work for the conservation, management, and maintenance of the wetlands.
- Bridging the knowledge gap among the researcher/academia, activist and the local community is crucial in wetland management. Programs should be organized to share and exchange knowledge on a regular basis.

10. Conclusion

This study finds that significant amount of wetland has been lost over the last few decades, which has contributed in the decline of overall environmental condition as well as intensified the waterlogging situation in Dhaka city. This is due to the fact that contributions of wetlands to human well-being have repeatedly been overlooked or underrated by the policy makers. Consequently, the issue of wetland management has been downplayed in development planning. In this backdrop, economic and environmental valuation of wetlands should be considered in formulating plans and policies for Dhaka city. Therefore, we should encourage policy makers across all sectors to recognize and take account of multi-functional values of wetlands, and their interdependencies, that will be essential for sustainable development of Dhaka city. Effective and sustainable management of wetlands requires collaboration from many sectors of society. Especially those who make use of the multiple benefits provided by wetlands, or who can influence the management and conservation of wetlands, need to work together. Ensuring community engagement in wetland conservation, preventing degradation and encroachment are also necessary. By and large, government should take appropriate steps for enforcement of wetland and environment related laws and regulations and monitor proper implementation of physical plans of Dhaka city.

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Chapter 3

Blue-Network of DAP (2016-35): Present Status and Potential Strategies for Implementation

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1. Introduction

A harmonious coexistence of man and nature is evident at the early years of urbanization in Dhaka. The city started its journey as a trading town located at the bank of river Buriganga. It developed and expanded on higher terrains and was surrounded by rivers and crisscrossed by networks of canals and large tracts of flood plains (Jahan et al., 2008). These wetlands were used for transport, fishing and agriculture. More over encompassing rivers were the defense for the city. Dhaka was once called Venice of East. Dhaka is gradually losing its identity due to the disappearance of natural resources like canals, rivers, and water bodies (Detailed Area Plan, 2022). The illegal encroachment of water bodies, land fillings and indiscriminate dumping of wastes into waterbodies is creating critical problems in Dhaka resulting in storm water flooding during rainfall and causing severe health and economic loss. According to Draft Dhaka Structure Plan (2016-2035), permanent wetlands reduced from 14% to 4% during the period1967 to 2010 (Draft Detailed Structure Plan, 2016). The number of major *khals* in Dhaka decreased significantly in recent decades.

A multitude of studies have been conducted to identify and assess temporal

changes in waterbodies and wetlands in Bangladesh. In most of the studies it was found that waterbodies are decreasing rapidly in the capital Dhaka. Mahmud et al., (2011) assessed wetland changes in Dhaka between 1978 and 2009. It was revealed that rivers and canals declined drastically in 30 years. In the opinion of Habib et al., (2020), a large number of waterbodies were converted into built-up areas between 1989 and 2019. According to Ishtiaque et al., (2014), canals in Dhaka City are in grave danger of extinction, and immediate recovery measures are required.

Encroachment of water bodies has led to a decrease in Dhaka city's natural drainage system, which exacerbates the effects of heavy rainfall and causes flooding and waterlogging. The loss of local ecology and biodiversity is also a significant concern, as these water bodies are home to a variety of plant and animal species (Ishtiaque et al., 2014; Chowdhury,2015; Mahmud, 2017).

Wetlands have been defined and categorized differently in different parts of the world. Depending on their location, hydrology, and vegetation cover, wetlands have a wide range of names as well (Mitsch & Gosselink, 2000). Bangladesh classifies its wetlands according to the Ramsar Treaty (Ministry of Water Resource,2016). Ramsar Convention, 1971, Article 1.1 broadly defines wetland as, *Areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres.* (Ramsar Convention Secretariat, 2016). According to the United Nations Environment Program-Centre on Water and Environment, Natural wetlands are ecosystems that are permanently or intermittently saturated in water, support aquatic plants as habitats, and foster the growth of hydric soils (Bertule et al., 2018). Natural wetland includes rivers, lakes, saltwater lakes, estuaries, swamps, tidal flats, coral reefs, peatlands, and mangroves (Ye et al., 2018).

The Open Space Protection Act 2000, defined natural wetland as *The place declared as the flood flowing land as river canal, beel, pond, stream, fountain indicated in master plan by the Government gazette or Government, and flowing water and the land which conserve the rainwater should be included here.* Wetlands, both natural or artificial, are crucial for managing storm water runoff in cities because they reduce the effects of flooding, absorb pollutants, limit erosion, recharge/discharge of groundwater, and enhance water quality. (Ministry of Environment and Forests, 2016).

There are very few cities in the world that are surrounded by so many rivers and canals like Dhaka. Wetlands in Dhaka City are divided into two categories-waterbodies and lowlands (draft DSP, 2016-2035). Policies of Detailed Area Plan (1995-2015) on conservation of wetlands and the enactment of the Water Body Conservation Act 2000 had strengthened the legal aspects for securing wetlands. Draft DSP (2016-35) contains policies for protecting flood flow zones, khals, rivers and water retention areas. In DAP (2022-2035) river, canal, lake, dighi etc. features are classified as water bodies. With the view to protect waterbodies, DAP (2022-2035) proposed

integrated network of river, canal and lake which is known as Blue-Network (Figure 3.1). The total length of the proposed Blue-Network is 1139.565 km. The objective is to create a waterway beside the roadway to reduce the pressure from roadways.

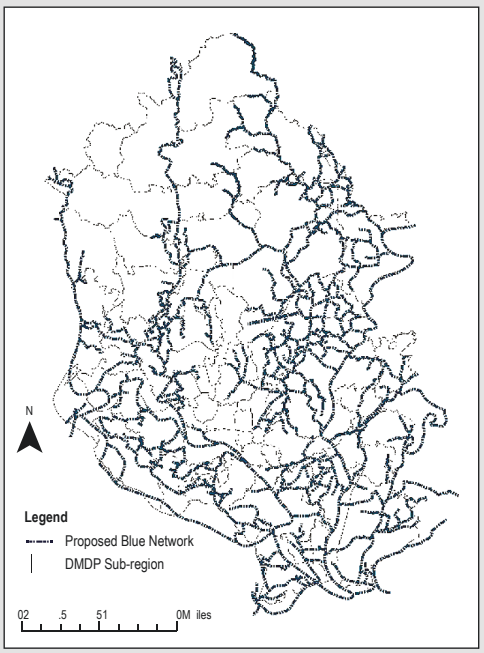


Figure 3.1: Proposed Blue-Network according to DAP (2022-2035) in DMDP area

Source: DAP 2022-2035

2. Methodology

Dhaka Metropolitan Development Plan (DMDP) area comprised of 1,528 sq. km, was taken as the study area having 75 sub- regions under 6 regions. Data was collected from both secondary and primary sources. Satellite image (2022), map of existing major waterbodies (2016) and map of proposed Blue-Network was collected from DAP (2022-2035) database of RAJUK as secondary source. The water bodies (Canals) along the Blue-Network were digitized from Google Earth Satellite Image of 2022 using ArcGIS. Satellite image (2022) of the study area of resolution 0.5 meter was collected from Google Earth and imported to ArcGIS 10.3.1 as raster data. Each tile is georeferenced and projected individually and finally mosaicked to a single image. The canals were then digitized along the "Blue-Networks" that is proposed by DAP (2022-2035). Ground truthing was conducted to validate the data using a total of 100 points for field survey, with an accuracy rate is found almost 86%. Overlay analysis was performed to identify areas with significant discrepancies between existing maps of waterbodies and proposed Blue-Network of DAP (2022-2035). From overlay analysis, encroachment was observed in 98 canals out of 219 canals inside the DMDP area. 48 canals have shown encroachment of more than 1 kilometer. From those,10 canals were selected for field visit (Figure 3.2). From primary source (field survey) information related to land use and encroachment status of 10 encroached portion of canals along Blue-Network was gathered. Information from field survey were taken using PRA tools such as FGD, timeline, cause-effect diagram etc. KII was conducted to view the perception of group of experts and professionals to gather idea about potential strategies for implementation of proposed Blue-Network and water-based parks of DAP (2022-2035). Data collected from primary survey (field survey, KII, FGD) was used to analyze prospects and constraints of Blue-Network from physical, social, economic, and institutional perspectives using descriptive statistics. From all the collected data along with suggestions from experts and reviewing from literature potential implementation strategies of Blue-Network was formulated.

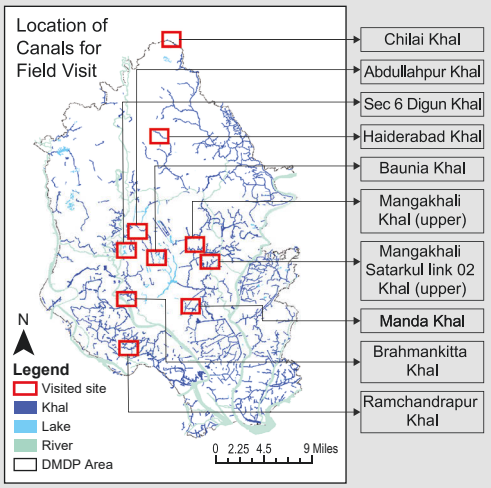


Figure 3.2: Map showing location of selected canal for field visit along Blue-Network.

Source: DAP (2022-2035) & Author 2022-2023

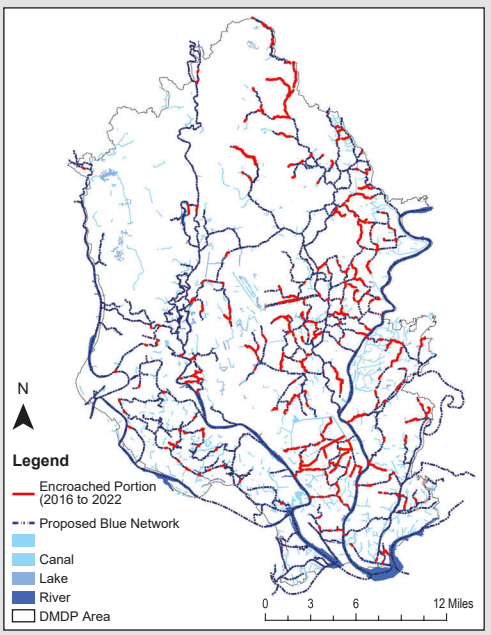


Figure 3.3: Map Showing Encroached Portion (Canal Network was recorded in 2016) along Blue Network in DMDP Area.

Source: DAP (2022-2035) & Author 2022-2023

3. Present status of the "Blue Network"

3.1 Encroachment of "Blue Network"

The proposed Blue-Network according to DAP (2022-2035) covers a total length of 1137.5 km. However, a concerning observation from the analysis is that 176 km of canals have been encroached upon in just six years, between 2016 and 2022. This encroachment is shown in Figure 3.3. Additionally, there are 69 km of the proposed network that pass-through areas where no recorded water bodies existed in 2016 (as seen in Figure 3.4). Furthermore, certain natural canals in the Eastern Region (Rupganj) and Southern Region (Narayanganj) have not been included in the Blue-Network plan.

3.2 Present use of encroached area

Many types of land uses were found on encroached portion of the canals from the site visits. The canals are being used as waste dumping sites, resulting in pollution and obstructed water flow, leading to floods during the monsoon season. Additionally, floating houses and slums built on the canals worsen the situation by further blocking water flow and adding to water pollution. Furthermore, many canals, namely *Manda khal* in *Dakshingaon, Brahmankitta Khal* in *Zinjira Keraniganj* and many others are being filled with sand for various purposes, such as land creation and construction, which disrupts the natural drainage system, causing severe flooding during the rainy season. For example, the *Haidarabad khal* in *Gazipur Chourasta* area, which was sand filled to widen the Bazar Road, led to overflow issues during the rainy season. Overall, encroachment and mismanagement of the canals are contributing to environmental problems and posing risks to the surrounding areas.

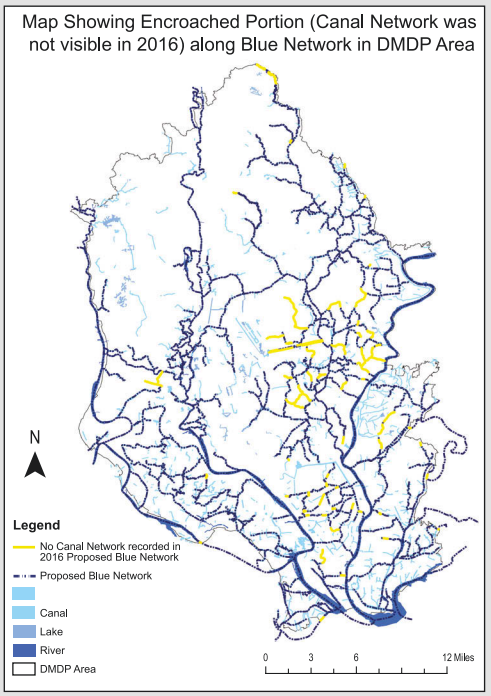


Figure: 3.4: Map showing Blue-Network where no canal was recorded in 2016.

Source: DAP (2022-2035) & Author, 2022-2023

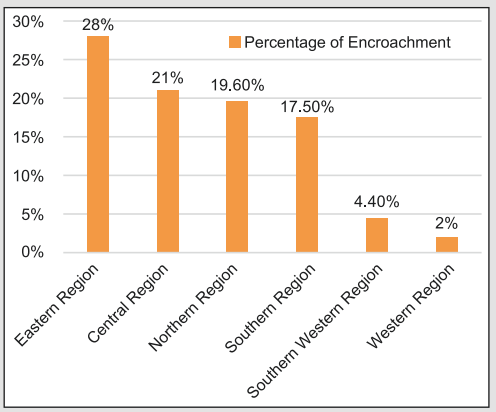


Figure 3.5: Bar Graph showing percentage of encroachment of total existing canal network in 2016 along Blue-Network for each region of DMDP area.

Source: DAP (2022-2035) & Author, 2022-2023

3.3 Region-wise encroachment

Dhaka Metropolitan Development Plan (DMDP) area consists of 6 regions- Dhaka (Central) Region, Gazipur (Northern) Region, Savar (Western) Region, Keraniganj (South-western) Region, Rupganj & Kaliganj (Eastern) Region and Narayanganj (Southern) Region. The percentage of encroachment of total existing canal network along Blue-Network for each region is shown in figure-3.5.

Western Region: This region, including Savar Upazila, has a 123 km Blue-Network. From 2016 to 2022, 2.5 km (2%) of this canal network was encroached upon, with an additional 2.8% disappearing from the 2016 record. Encroachment mainly occurs in Dhamsona, Tetuljhora, and Banagram unions. Rapid urbanization and industrialization in Savar upazila are polluting the Karnapara, Bamuni, and Kanatali canals due to inadequate waste management.

Southern Region: The Blue-Network spans 194.64 km here, having 32.5 km (17.5%) encroached upon from 2016 to 2022. Areas like Tushardhara, Pagla Khal, and Konson Khal see the highest encroachment, causing waterlogging issues in the DND area during rainy seasons. Regular waste dumping obstructs the 93.98 km canal network in DND districts (Alam, 2016).

South Western Region: Keraniganj Upazila contains 157.22 km of Blue-Network, with 7 km (4.3%) encroached upon between 2016 and 2022. The Brahmankitte Khal in Zinzira union is heavily sand-filled by developers. Most canals, which once connected to the Buriganga and Dhaleshwari rivers, are polluted by waste from local garment industries and residents, leading to severe contamination (Alam, 2009).

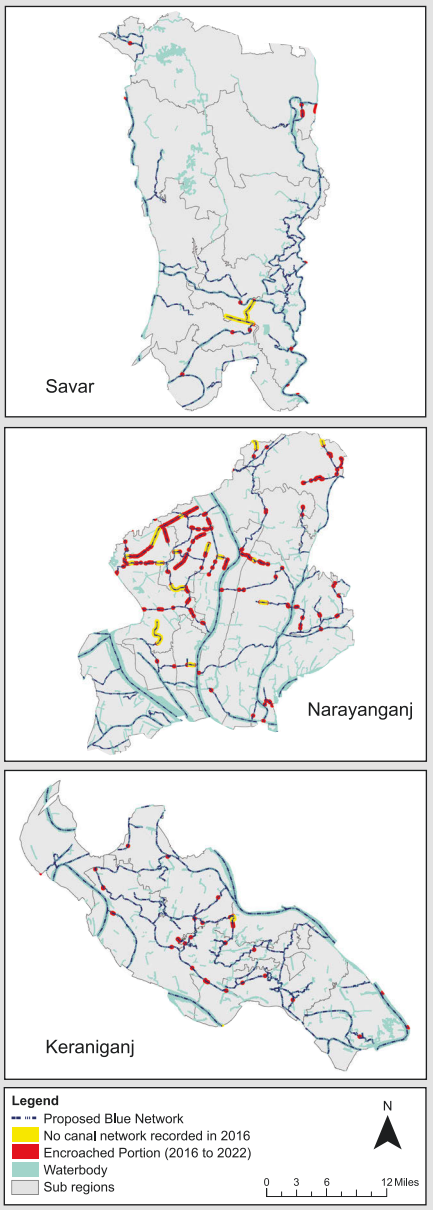


Figure: 3.6: Map showing encroachment of canal from 2016 to 2022 and unrecorded/ non existing canal network along Blue-Network in (a) Western Region, (b) Southern region and (c) South western region of DMDP area.

Source: DAP (2022-2035) & Author, 2022-2023

Northern Region: This region, covering Gazipur Upazila, has a Blue-Network of 138.4 km. From 2016 to 2022, 26.7 km (19.6%) of the canal network was encroached, with 1.67% being missing since 2016. Major encroachment occurs in Banua, Chilai, Chhayabithi, and Haiderabad Khals. The dense industrial area of Gazipur, where waste is often dumped untreated, exacerbates pollution (Islam, 2022).

Eastern Region: Rupganj Upazila spans 180 km of Blue-Network, with 44 km (28%) encroached and 22.4 km (12.5%) missing since 2016. This region has the highest canal encroachment, with Tumulia, Nagari, and Purbachal khals particularly affected. Rapid industrial growth, driven by proximity to Dhaka and waterway access, has led to widespread waterbody filling for construction in this area (Alam, 2016).

Central Region: Dhaka Metropolitan Area contains nearly 200 km of Blue-Network, with 36 km (21%) encroached and 30 km (14.4%) missing since 2016. Canals like Ramchandrapur, Kallyanpur, and Satarkul-Barail face heavy encroachment due to unplanned urbanization and poor maintenance (Ishtiaque et al., 2014).Some areas in Uttarkhan-Dakshinkhan, Gulshan-Banani, Satarkul, and Badda show no canal traces from 2016 record.

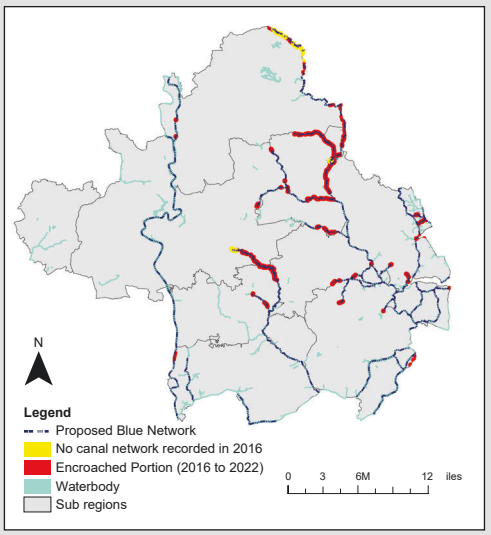


Figure 3.7: Map showing encroachment of canal from 2016 to 2022 and unrecorded/ non existing canal network along Blue-Network in Northern Region of DMDP area.

Source: DAP (2022-2035) & Author, 2022-2023

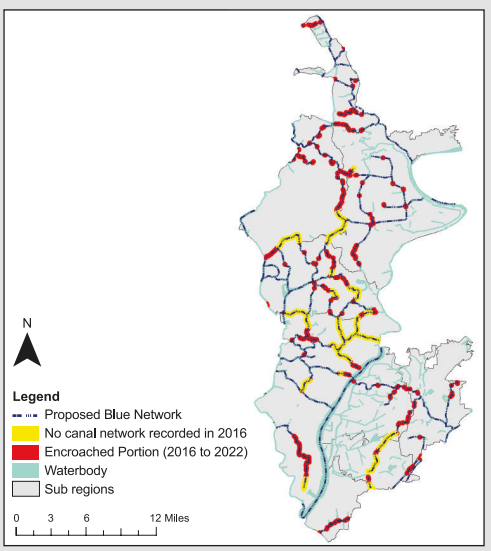


Figure 3.8: Map showing encroachment of canal from 2016 to 2022 and unrecorded/ non existing canal network along Blue-Network in Eastern Region of DMDP area.

Source: DAP (2022-2035) & Author, 2022-2023

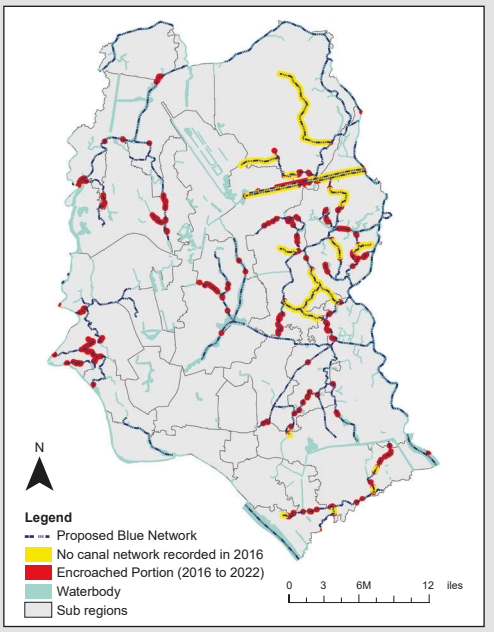


Figure 3.9: Map showing encroachment of canal from 2016 to 2022 and unrecorded/ non existing canal network along Blue-Network in Central Region of DMDP area.

Source: DAP (2022-2035) & Author, 2022-2023

3.4 Encroached Length of the Canals Along Blue-Network

48 canals have encroachments of more than 1 km. The name of top 30 canals based on encroached length is as follows:

Table 3.1: Top 30 canals based on length of encroachment

Serial no.	Name of the Canal	Encroached Length (meter)
1	Chilai Khal	8678.081
2	DL-1 Khal	6261.48
3	Haiderabad Khal	4869.90
4	Ramchandrapur Khal	4364.16
5	Gazaria Khal (PRB14)	4302.49
6	Banua Khal	4233.82
7	Nagori khal	4196.43
8	Tatkir Khal	4046.48
9	Kayetpara Khal (Nagorpara Khal)	3462.74
10	Manda Khal	3338.06
11	NRWCP Canal	3200.02
12	Nagori-Daudpur Khal	2867.77
13	Manairbari Khal	2817.53
14	NNIP_Canal02	2667.66
15	Mangakhali Khal (Upper)	2636.28
16	Tumulia Khal (Rupganj Khal)	2540.73
17	Pagla	2349.77
18	Balsair Khal	2209.45
19	Satarkul Barail Khal	2044.14
20	Khilkhet-Boalia North Khal	2038.49
21	Purbachal Khal	2025.70
22	Banani Lake	2022.21
23	Purbachal Khal (PRBL10)	2008.85
24	Nolkhali Khal	1860.96
25	DL-2	1782.55
26	Bara khal	1737.18
27	DL1-6	1713.25
28	SD-04	1637.66
29	Baunia Khal	1631.33
30	Sector no 12 Abdullahpur Khal	1574.08

Source: DAP (2022-2035) & Author, 2022-2023

Table 3.2: Table Showing Encroachment done by whom in 10 studied canals.

	Local People	Influential individual	Real estate Developers	Industrial Developers	Government (Public Infrastructure)
Abdullahpur Khal	✓				
Haidarabad Khal	✓			✓	
Baunia Khal	✓	✓			
Sec-6, Digun Khal	✓				
Manda Khal	✓	✓			
Ramchandrapur Khal					✓
Brahmankitta Khal			✓		
Chilai Khal				✓	
Mangakhali Khal			✓		
Mangakhali Satarkul Link 2 Khal			✓		

Source: Field Survey 2022 & 2023

3.5 Key finding from the Case Studies

Encroaching entities

Manda and Baunia are illegally grabbed by Government officials. Dhaka being one of the populated cities, housing scarcity is a major problem here. Owing to this, real estate developers, fills water bodies indiscriminately in order to create more land for development illegally. Such examples are seen in Brahmankitte, Mangakhali etc. khals. Industrial developers mainly encroach canals either by dumping waste on canals or filling area of canal for building industrial infrastructure. The flow of Haidarabad Khal is disrupted and the canal is clogged due to waste dumping of industries. Ramchandrapur khal was once encroached for making truck stand. The land was allocated by Government entity which was illegal.

Year of beginning of encroachment

Among the studied canals, the earliest encroachment began in 2005. The majority of encroachments in canals began between 2010 to 2015. From other studies similar scenario is observed. A study on the change in water bodies in Dhaka North revealed that about 59% of water bodies were lost between 1991 and 2005. Again about 72.5% waterbodies were lost by 2014. The significant causes behind these abrupt changes include unregulated landfilling and construction activities carried out by both governmental and private entities, as well as encroachment by powerful groups and individuals. The southeastern region has also encountered similar water body depletion. (Arifeen et al., 2018).

Cause and Effect of Encroachment of the Canals

Cause and effect analysis of encroachment of khal was conducted for 10 khals through Focus Group Discussion (FGD) with the local people. The root causes of encroachment are identified and discussed below followed by the impacts of such encroachment on environment.

Causes of Encroachment of Canal

The housing market in Dhaka city is uncontrolled as the demand for housing is increasing day by day. The portion of canals such as: Mangakhali Khal, Mangakhali Satarkul Link 02 Khal, Chilai Khal etc. is encroached by sand filling by the real estate developers. Powerful developer groups, such as Bashundhara and Bashumoti developers, are encroaching on canals like Mangakhali and Satarkul, driven solely by profit motives, disregarding the importance of these waterways. Such encroachment is strictly prohibited by prevailing laws. In addition, influential individuals have also encroached on some canals in Dhaka, including Manda Khal and Baunia Khal.

Every day, rural poor migrate to Dhaka for a better future. Many of them people reside in slums that have developed by encroaching on urban canals like Digun Khal.

In addition to encroachment by earth filling, many of the canals are filled with waste. Local people are often not aware of the importance of canal conservation and waste dumping on canals has become a common practice and it was evident in canals like Haidarabad Khal. Haidarabad Khal and Digun Khal has turned into dumping sites, affecting water flow and leading to waterborne diseases.

Impacts of Encroachment of Canal

The canals and water bodies play an enormous role in flood management. With rapid urbanization and an increase in impervious surface Dhaka faces severe water-logging during the rainy season. The encroachment of canals in Dhaka is one of the major causes of water-logging in the city, which has significant socio-economic, health and environmental impacts. From field survey, it was felt that overflowing waste-water from encroached canals has deteriorated the overall environment of the areas. Wastewater overflowing in Haiderabad and Manda Khal due to encroachment by waste and built-up areas is a vivid example.

According to the local people, stagnant water in encroached portion of the canals become the ideal breeding ground for mosquitoes and is causing diseases like dengue, malaria etc. The locals stated that, a portion of Abdullahpur Khal is encroached by box culvert scoping the accumulation of stagnant water which is initiating mosquito breeding. Again, encroachment can lead to contamination of water sources, as untreated or partially treated wastewater can overflow and pollute nearby water bodies. This can increase the risk of waterborne diseases such as cholera, typhoid, and diarrhea. The locals of Digun Khal face the issue of water-borne diseases.

Canal encroachment can lead to the loss of aquatic habitats and biodiversity by fluctuating the natural flow and quality of water in canals and adjacent water bodies. When canals are encroached, the natural hydrological cycle is disrupted, and this can lead to changes in water levels, water flow, and water quality. The aquatic life and biodiversity of Chilai Khal is at stake due to sand filling. In Baunia Khal fishing used to be done about 10 years ago, but now waste is being dumped in the canal. This is greatly affecting biodiversity and aquatic life.

Residents mentioned that encroachment of Chilai Khal affects irrigation water supply, impacting the agricultural productivity and economic condition of local people.

Case Study 3.5.1: Sec-6, Digun Khal Location: Mirpur North

he canal was measured 3.7 km in length by RAJUK in 2016. It was previously used for fishing and transportation but has now become a site for habitation and dumping of residential waste. Local people began encroaching on the canal between 2015 and 2016, and as of 2022, 1.237 km of the canal has been encroached (as found from analysis of maps) upon by floating slum, construction of high rise buildings and roads. DNCC is responsible for managing the Khal, and they should take action to prevent further encroachment and to address the current situation.

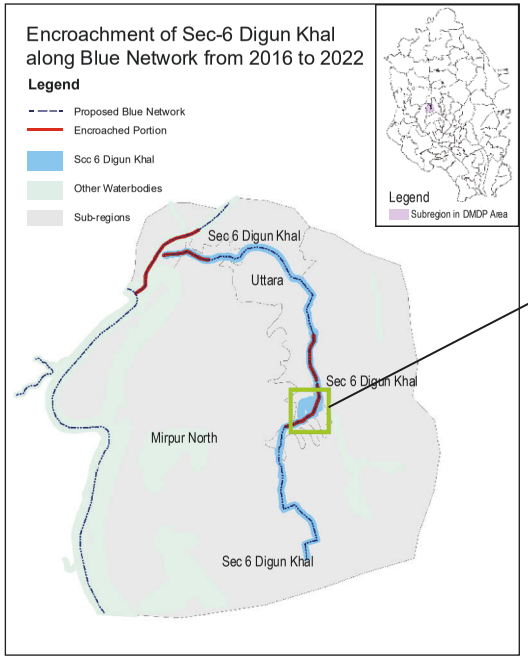


Figure 3.10: Map Showing Encroachment of Sec-6 Digun Khal along Blue-Network from 2016 to 2022. Prepared by Author, Data.

Source: DAP (2022-2035) & Google Earth, 2022

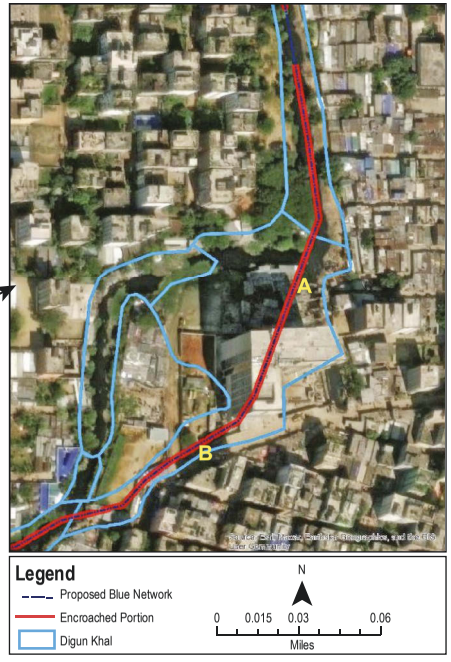
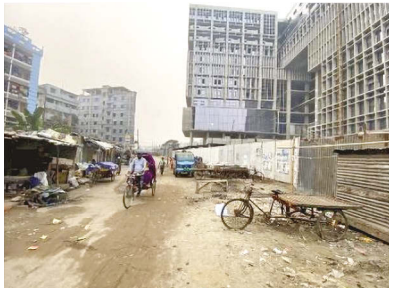


Figure 3.11: Google Earth Image 2022 showing a portion of encroachment of Digun Khal. Prepared by Author, Data .

Source: Google Earth, 2022

(A) Floating slums and waste dumping site is created in many portion of the canal (Field survey, 2022).



(B) The canal has been encroached for constructing buildings and roads. (Field survey, 2022

Case Study 3.5.2: Manda Khal Location: Dakshingaon

The canal, with a recorded length of 11 km by RAJUK in 2016, was previously used for transportation but currently remains unused. Its water level increases during the rainy season and decreases during winter. Encroachment began in 2005. From 2016 to 2022. 3.338 km of the canal got encroached (figure-3.12). The canal is mainly encroached by Government officials and local people, resulting in the construction of residential buildings and foot bridges. DNCC is currently responsible for managing the canal.

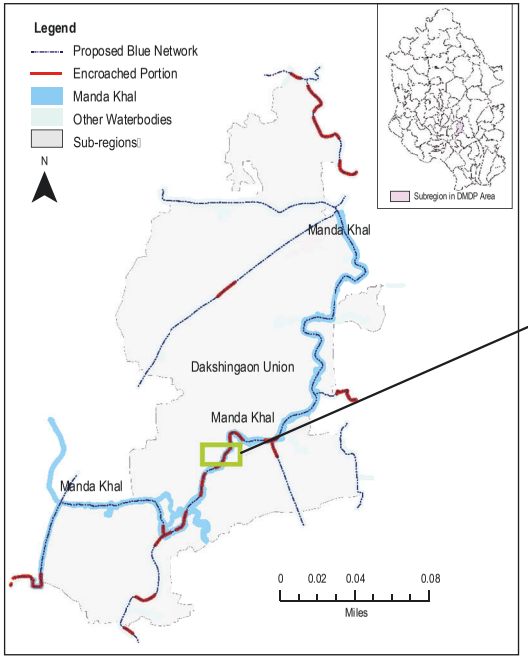


Figure 3.12: Google Earth Image 2022 showing a portion of encroachment of Manda Khal. Prepared by Author, Data.

Source: Google Earth, 2022

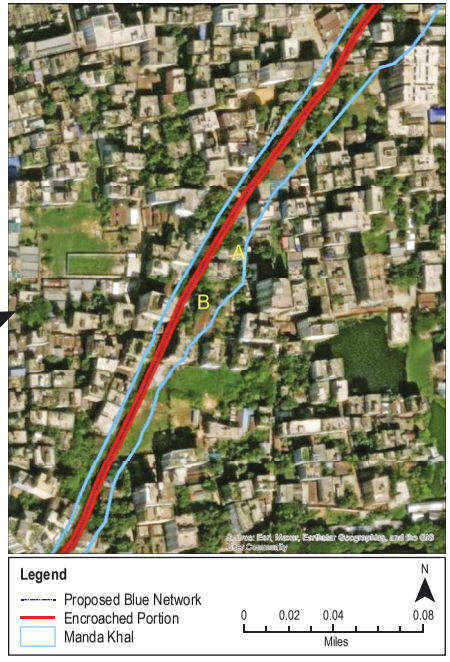
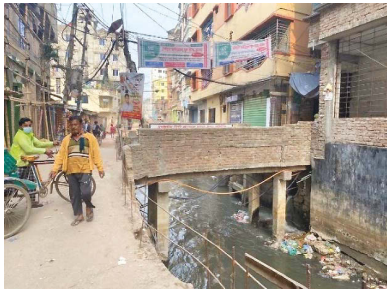


Figure 3.13: Encroachment of Manda Khal along Blue-Network from 2016 to 2022. Prepared by Author, Data.

Source: DAP (2022-2035) & Google Earth, 2022



(A) The canal is encroached by building structures like foot over bridge. (Field survey, 2022).

(B) Many buildings are built encroaching canal area. (Field survey, 2022).

Case Study 3.5.3: Mangakhali Khal (Upper) Location: Badda

The canal was recorded by RAJUK in 2016 as 8.3 km. It experiences very dry conditions during the winter season. From 2016 to 2022 2.63 km of it has been encroached (figure-3.14). Encroachment of this canal began in 2013 according to the statement of the locals; The Bashumoti Developer and Bashundhara Group are responsible for the encroachment. The encroached portion is currently undergoing sand filling and housing development. This canal is under the responsibility of DNCC.

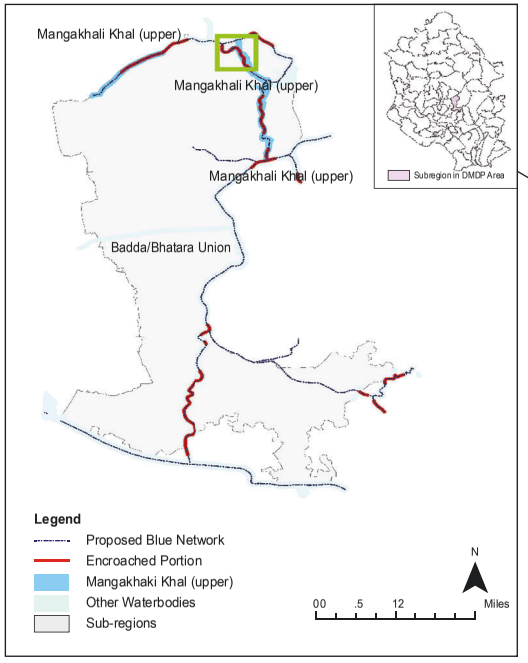


Figure 3.14: Map Showing Encroachment of Mangakhali Khal along Blue-Network from 2016 to 2022. Prepared by Author, Data.

Source: DAP (2022-2035) & Google Earth, 2022

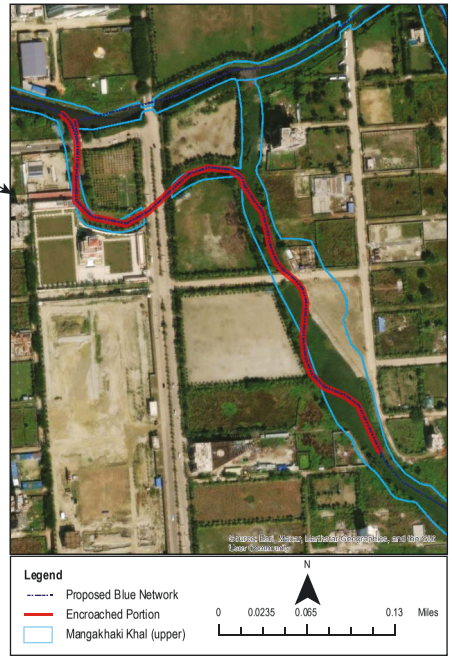


Figure 3.15: Google Earth Image 2022 showing a portion of encroachment of Mangakhali Khal. Prepared by Author, Data.

Source: Google Earth, 2022

- The ownership of the land is under developers.
- Housing project is taken in the area.
- Some portion of the canals have been filled for constructing roads and turning into plots shown in Figure- 3.15

4. Constraints and Prospects of Implementation of Proposed "Blue-Network"

4.1 Physical Prospects of Implementing "Blue-Network"

Topography of DMDP Area: The DMDP area, on the flat, sandy Madhupur terrace from the Pleistocene period. It requires minimal excavation for canal reconstruction, reducing costs and the need for expensive water management structures. The flat terrain supports steady water flow in the canals (RAJUK, 2015).

Water Availability: Dhaka's canals draw water from surrounding rivers—such as the Buriganga, Turag, and Shitalakkhya—which rise during monsoon, helping fill the canals. Some khals, like Baunia and Manda, retain water year-round (Islam et al., 2010).

Infrastructure for Canal Demarcation: Demarcating canals with sidewalks can prevent encroachment, as observed in projects along Ramchandrapur, Baunia, and Mangakhali khals. Examples include walkways built along Hatirjheel Lake and the DND canal in Narayanganj, which help prevent illegal land use (Hossain, 2020; Rahman & Debnath, 2015).

Excavation and Development: Revitalizing canals through excavation, as seen with Ramchandrapur Lake, aims to curb encroachment. Projects like the "Excavation and Development of 100-Foot Canals" along the Kuril-Purbachal Link Road by the Bangladesh Army also align with DAP's proposed Blue-Network (Bangladesh Post, 2019).

4.2 Physical Constraints for Blue-Network Implementation

Water Scarcity: Many canals, such as Chilai and Ramchandrapur Khal, dry up in winter, impacting Blue-Network viability.

Canal Encroachment: Encroachment for buildings, floating houses, and markets affects canals like Manda and Haiderabad, threatening long-term water availability.

Waste Accumulation: Untreated waste dumped into Abdullahpur, Haiderabad, and Ramchandrapur khals obstructs water flow, hindering Blue-Network implementation.

Figure 3.16: Flow of water in Baunia Khal

Source: Field Survey, 2022 & 2023

Figure 3.17: Flow of water Manda KhalS

Source: Field Survey, 2022 & 2023

Figure 3.18: Flow of water Abdullahpur Khal

Source: Field Survey, 2022 & 2023

4.3 Social Prospects of Implementing "Blue-Network"

Improved Environment: Locals near canals like Haidarabad and Abdullahpur express a desire for revitalization to enhance environmental conditions and health, reducing issues such as waste accumulation and disease spread (Gazipur Chowrasta and Uttara Sector residents).

Social Cohesion: DAP (2022-2035) notes that revitalized canals can foster recreation, drainage, and social interaction. Improved canal areas in Uttara Model Town and Hatirjheel have already strengthened community engagement.

4.4 Social Constraints of Implementing "Blue-Network"

Land Acquisition: Revitalization may displace residents, especially those in informal settlements near canals like Ramchandrapur Khal.

Impact on Floating Populations: Floating communities living in areas like Sec-6 Digun Khal may lose shelter, impacting livelihoods.

Social Equity: Benefits may not be evenly distributed, causing resistance from marginalized groups who feel excluded from project benefits.

Encroachment by Influential Groups: Canals like Mangakhali Khal face challenges in land acquisition due to encroachment by powerful real estate entities, such as Bashundhara and Bashumuti Group.

Governance and Participation: Effective governance and community input are crucial. Resistance may arise if residents, like those in Manda Khal, fear property loss.

4.5 Economic Prospects of Implementing "Blue-Network"

Funding Opportunities: According to Joint Secretary of BAPA Mr. Iqbal Habib, huge fund is allocated by the Government for constructing transportation infrastructure and as Blue-Network will be used for transportation beside roadways so Government will be interested in allocating funds for Blue-Network.

Intangible Benefits: Reducing waterlogging could save billions, as noted by World Bank and DWASA. Enhanced drainage will also improve Dhaka's micro-climate and social welfare.

Figure 3.19: Manda Khal Encroached by Buildings

Source: Field Survey, 2023

Figure 3.20: Sec 6 Digun Khal Encroached by Floating Houses.

Source: Field Survey, 2022

Figure 3.21: Haidarabad Khal Encroached by Bazar

Source: Field Survey, 2022

Real Estate Value: Improved canals may increase nearby property values, attracting real estate investment.

4.6 Economic Constraints of Implementing "Blue-Network"

High Costs: Substantial capital and maintenance costs could be barriers.

Funding Limitations: Government and private funding may fall short, impacting feasibility.

Figure 3.22: Mangakhali Khal Encroached by Sand-fillings.

Source: Field Survey, 2023

Economic Viability & ROI: Benefits may take years to materialize, and initial costs might not yield immediate returns, raising concerns about economic viability.

Political Influence: Resource allocation and project prioritization may fluctuate with political changes.

4.7 Institutional Prospects of Implementing "Blue-Network"

International Policies: SDGs 6, 12, 13, and 15 support wetland conservation, and as a signatory, Bangladesh shows commitment to protecting its wetlands.

National Policies: The National Adaptation Plan (2023-2050) calls for urban wetland conservation, and the 8th Five-Year Plan promotes water body restoration.

Local Policies and Laws: Bangladesh's Constitution (Article 18.A), the Bangladesh Water Act (2013), Environmental Conservation Act (1995), and others emphasize wetland protection. DAP (2022-2035) supports multi-use water entity preservation, including "Blue-Network" integration and water-based parks.

Institutional Involvement: Various government bodies, such as DNCC, DSCC, RAJUK, and BWDB, are tasked with protecting DMDP wetlands.

Institutional Projects: Projects like Keraniganj and Motijhil waterparks (RAJUK), and Kallaypur and Gabtoli waterparks (DNCC) reflect institutional efforts for canal and lake preservation (Ashraful Islam, RAJUK).

4.8 Institutional Constraints of Implementing "Blue-Network"

Institutional Weakness: Effective implementation is hindered by inter-agency coordination challenges. Institutions often deflect responsibility (Mehedi Ahsan, Bangladesh Institute of Planners; Dr. Adil Mohammed Khan, Jahangirnagar University).

Funding Challenges: Building and maintaining the Blue-Network requires substantial investment, but funding sources are limited.

Maintenance and Operational Capacity: Regular maintenance for the Blue-Network requires resources and expertise that are often lacking.

Legal Issues: Legal barriers exist, like restrictions on changing land classification in maps, which hinders canal protection (Maqsud Hashem, Dhaka North City Corporation). Additionally, weak environmental fines fail to deter encroachment on water bodies (Dr. Adil Mohammed Khan).

5. Potential Strategies for Implementation of Blue-Network

Formulation of Action Plan: Master plans and detail plans for all the canals under Blue-Network must be prepared for proper implementation. According to the Town Planner of DNCC, Mr. Maqsud Hashem, Action Plan should be formulated by concerning institutions for the implementation of Blue-Network. He also stated that "Due to the lack of action plan Kallyanpur Khal was again grabbed by private owners even after acquisition."

Each City Corporation, Pourashova and other concerning institutions covering any particular jurisdiction should formulate action plan of Blue-Network in their concerned area, this should be done collaborating with other institutions. According to Mr. Sirajul Islam, Chief City Planner, DSCC, Detail Drawing of Manda and Shyampur Khal will be prepared according to CS map. But these detail drawings and designs should be done considering other canals too as connectivity of canals with each other is a major concern for the implementation of Blue-Network.

Demarcation of Canals: Area under canal according to CS record should be demarcated for conserving the canal. The pillars act as markers to show the canal's boundaries and are normally positioned at regular intervals along its banks.

Selection of Canals: From the field survey, it is observed that the state of different canals varies and their respective degree of effects on surrounding environment are also different. For example, during rainy season the local people surrounding the Manda Khal and Haidarabad Khal face overflow of water. So canal revitalizing should be done on the basis of priority sites. According to Mr. Ashraful Islam, the Town Planner of RAJUK, *phase by phase implementation of Blue-Network should be done. Priority sites should be identified on*

the basis of vulnerability where, vulnerable sites are those regions that faces waterlogging issues and scarcity of waterbodies. RAJUK has already identified 8 to 10 sites for 1st phase implementation of Blue-Network.

Responsibility of Concerned Authority: The main authorities of implementing the Blue-Network are Dhaka North City Corporation (DNCC), Dhaka South City Corporation (DSCC), other Local Government Institutions (Pourashovas) and RAJUK. The other responsibilities for implementing Blue-Network should be divided among Ministry of Land; Ministry of Environment and Forest; Ministry of Water Resources; Ministry of Housing and Public Works; National River Protection Commission; Department of Environment (DoE); Dhaka Water Supply and Sewerage Authority (DWASA); Bangladesh Water Development Board (BWDB); Deputy Commissioner, Dhaka; and Dhaka Metropolitan Police Commissioner.

A dedicated "Canal Team" with members from all relevant institutions and expertise from various fields such as, urban planning, transportation, environment, water management etc. could be formed.

Reviving Historical and Cultural Value: From the statement of locals, it was found that historically many of the studied canal were considered valuable environmental asset and source of fishing and transportation. For example: Digun khal and Baunia khal was once used for fishing and transportation but now they are in a very miserable condition. It is important to prioritize efforts toward revitalizing the historical and cultural significance of a local area as it can greatly benefit the livelihood of the community.

Enforcement of Law: Chief Executive of BELA, Ms. Syeda Rizwana Hasan stated that, *law must be developed to restrict any type of development within a certain buffer area of canal according to recorded CS map.* For example, in Manda Khal multistoried residential building is constructed along the canal without keeping any minimum distance from the bank. Foot over bridges are also developed above the canal. According to the Professor of Jahangirnagar University, Mr. Adil Md Khan, the penalty system for breaking environmental law should be strengthened.

Prohibition of Waste Dumping: Waste dumping in canals is a major hindrance in implementation of Blue-Network. There should be strong provision of penalties and fines for individuals or organizations found to be violating these laws. Additionally, efforts should be made to improve waste management practices and increase public awareness of the importance of protecting water sources.

Recovering Land for Canal: The canals should be recovered following the area demarcated in the CS record. According to Chief Executive of BELA, Ms. Syeda Rizwana Hasan, canals where the box culverts are constructed should be recovered again by removing the box culvert and making bridge type roads. For example, Baunia and sector no 12 Abdullahpur Khal box culverts are used. The privately encroached portions should be nullified by the Government. Private encroachment can be of two types- (1) With illegal document in which no mercy should be shown for acquiring the canal land; and, (2) In case of bona fide purchasers, the Government should provide compensation

and acquire land following appropriate procedure. A bona fide purchaser is a person who buys something in good faith and without knowledge/idea of any issue in the ownership of the property. In case of land, bona fide purchaser has also been paying land taxes properly.

Standardizing Public Space Along Canal and Engaging Community: Public space should be standardized along a canal creating uniform guidelines and regulations for the design, development, and use of the area surrounding the canal. This should include elements such as walkways, cycle route, seating areas, landscaping, lighting, and other amenities. According to Town Planner of RAJUK Mr. Ashraful Islam and Vice President of BAPA Mr. Iqbal Habib, safe, attractive, and functional public space should be created along canals that will serve the needs of both residents and visitors while preserving the natural beauty and cultural significance of the canal which will further create a sense of belongingness among the community. A management team along with members or representatives from community can be formed for canal management. This will help keep local government institutions or other authorities related to canal management updated about any issues related to canal.

6. Conclusion

Dhaka's environmental challenges, such as flooding and pollution, highlight the need for wetland conservation. The DAP (2022-2035) aims to protect flood flow zones, canals, rivers, and water retention areas through the proposed Blue-Network of integrated waterways. However, rapid wetland loss, due to encroachment and waste dumping, raises concerns about policy effectiveness. Issues like unclear demarcation and conflicting land use impede implementation, though ongoing canal projects show promise. For success, authorities must prioritize enforcement, community involvement, and a clear action plan, aligning with Bangladesh's 2030 Agenda for Sustainable Development and relevant SDGs.

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Chapter 4

Wetlands of Rajshahi Metropolitan Area (RMA): Spatiotemporal Changes its Integration in the Development Plan

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1. Introduction

Wetlands and water bodies are the lifeline of a country. Bangladesh holds its identity through its name as a riverine country. But unfortunately, the country is losing its wetlands and water bodies at a very fast pace Khan et al., (2021). Rajshahi is one of the oldest cities in Bangladesh. The city holds considerable importance due to its historical heritage, academic institutions, and economic significance. The city was once termed as the city of ponds. However, a significant number of waterbodies are declining very quickly. Research findings of Kafy et al., 2021 revealed that from 1989 to 2019, waterbody loss was about 8% in Rajshahi. The city experienced a loss of 4000 ponds in the last five decades (Kafy et al., 2021). *Tikure beel* and *Shilindir Beel* in Rajshahi City Corporation (RCC) lost their ecosystem due to the discharge of waste water (Rajshahi Development Authority, 2003). The primary causes include increasing the built-up area and infrastructure development as well as the deficiencies in policy implementation and necessary actions (Haque & Ullah, 2017).

With the pace of time, and increasing population demand, development works are conducted through the filling of the waterbodies in an unplanned way. Rapid

construction of different structures such as commercial (41.27%), residential (28.58 %), and educational (4.36%), exacerbated the loss of waterbodies in Rajshahi (Haque & Ullah, 2017). Due to the development of transport infrastructures, 5.16% of the ponds and water bodies are filled (Haque & Ullah, 2017). According to a study conducted by the Bangladesh Environmental Lawyers Association (BELA), within the last eight years, Rajshahi city saw the occurrence of the filling of approximately 80% of ponds (The Daily Star, 2022).

Rajshahi Metropolitan Development Plan (RMDP) (2004-2024) is the main policy document that has been prepared to regulate the Rajshahi Metropolitan Area (RMA) in all respects. This document gave immense importance to wetlands, water bodies, and ponds. The reasons behind the loss of wetlands were also identified in the RMDP (2004-2024). This document suggested different initiatives and policies for the preservation of the ponds and other wetlands. This document also tried to be consistent with acts like the Open Space Act, 2000, Water Body Conservation Act, 2000, Rajshahi Development Authority Act, 2018, and so on. Government agencies namely, Rajshahi City Corporation (RCC), Rajshahi Development Authority (RDA), Department of Environment (DOE), Rajshahi, District Administration of Rajshahi, etc. are liable for the enforcement of the rules and regulations as per the plan. The pattern of wetland loss in Rajshahi has not yet been documented in the prevailing literature. Most importantly, the wetland issues were never studied in the light of the implementation status mentioned in RMDP (2004-2024).

From such a background, this study tries to understand and visualize the decreasing scenario of the wetlands in the Rajshahi Metropolitan Area (RMA). The review of the master plan is also undertaken under the scope of the study. Considering all these, this paper focused on mandates on wetland conservation in Rajshahi Metropolitan Development Plan (RMDP) (2004-2024). It also aims to evaluate the chronological changes of the wetlands in the RMDP area during the period 2004 to 2024.

2. Study Area Profile

Rajshahi Metropolitan Area (RMA) is located in the northwest region of Bangladesh. It has a land area of 368 square kilometers. According to the Bangladesh Bureau of Statistics (BBS), the estimated population in 2021 was 1.2 million (Bangladesh Bureau of Statistics, 2021). Rajshahi Metropolitan Area is geographically characterized by its flat terrain, part of the larger Gangetic Plain, with the Padma River (Ganges) flowing to the south of the region. The growing intensity of urbanization reveals a pattern of decreasing wetlands in the RMA region. A significant number of ponds declined from 4,283 in 1961, to 2,171 in 1981 (Kafy et al., 2021). As a consequence, there is also a loss of biodiversity and wetland-based activities (Haque & Ullah, 2017). The study area map is given in Figure 2.1.

3. Methodology

3.1 Data collection:

Several factors were considered to review the RMDP (2004-2024). The factors include nature, number, area, spatial boundary, and

use of wetlands. Also, wetland management strategies were reviewed. Along with this document, Rajshahi Development Authority Act, 2018, and other relevant policy documents were studied. Landsat 5 and 6 data were collected for the years 2001 to 2014 and Landsat 8 and 9 data were collected for the years 2017 to 2022 for January from United States Geological Survey (USGS), website to observe changes in wetland patterns. The data were collected at the interval of three years starting from 2001.

3.2 Data analysis:

The descriptive review method was applied to analyze the factors identified to study the RMDP (2004-2024) for observing the status of wetlands. Raster calculation of the satellite image was conducted and the Normalized Difference Water Index (NDWI) technique was applied to identify the changing pattern of wetlands over the last 20 years.

To monitor changes in water bodies using NDWI, a time-series analysis of satellite imagery was conducted. Multiple images acquired at different time points are processed and analyzed to identify temporal variations in water content. After collecting the Landsat satellite images for the desired time, they were preprocessed to remove atmospheric effects, sensor noise, and geometric distortions. Later, a change detection analysis in Arc GIS was performed using NDWI images. After obtaining the amount of wetland changing patterns, this data was compared with the policy document through the descriptive review method.

4. Results

4.1 Overview of RMDP (2004-2024)

RMDP (2004-2024) was prepared to aim at implementing a future development guideline for RMA. This whole plan is categorized in four hierarchical orders, (i) Strategic Plan, (ii) Structure Plan, (iii) Functional Master Plan, and (iv) Detailed Area Plan (DAP). RMDP (2004-2024) is shown in Figure 4.2. Some strategic options regarding the future development of Rajshahi City are stated in the strategic plan. The options are aligned with the goals and strategies at the national level. The structure plan or general development plan is prepared for 20 years from 2004. This plan covers 364.19 sq. km or 89,957.35-acre area. The plan is to be executed in three phases: (i) Phase 1: 2004-2009; (ii) Phase 2: 2009-2014 and (iii) Phase 3: 2014-2024.

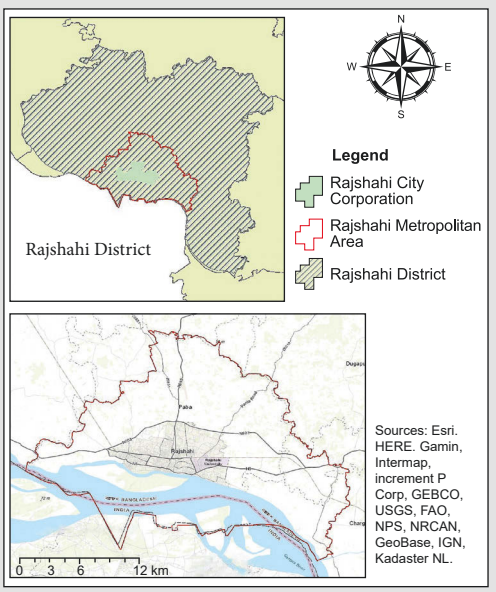


Figure 4.1: Study area map

Source: Prepared by authors, 2023

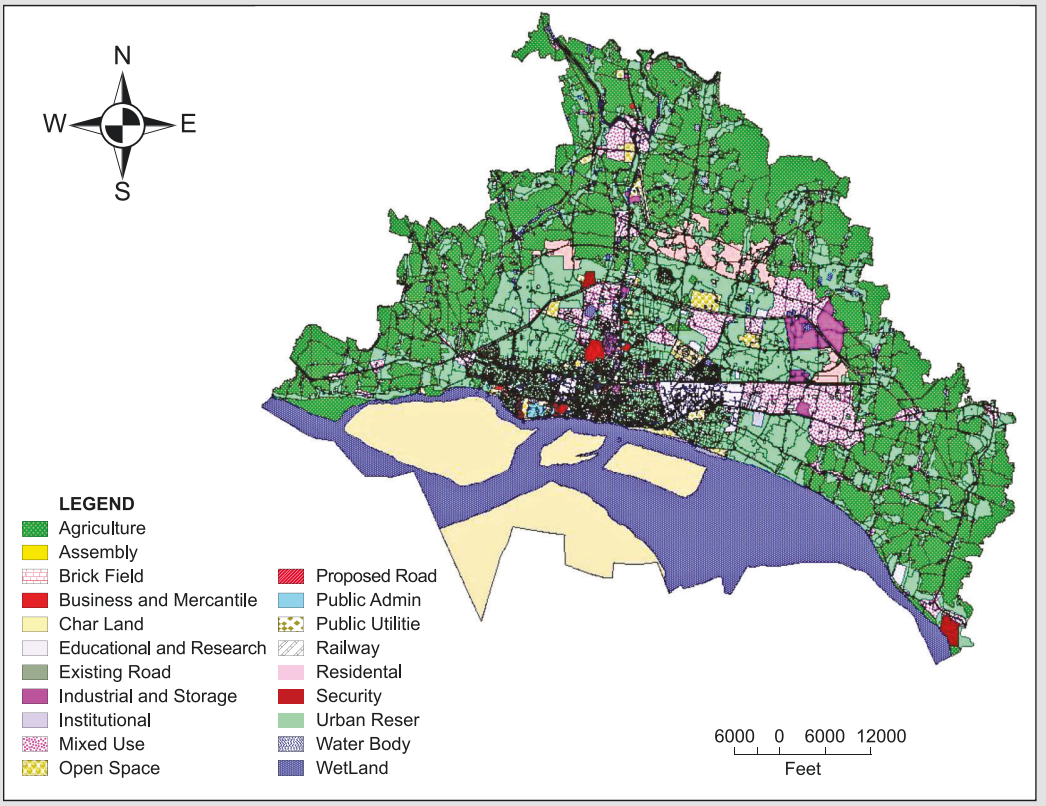


Figure 4.2: Rajshahi Metropolitan Development Plan (RMDP) (2004-2024)

Source: RDA, 2023

In Phase 1, a functional master plan is prepared for 10 years starting from 2004. In this functional master plan, an urban area and an extended area are proposed. The area of this plan is the same as the structure plan. The area of the proposed urban area is 24,719.89 acres and the area of the extended part is 65,237.46 acres. The functional master plan is mainly focused on the development of the proposed urban area. The Detailed Area Plan (DAP) has been prepared that divides the structure into 25 Spatial Planning Zones (SPZ).

4.2 Nature and area of wetlands as per RMDP (2004-2024)

In the functional master plan (2004-2014) in RMDP, wetlands are mainly beels, whereas rivers, khal, ponds, and other water reservoirs are considered waterbodies. Including the waterbodies in wetlands, the area is 16522.43 acres or 18.36% of the total RMA. According to this plan, about 1,923 ponds were present in 2004 with an area of 1,369 acres. In the proposed urban areas, the amount of wetland in 2002 was 1910.32 acres and reduced to 999.31 acres in 2014 which shows a loss of 3.7%. This is due to the construction

activities. Considering the Open Space Act, 2000, the plan aimed to conserve 165 ponds within the demarcated urban area of RMA. Protection of these ponds is especially emphasized in the extended areas to ensure a potable water source.

4.2.1 Scenario of wetland loss at present time

According to the RMDP (2004-2024), the process of urbanization in Rajshahi is the main reason for the loss of water bodies and ponds.

Due to unawareness, and proper maintenance, waste dumping in the ponds is a regular phenomenon here. This affects the ecosystem, makes the wetlands unproductive, and causes environmental degradation. Presently, encroachment of the ponds by the real estate developer is a common scenario. This caused the conversion of low-cost wetlands including ponds into high-priced real estate assets. The existing condition of the ponds is shown in Figure 4.3.

4.3 Changes in the wetlands in the last 20 years

The water body area in the Rajshahi Metropolitan Area has experienced a continuous decline over the years, as evident from the following observations.

In 2001, the RMA boasted a considerable wetland cover, spanning 16,308.04 acres, which represented a notable 18.09% of the total area (Figure 4.4 (a)). This indicated sufficiency. However, the subsequent years witnessed a gradual and persistent decline in wetland areas, leading to pronounced changes by 2022 (Table 4.1).

By 2005, wetlands had already shrunk to 15,243.12 acres, encompassing 16.90% of the total area (Figure 4.4 (b)). This initial decay suggested that factors affecting wetland areas were gaining momentum. Urbanization and land development began tocover the wetlands, primarily due to turning these areas into agricultural land and constructing buildings. In 2008, this trend continued and the wetlands decreased to 14,178.19 acres, which is 15.72% of the total area (Figure 4.4 (c)). The factors behind this trend became increasingly evident as agricultural expansion intensified, and wetland ecosystems faced pressures from land use changes. In 2011, the wetland extent had fallen to 13,113.27 acres, equivalent to 14.5% of the total area (Figure 4.4 (d)). This decline signified an ongoing, gradual transformation of the wetlands. Urbanization continued to exert pressure, resulting in wetland degradation and habitat loss.

By 2014, wetlands covered 12,048.35 acres, representing 13.36% of the total area (Figure 4.4 (e)). This decline emphasized the consistent impact of various factors on wetland ecosystems, including policy decisions that did not prioritize wetland conservation. The situation worsened by 2017, with wetland coverage reducing to 10,983.42 acres, constituting only 12.18% of the total area (Figure 4.4 (f)). Urbanization, land development, and altered land use patterns were taking their tolls. By 2020 the extent of wetlands further diminished to 9,818.52 acres, accounting for merely 10.89% of the total area (Figure 4.4 (g)). The most recent data, from 2022, indicated that wetlands covered just 9,222.958 acres, which represented only 10.23% of the total area (Figure 4.4 (h)). This observation highlighted that the trend of diminishing

wetlands has continued to the present day, reflecting the relentless pressures on these critical ecosystems. Figure 4.4 depicts the scenario of the change. The statistics of the year-wise wetland changes are given in Table 4.1.

Figure 4.3: Encroachment of ponds and waste dumping due to construction activities

Source: Authors, 2023

4.4 Discussion

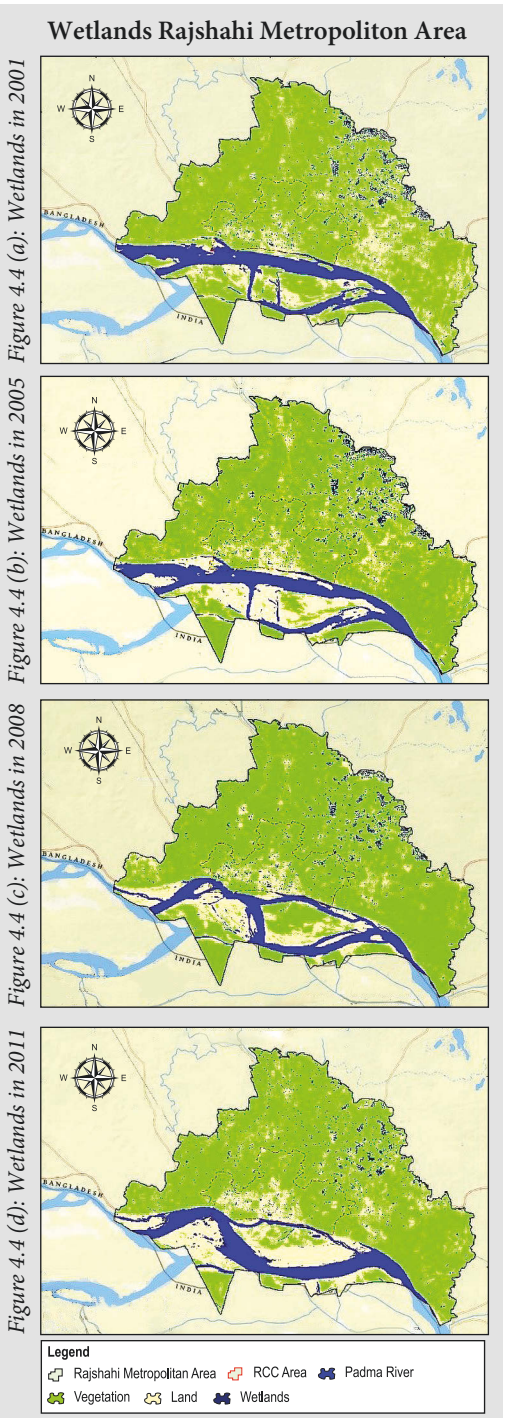
According to the RMDP (2004-2024), the amount of wetland in 2003 was 18.36 %. But the analysis shows that the amount in 2001 was 18.09 %, approximately 0.3% less than in 2003. There is a discrepancy between reality and the document. A scenario of the changing pattern of RMA and RCC in 2001, 2011, and 2022 is shown in Figure 4.5. The development plan is more focused on the ponds rather than the wetlands, which creates a discrepancy in understanding the declination pattern of wetlands in reality.

Despite these issues, RMDP (2004-2024) is linked with several policies for preserving and managing wetlands and water bodies. Among them, the Open Space and Wetland Preservation Act, of 2000 are mentionable in terms of the conservation of water bodies (Table 4.2). Also, the natural waterbodies and flood flow areas should be preserved for the movement of flood water and retention of the excess water. According to the Water Reservoir Conservation Act, 2000, wetlands are flood-flowing land. These include rivers, canals, beel, ponds, streams, fountains. As per the RDA Act, 2018, the use of land and

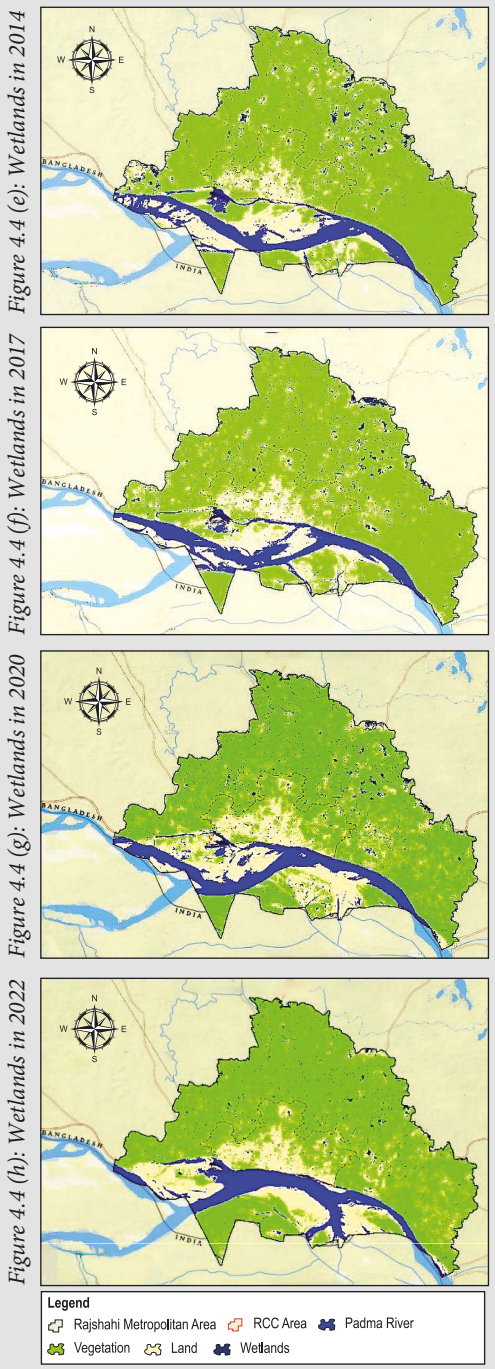
waterbodies cannot be changed or filled without the permission of the authorities. In the case of pond filling without permission, punishment is also declared. Some initiatives are proposed in the RMDP (2004-2024) in its first phase.Some mechanisms are said to be applied as per the statement in the RMDP (2004-2024) to protect the water bodies. The initiatives include development control, road plantation, protection of important water bodies, and so on. The regulatory mechanism of the water bodies Conservation Act, 2000 has been followed in the RMDP (2004-2024), to conserve the significant number of ponds (Table 4.2). For environmental improvement, and flood and river erosion protection, Padma riverbank protection through the Padma Embankment (Bundh) Project is an important initiative as Padma River is a critical lifeline for Rajshahi City (Table 4.2). The embankment is important to prevent flood water from entering the city. Under the Rajshahi Metropolitan Development (RMD) projects, flood embankments on the eastern and western sides of the river have been proposed. The area of the structure plan is rich in fish farming. This is another way of preserving the ponds.

The master plan clearly stated the responsible agencies at every policy option for the protection of wetlands. The agencies include the Rajshahi City Corporation (RCC), Rajshahi Development Authority (RDA), the Department of Environment (DoE), the Bangladesh Water Development Board (BWDB), the Department of Fisheries (DoF), NGOs, etc. Authorities should take necessary actions to protect the remaining wetlands, ponds, and other water bodies.

Table 4.2 summarizes the policy options in the master plan and links them with other policies.



Source: Authors, 2023



Source: Authors, 2023

5. Conclusion

In recent times, Rajshahi has been growing fast due to rapid urbanization. The wetlands and waterbodies are filled due to unplanned construction, lack of monitoring from the authorities as well as lack of enforcement of laws and regulations, etc. RMDP (2004-2024) provides guidelines for the overall development of RMA, where the protection of wetlands is integrated. Despite having some guidelines in the plan, the waterbodies are already being demolished and losing their actual purpose. A significant decreasing trend from 18.1 % to 10% is observed from 2001 to 2022. It is tough to control the diminishing trend of the wetlands only with the strategies stated in the RMDP (2004-2024). Rather it should be consistent with other relevant policies that guide the planned development of a city. The study tries to show the decreasing pattern of wetlands in Rajshahi to attract the attention of policymakers. Also, revitalization of the filled ones as much as possible is recommended. In this case, collaboration and coordination between the agencies are mandatory to take all the actions according to the plan and beyond. Furthermore, the central authorities should come forward to provide all necessary support to the local authorities. Otherwise, the city will lose its beauty and aesthetics.

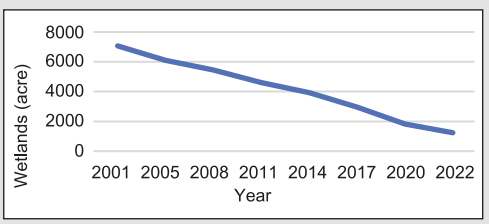


Figure 4.5: Decreasing pattern of wetlands from 2001 to 2022

Source: Authors, 2023

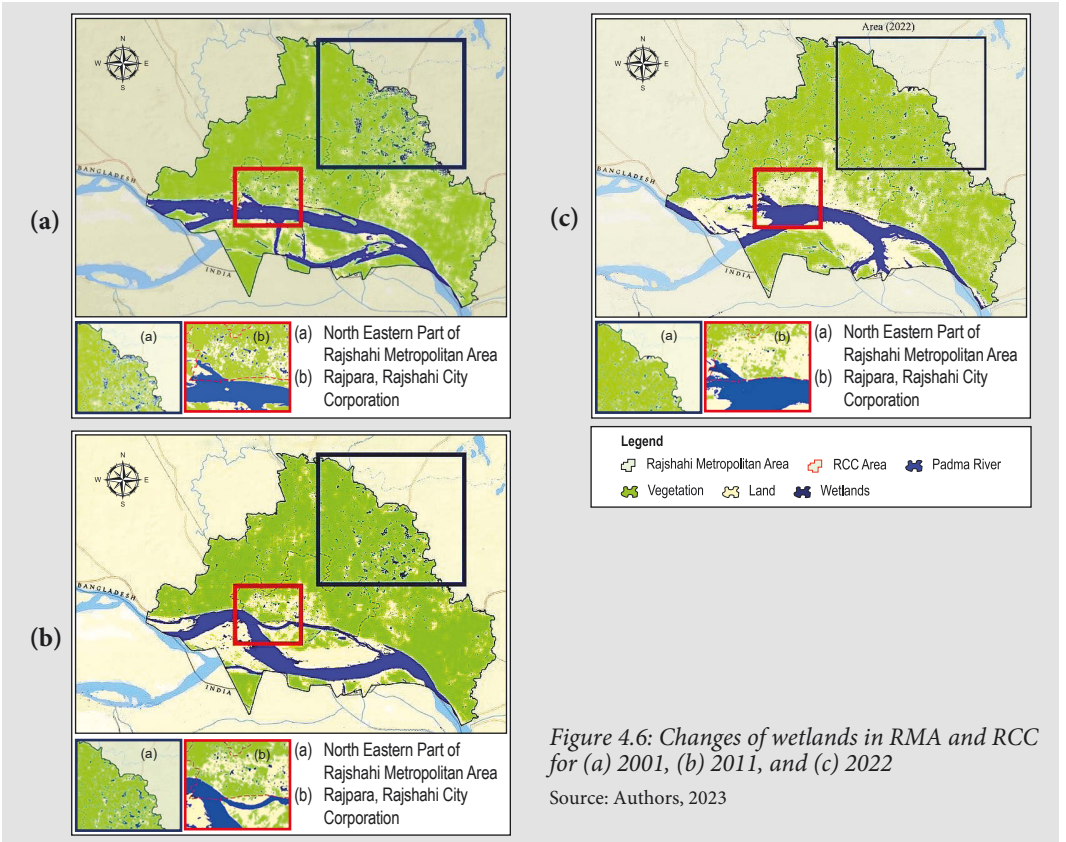


Figure 4.6: Changes of wetlands in RMA and RCC for (a) 2001, (b) 2011, and (c) 2022

Source: Authors, 2023

Table 4.1: Amount of wetland, vegetation and land area in RMA from 2001 to 2022

Year	Padma River		Wetlands		Vegetation		Land	
	Area (acre)	Area (%)	Area (acre)	Area (%)	Area (acre)	Area (%)	Area (acre)	Area (%)
2001	9232.94	10.24	7075.1	7.85	63760.9	70.71	10099.6	11.20
2005	9095.53	10.09	6147.6	6.82	62368.5	69.17	12554.2	13.92
2008	8657.00	9.60	5521.2	6.12	59310.8	65.78	16678.5	18.50
2011	8411.23	9.33	4702.0	5.21	58946.5	65.37	18109.2	20.08
2014	8002.70	8.88	4045.6	4.49	57188.3	63.42	20929.3	23.21
2017	7876.66	8.74	3106.8	3.45	56549.1	62.71	22636.4	25.10
2020	7804.97	8.66	2013.5	2.23	55816.9	61.90	24530.1	27.20
2022	7769.69	8.62	1453.3	1.61	54013.1	59.90	26930.9	29.87

Source: Authors, 2023

Table 4.2: Policy options in the master plan and links with other policies

Issues	Policies adopted in the RMDP	Link with other policy documents and Acts
Conservation of waterbodies and flood flow areas	✓ Especial focus on ponds ✓ Conserve all the ponds in the extended areas ✓ Development control measures: *Refusal of filling up the ponds; Refusal of building permission in the areas covered by ponds* ✓ Initiation of new laws if necessary	✓ Open Space Act, 2000
Protection of wetlands	✓ Fixation of road alignment avoiding wetlands ✓ Cut off the drainage outlets to the wetlands (beels and ponds) ✓ Prohibition of earth filling by real estate, industries, etc. in demarcated wetland ✓ Prohibition of landfilling to maintain the groundwater level ✓ Preservation of surface water in the wetlands for irrigation ✓ Implementation of the Water Body Conservation Act, 2000 strictly	✓ Waterbody Conservation Act, 2000 ✓ RDA, Act 2018
Padma Riverbank Improvement projects	✓ Restriction on the settlement ✓ Construction of groynes and bank matressing works for the protection of river erosion	
Punishment for filling the ponds	✓ Implementation of RDA Act, 2018	RDA Act, 2018

Source: Authors, 2023

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Chapter 5

Spatiotemporal Analysis of Wetland Dynamics in Chattogram City, Bangladesh

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1. Introduction

Wetlands are invaluable ecosystems that play a crucial role in urban planning and development. They are often referred to as the "kidneys of the Earth" due to their ability to filter and purify water, reduce the risk of flooding, and provide habitat for diverse plant and animal species. However, in major cities around the world, wetlands are rapidly diminishing due to urbanization and land development. As cities expand, wetlands are drained, filled, or paved over to make way for infrastructure and housing, leading to the loss of these critical natural resources (Hassan & Nazem, 2016; Siddique & Uddin, 2022). This decline in wetlands has significant implications for urban planning, as it can exacerbate issues such as flooding, water pollution, and habitat loss. It is essential to conserve wetlands not only for their ecological significance but also for the tangible benefits they provide to urban areas, including improved water quality, enhanced resilience to climate change, and opportunities for recreation and education. Preserving wetlands in urban planning is crucial for building sustainable and resilient cities that can thrive in the face of environmental challenges (Kerry Turner, 1991; Lynch, Kalumanga, & Ospina, 2016; Zhou, Liu, Tan, & Song, 2014).

The examination of existing literature reveals diverse wetland definitions that vary geographically, devised to serve distinct objectives. In the context of this study, the following definition is deemed suitable for scientific inquiry and managerial applications. Within the specified region, wetlands manifest organically in locations across the landscape where surface water accumulates intermittently over a discernible period and/or where seasonal groundwater discharge is adequate to create waterlogged soils (Tiner, 1999). In Bangladesh, wetlands are experiencing significant challenges and reductions in their extent, mirroring global trends of wetland loss. The country, with its extensive network of rivers, lakes, and coastal areas, is naturally rich in wetlands. However, rapid urbanization, population growth, and agricultural expansion have led to the drainage and conversion of many of these valuable ecosystems. This loss of wetlands in Bangladesh has serious implications for water resource management, biodiversity conservation, and the livelihoods of communities that depend on wetland resources for their sustenance. Pollution from industrial and domestic sources further compounds the problems faced by these ecosystems, threatening water quality and ecosystem health (Ghosh & Mondal, 2013; Gibbs, 2000).

Chattogram, as a major city in Bangladesh, exemplifies these challenges. Chattogram City, situated in the southeastern part of the country, has witnessed a significant reduction in its wetland areas due to rapid urbanization and population growth (Siddique & Uddin, 2022). One of the major problems faced by wetlands in Chattogram City is encroachment, where wetland areas are reclaimed for housing, commercial, and industrial purposes. This encroachment often occurs without proper land-use planning and regulation, leading to the loss of critical wetland ecosystems. Additionally, pollution from industrial and domestic sources has severely degraded water quality in many of Chattogram's wetlands, making them less suitable for supporting aquatic life and affecting the livelihoods of local communities dependent on these resources (Gibbs, 2000).

The reduction of wetlands in Chattogram City can be attributed to several factors, including rapid population growth and urban expansion, insufficient enforcement of wetland protection laws and regulations, and a lack of awareness about the ecological importance of wetlands. As the city's population continues to grow, the demand for land for housing and infrastructure increases, putting further pressure on remaining wetland areas. Additionally, inadequate waste management practices and improper disposal of sewage exacerbate pollution levels in these ecosystems (Molla, Chowdhury, & Islam, 2021). To address these challenges and protect Chattogram City's remaining wetlands, there is a pressing need for comprehensive urban planning that prioritizes wetland conservation, stricter enforcement of environmental regulations, and community engagement to raise awareness about the value of these vital ecosystems for both the environment and human well-being (Molla & Chowdhury, 2021; Yangfan, Yalou, Xiaodong, Huhua, & Tao, 2013).

The reduction of wetlands in Chattogram City exacerbates the problems of flooding

and waterlogging in several ways. Wetlands act as natural buffers against flooding by absorbing excess rainwater and releasing it gradually. As Chattogram's wetlands are drained or filled for urban development, this crucial capacity is lost, leading to increased surface runoff and faster water flow into rivers and drainage systems. During heavy monsoon rains, the overwhelmed drainage infrastructure struggles to cope, resulting in urban flooding and significant damage to the city's infrastructure. Additionally, the loss of wetlands reduces their capacity to act as floodplains, where floodwaters can be temporarily stored. This reduction in storage space makes Chattogram City more susceptible to inundation during flood events, further exacerbating the flood and waterlogging issues (The Daily Star, 2023).

Moreover, the decline of wetlands disrupts the local hydrological balance, altering groundwater levels and water availability. Lowered groundwater levels can exacerbate waterlogging in low-lying areas during the wet season, as inadequate drainage combines with reduced water absorption capacity. Additionally, the loss of wetlands leads to increased water pollution, as these ecosystems naturally filter pollutants from runoff. With the decline in wetlands, pollutants from urban and industrial areas in Chattogram City are more likely to enter Wetlands directly, deteriorating water quality and compounding waterlogging problems. Addressing these challenges requires a comprehensive approach that includes wetland conservation, sustainable urban planning, improved drainage infrastructure, and community engagement to raise awareness about the importance of wetlands in mitigating flood and waterlogging issues (Lee et al., 2006).

Analyzing the spatiotemporal patterns of wetlands is crucial for understanding their dynamic nature and the broader ecosystems they are part of. Such analysis helps scientists, conservationists, and policymakers gain valuable insights into the health, resilience, and ecological functions of wetlands. By tracking changes in wetland size, distribution, and condition over time, we can assess the impacts of human activities, urbanization, and climate change on these ecosystems. This information is essential for informed decision-making in land-use planning, habitat preservation, and disaster risk reduction. Furthermore, studying spatiotemporal patterns allows us to identify critical wetland areas that may require special protection or restoration efforts (Clarkson, Ausseil, & Gerbeaux, 2013; Ghosh & Mondal, 2013; Kerry Turner, 1991). Ultimately, a thorough analysis of wetland spatiotemporal dynamics contributes to the effective management and conservation of these invaluable ecosystems, which play a vital role in biodiversity, water quality, and climate regulation.

Evaluating the spatiotemporal patterns of wetlands poses several challenges, primarily due to the dynamic nature of these ecosystems and their often remote or inaccessible locations. One major challenge lies in obtaining accurate and up-to-date data. Wetlands can change rapidly in response to natural processes and human activities, making it difficult to maintain comprehensive records. However, the use of Geographic Information Systems (GIS) and remote sensing technologies has significantly improved our ability to address these challenges. GIS allows for the integration

of various data sources, including satellite imagery and ground-based measurements, facilitating the analysis of wetland changes over time. Remote sensing technologies, such as satellite and aerial imagery, provide valuable insights into wetland dynamics by capturing information on wetland extent, vegetation health, and water levels. Despite these advancements, challenges persist, including the need for high-quality and consistent data, technical expertise, and the capacity to process and interpret vast amounts of information. Nonetheless, the application of GIS and remote sensing tools remains instrumental in enhancing our understanding of spatiotemporal wetland patterns, supporting conservation efforts, and informing sustainable land management practices. The aim of our study is to identify the existing wetlands, investigate the spatiotemporal dynamics of wetland change, and identify the factors influencing the wetlands loss in the Chattogram Development Authority (CDA) Area, Bangladesh. By conducting a comprehensive analysis of the evolving patterns of wetland coverage and distribution over time, we seek to understand how urbanization, land-use changes, and environmental factors have influenced these critical ecosystems within the city.

2. Data & Methodology

2.1 Identification and Validation of Existing Wetlands

The initial step in this study involved the identification of existing wetlands within the Chattogram Development Authority (CDA) area. Secondary data sources, such as Google Earth images, reports, and newspaper archives, were utilized for preliminary wetland identification. Subsequently, extensive field surveys were conducted to validate and update the information obtained from secondary sources. This comprehensive fieldwork allowed for the collection of ground-truth data, ensuring the accuracy of wetland locations and conditions. The identified wetlands were further categorized based on their functions, providing a detailed representation of the current wetland landscape in the CDA area.

2.2 Analysis of Spatiotemporal Patterns of Wetlands Dynamics

To assess the spatiotemporal dynamics of wetland change, Landsat satellite imagery from the years 2000 and 2010, as well as Sentinel imagery from 2022, were utilized shown in Table 5.1. A supervised classification method, employing the Random Forest algorithm, was employed to classify land use and land cover (LULC) within the study area for these specific years (Amini, Saber, Rabiei-Dastjerdi, & Homayouni, 2022; Avci, Budak, Yağmur, & Balçik, 2023). To validate the LULC classification accuracy for each year, a rigorous accuracy assessment was carried out by comparing the classified images with ground-truth data collected during the field survey (Rwanga & Ndambuki, 2017). The spatiotemporal dynamics were subsequently analyzed by comparing the LULC classifications of different years, allowing for a clear representation of how wetlands have changed over time.

Table 5.1: Acquired remote sensing data for LULC classified map preparation

Satellite (Sensor)	Band	Resolution	Year	Collection Type	Cloud Coverage (%)
Landsat 5 TM	1-5	30 m	2000, 2010	Annual Collection (14, 9)	Less than 10
Sentinel-2 MSI Level-2A	2,3, 4, 8	10 m	2022	Annual Collection (84)	Less than 1
	11	20 m			

Source: Earth Engine Data Catalog, Authors, 2023

2.3 Identification of Factors Affecting Wetland Loss

Factors contributing to wetland loss within the CDA area were identified through a combination of field surveys, interviews with the local people, and an extensive review of existing literature. Field surveys provided on-the-ground insights into local conditions and potential stressors affecting wetlands, while the literature review offered a broader perspective on the drivers of wetland degradation and loss in the urban context.

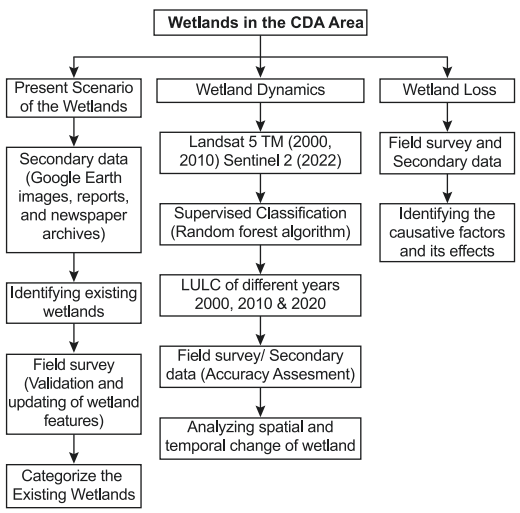

Figure 5.1: Flow chart of the methodology

Source: Authors, 2023

This comprehensive methodology combining field surveys, remote sensing analysis, and literature review provides a robust framework for investigating the spatiotemporal dynamics of wetland change and identifying the factors influencing wetland loss within the Chattogram Development Authority area. A brief overview of the study methodology is depicted in Figure 5.1.

3. Result and Discussion

3.1 Existing Wetlands in the CDA Area

In Figure 5.2, the existing wetlands within the CDA area are depicted. These wetlands were initially identified through secondary data analysis and subsequently validated and updated through comprehensive field surveys (Tiner, 2017). The identified wetlands have been systematically categorized according to their respective functions. This classification encompasses rivers, canals, lakes, coastal wetlands/salt marshes, estuaries, and ponds. The following sections provide detailed descriptions of the identified wetlands.

Two major *river* networks are present in the CDA area: the Karnaphuli and Halda rivers. The Karnaphuli is the primary water network, flowing alongside the main city. It enters the CDA area from the northeast and ultimately empties into the Bay of Bengal to the west of the CDA area. This river plays a crucial role in transporting goods and people within the area and supports the livelihoods of many communities living along its banks.

The Halda River originates at the Badnatali Hill Ranges in Ramgarh Upazila in the Chittagong Hill Tracts. It enters the northern part of the CDA area and flows into the Karnaphuli River. During the rainy season, a substantial amount of water is generated from both within and outside the CDA area, which drains into these rivers.

Another river, named the Sangu, is situated in the southern part of the area and flows alongside the CDA boundary. These three rivers are depicted in Figure 5.2 for reference.

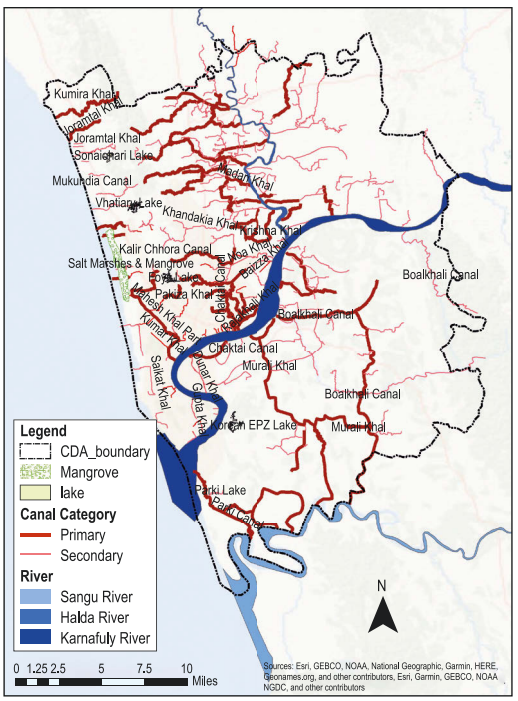

Figure 5.2: Wetlands in CDA Area

Source: Authors, 2023

Around 60 natural *canal* names were revealed in the CDA area during a field survey, and there are approximately 755.4 km of canals in the CDA area. These canals can be divided into two major categories: primary and secondary canals, as shown in Figure 5.2. Unfortunately, many of these canals are not in good condition. Most of them are narrow, and their water flow is obstructed due to siltation caused by city garbage and illegal encroachments, among other factors. Most of the canals are connected to the Karnaphuli and Halda rivers, while some of them directly flow into the Bay of Bengal. As this region features a hilly topography, these canals play a vital role in collecting and draining a substantial amount of rainwater during the monsoon seasons. Additionally, they support the local aquatic biodiversity. A short list of all the canals is provided in Annexure.

The CDA area comprises four distinct *lakes*: Foy's Lake, Vatiari Lake, Korean EPZ Lake, and Sonaichari (AKSML) Lake. These lakes play a critical role in serving as essential water sources and sustaining aquatic biodiversity within the region. Notably, Sonaichari Lake underwent excavation beginning in 2012 under the initiative of AKSML. This excavation was primarily undertaken to create a reservoir for rainwater storage during the rainy season, with the intention of utilizing it in their steel industry operations. The sizes of these lakes are provided in Table 5.2.

Table 5.2: The current extent of Lake within CDA.

Name of the Lake	Year (Area in Acre)		
	2010	2015	2010
Vhatiari Lake			2872.52
AKSML Llake	Does nNot eExist	AKSML Llake	Does nNot eExist
Foyz's Llake			2872.52
Korean EPZ Llake			2818.46

Source: Authors, 2023

In the western vicinity of Chattogram city, a distinct ecosystem comprising *mangrove forests and salt marshes* thrives. This ecological enclave is located along the city's coastal zone, as illustrated in Figure 3.1, and is subject to recurrent inundation by seawater. These habitats play a pivotal role in providing essential environments for migratory avifauna while also serving as crucial nurseries for a diverse range of fish and crustacean species, facilitating their breeding and development.

The Karnaphuli River *estuary*, located in close proximity to the city of Chattogram, represents a significant estuarine ecosystem, serving as a pivotal transitional interface between freshwater and seawater domains. Estuaries hold paramount significance in facilitating nutrient cycling and serve as vital breeding habitats for marine organisms.

In the city area, numerous sizable *ponds* have been identified, some of which have existed since inception. Presently, there are approximately 32,352 ponds within the jurisdiction of the CDA. These ponds serve as vital water reservoirs and contribute to the preservation of aquatic biodiversity.

3.2 Spatiotemporal Patterns of Wetlands Dynamics in CDA area over the Year 2000 to 2022

To analyze the dynamics of wetlands in the CDA area from 2000 to 2022, the Land Use and Land Cover (LULC) of Landsat 5TM (for the years 2000 and 2010) and Sentinel 2 (for the year 2022) satellite data were classified into four major categories: Wetland, Vegetation, Build-Up, and Others. These major LULC categories encompass various subcategories, as detailed in Table 5.3. The classified LULC for the years 2000, 2010, and 2022 are presented in Figures 5.3, 5.4, and 5.5, respectively.

The accuracy assessment of these classified LULC datasets yielded an overall accuracy of 93% with a Kappa Coefficient of 0.9 for the year 2000, 89% and 0.9 for the year 2010, and 90% and 0.9 for the year 2022.

Table 5.3: Major LULC class includes the LULC properties

Class	LULC Properties
Wetland/ Water	River, Estuaries, Canals, Lakes, Pond, Salt marshes, and Lowland
Vegetation	Trees, Shrubs, Hilly area covered with vegetation, Agricultural land
Build-up	Any kind of infrastructure such as Buildings, Semi-paca buildings, Roads, Embankments, Drains, etc.
Others	Barren land, Open space, Sand, Seabeach, Earth filling

Source: Authors, 2023

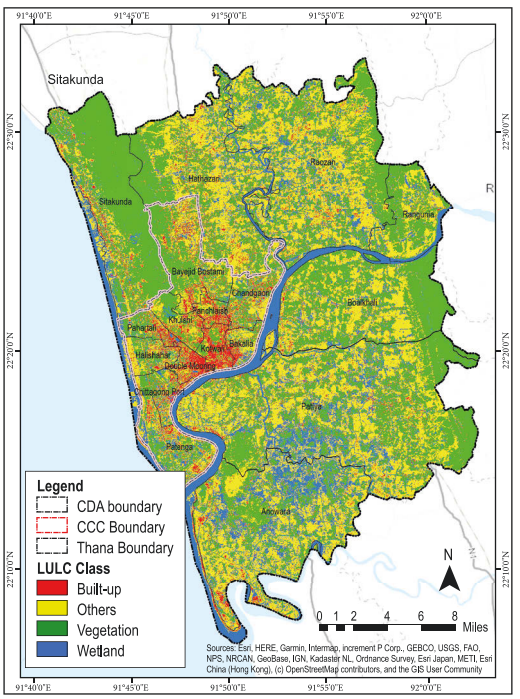

Figure 5.3: The LULC classification map of the year 2000

Source: Authors, 2023

The analysis of classified Land Use and Land Cover (LULC) data reveals significant changes in the CDA (Chattogram Development Authority) area over the years. In 2000, the wetlands covered an area of 187.03 km², which accounted for 14.82% of the total area. In 2010, the wetlands occupied 132.58 km², representing 10.50% of the total area, and by 2022, the wetlands had shrunk to 85.49 km², making up only 6.77% of the total area.

Among the four LULC classes considered, approximately half of the CDA area was covered by vegetation in the year 2000, with only 5.48% of the area classified as build-up. During this period, 14.82% of the area was characterized as wetlands, while the remaining 36.24% fell under the "Others" category.

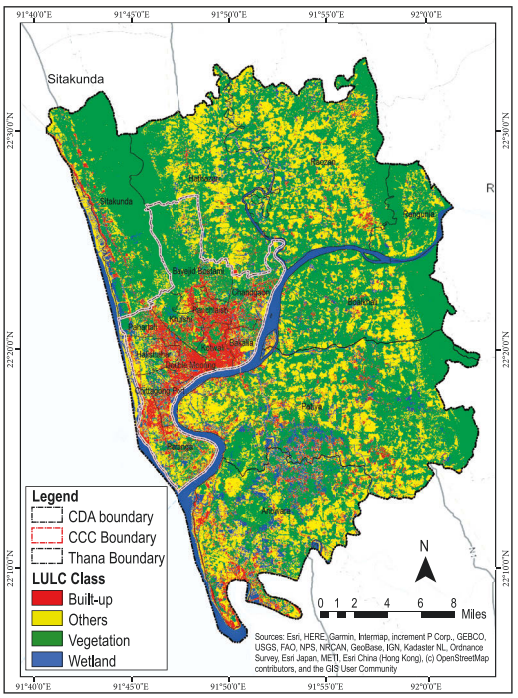

Figure 5.4: The LULC classification map of the year 2010

Source: Authors, 2023

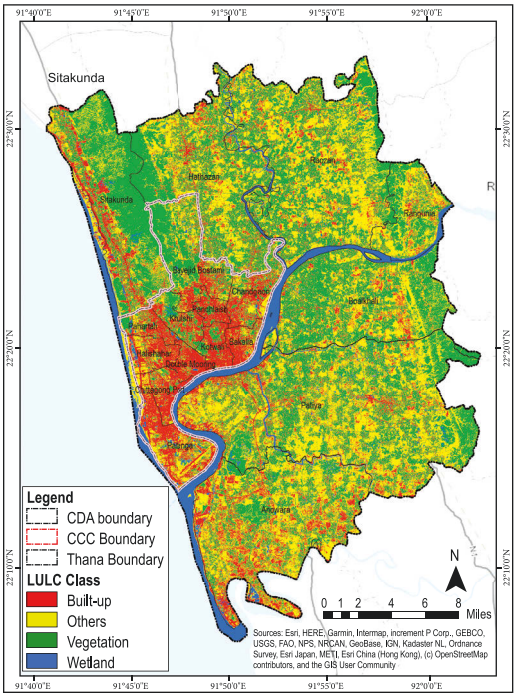

Figure 5.5: The LULC classification map of the year 2022

Source: Authors, 2023

The situation evolved in 2010, with an increase in both build-up and vegetated areas, reaching 7.90% and 53.70%, respectively. Conversely, wetlands decreased by 10.50%. A similar pattern emerged in 2022, where the build-up area expanded rapidly by 15.38%, while wetlands continued to decline, now comprising only 6.77% of the total area.

The data clearly indicates an alarming trend of wetland loss in the CDA area. If this trend persists, it is projected that after 10 years, wetlands will occupy a mere 3% of the total CDA area, posing a severe threat to the local environment. Additionally, it is noteworthy that the build-up area has experienced substantial growth, particularly between 2010 and 2022, where it increased at twice the rate observed previously. The

LULC of the CDA area is depicted in Figure 5.6 and Table 5.4.

Changes in hydrological conditions within a watershed, compounded by climate change, exert substantial and far-reaching impacts on various wetland ecosystems, encompassing rivers, lakes, ponds, wetlands, and coastal areas. These effects exert influence over water quantity, quality, and the overall health of ecosystems (Zunaira et al., 2020). Alterations in precipitation patterns, coupled with heightened temperatures causing increased evaporation, are contributors to more frequent and severe drought occurrences(Adler et al., 2018). Diminished rainfall levels can lower water levels in rivers and lakes, thereby affecting water availability across multiple sectors, including agriculture, industry, and municipal supply (Instanes et al., 2016). Heightened rainfall intensity and shifts in runoff timing contribute to more frequent and intense floods, along with reduced low-flow periods during dry seasons. These modified flow patterns can induce changes in river channel morphology, potentially amplifying erosion and sedimentation, ultimately compromising water quality and aquatic habitats(Boix-Fayos et al., 2007).

Furthermore, escalating sea levels attributed to climate change can prompt saltwater intrusion into coastal aquifers and estuaries, consequently degrading water quality and rendering freshwater resources in coastal zones less suitable for drinking and agricultural purposes (Chang et al., 2011). Concurrently, changes in hydrological conditions, notably shifts in precipitation patterns, can result in the loss and deterioration of wetlands (Adler et al., 2018). These transformations affect waterfowl habitat, biodiversity, and the wetlands' capacity to mitigate pollutants(Adler et al., 2018; Zunaira et al., 2020). Heightened rainfall events may also escalate soil erosion within watersheds, culminating in increased sediment loads in rivers and lakes. This sedimentation process can lead to diminished water quality, harm aquatic ecosystems, and hinder navigation (Boix-Fayos et al., 2007; Fang et al., 2012).

These transformations affect waterfowl habitat, biodiversity, and the wetlands' capacity to mitigate pollutants(Adler et al., 2018; Zunaira et al., 2020). Heightened rainfall events may also escalate soil erosion within watersheds, culminating in increased sediment loads in rivers and lakes. This sedimentation process can lead to diminished water quality, harm aquatic ecosystems, and hinder navigation (Boix-Fayos et al., 2007; Fang et al., 2012).

3.2.1 No administrative jurisdiction for wetland management

Ineffective administrative jurisdiction over wetland management can result in the degradation and loss of various aquatic ecosystems, encompassing wetlands, rivers, lakes, and ponds (Lynch et al., 2016). Suboptimal governance and administrative supervision can give rise to a range of issues that detrimentally affect these wetlands. In the absence of clearly defined administrative authority and regulatory measures, wetlands may be excessively exploited for purposes like agriculture, industrial utilization, and urban development. This overuse of water resources can lead to wetland depletion and, in some instances, complete desiccation. The absence of administrative oversight can also foster encroachment and habitat destruction within wetland areas

(Ramachandra et al., 2012). (Ramachandra T.V, Aithal, & Kumar, 2012). Processes such as urbanization, land development, and agricultural expansion may cause wetland drainage or filling, resulting in reductions in their size and ecological significance (Li et al., 2013). Insufficient enforcement of regulations pertaining to wetland preservation and water resource management can facilitate illicit activities, including land encroachment, unauthorized construction, and deforestation within and in the vicinity of wetland areas(Lynch et al., 2016; Ramachandra T.V et al., 2012).

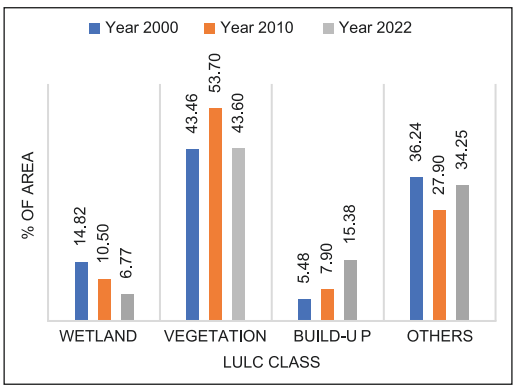

Figure 5.6: The distribution of different LULC class areas over the period of the year 2000 to 2022

Source: Authors, 2023

Table 5.4: The distribution of LULC area (km²) in different year

LULC Class	Year					
	2000		2010		2022	
	km²	%	km²	%	km²	%
Wetland	187.03	14.82	132.58	10.50	85.49	6.77
Vegetation	548.68	43.46	677.92	53.70	550.42	43.60
Build-up	69.17	5.48	99.74	7.90	194.11	15.38
Others	457.54	36.24	352.18	27.90	432.41	34.25
Total	1262.43	100.00	1262.43	100.00	1262.42	100.00

Source: Authors, 2023

It is essential to conduct an analysis to determine the primary driver of wetland loss in the study area. To this end, we have conducted a year-wise Land Use and Land Cover (LULC) conversion assessment, as illustrated in Figures 5.5 and 5.6. The figures reveal a clear trend: coastal wetlands in the western part of the CDA have undergone conversion into built-up and other LULC classes between the years 2000 and 2022. During this period, these areas were enclosed for purposes such as shrimp farming and various other land uses.

Figure 5.3 indicates that, in the year 2000, a larger number of wetlands were present in the northern part of the CDA area. However, our analysis shows that these wetlands have experienced conversion into built-up and other LULC classes during the period from 2000 to 2022. This transformation can be attributed to the rapid urbanization observed in these areas, with the expansion of human habitats and agricultural land.

From the analysis of Land Use and Land Cover (LULC) conversion data presented in Table 5.5, it is evident that wetland areas experienced a net loss between the years 2000 and 2022. This loss is substantiated by the fact that the reduction in wetland extent surpasses the gain observed in other LULC categories. Notably, a significant portion of wetlands, amounting to 53.33 km², underwent conversion into vegetated areas during the decade from 2000 to 2010. These converted areas predominantly lie on the periphery of the primary urban center, serving primarily for agricultural purposes. However, this conversion trend exhibited a decrease during the subsequent period from 2010 to 2022.

Conversely, an area measuring approximately 13.08 km² was permanently transformed into built-up areas during the initial decade from 2000 to 2010, attributed to rapid urbanization. Notably, this conversion rate accelerated notably from 2010 to 2022. Examination of Figures 5.8 and 5.9 reveals that this conversion phenomenon occurred both within and outside the urban core. It is worth mentioning that wetlands initially experienced infilling with sand and soil, resulting in a substantial portion of wetlands transitioning into "Others" LULC categories during the 2000 to 2010 period. Remarkably, these "Others" LULC areas have now been permanently converted into built-up or vegetated areas as of the year 2022.

In conclusion, the period from 2020 to 2022 witnessed a continuous decline in wetland extent, with built-up areas exerting a significant influence on the permanent conversion of wetlands.

Another study also corroborated these findings. According to Arefin and Dayem (2017), the total length of canals within the jurisdiction of the Chattogram City Corporation area was 1009 kilometers in 1969, encompassing all canal branches. However, this length diminished to 792.5 kilometers by the year 2000 and further decreased to 433.03 kilometers in 2017. The canal's length is exhibiting a consistent decline, with approximately 575.91 kilometers of canals having been lost since 1969. The principal factors contributing to this reduction include unplanned urbanization, unauthorized land reclamation, and encroachment. Over the period from 1969 to 2000, there was a 21% reduction in canal length, and from 2000 to 2017, a substantial 57% reduction occurred. These trends are visually depicted in Figure 5.7, illustrating the changes in canal length over time in Chittagong City.

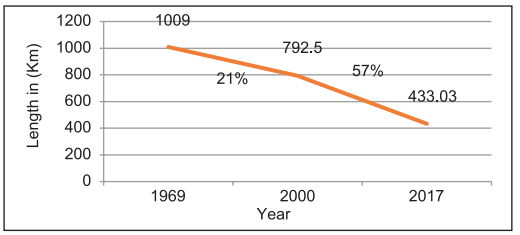

Figure 5.7: Change of Canal Length in the Chattogram City Corporation (CCC) area over the period of 1969 to 2017

Source: Authors, 2023

A study conducted by Chattogram Development Authority (CDA) within the jurisdiction area focuses on ponds. Over the past decade, a limited number of ponds have undergone demolition. Table 5.6 presents data illustrating the reduction in the number of ponds from 2010 to 2023. According to the table, approximately 176 ponds with an area exceeding 2.5 acres have remained intact, while smaller ponds have been subject to demolition during this period.

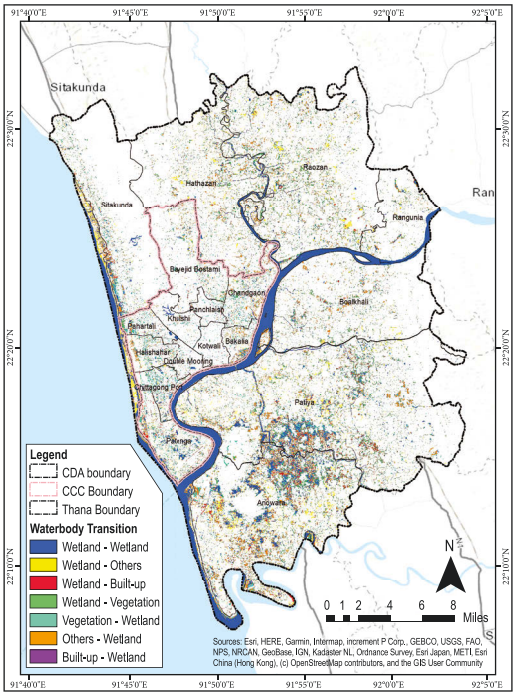

Figure 5.8: The LULC conversion over the year 2000 to 2010

Source: Authors, 2023

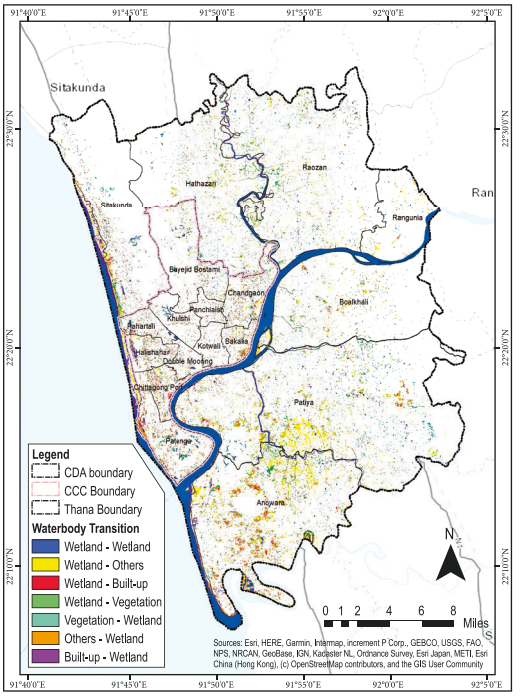

Figure 5.9: The LULC conversion over the year 2010 to 2022

Source: Authors, 2023

Table 5.5: Wetland conversion from the year 2000 to 2022

Wetland Conversion	Wetland in the year 2000	Wetland Change Year 2000 – 2010		Wetland in the year 2000	Wetland Change Year 2010 – 2022		Wetland in the year 2000
	(km^2)	(km^2)		(km^2)	(km^2)		(km^2)
Wetland-Wetland	187	83.27	Unchanged	132.57	63.23	Unchanged	85.48
Wetland- Vegetation		53.33	Loss (103.74)		19.40	Loss (69.33)	
Wetland-Build-up		13.08			15.69		
Wetland-Others		37.33			34.24		
Vegetation-Wetland		13.19	Gain (49.29)		8.26	Gain (22.23)	
Build-up-Wetland		4.35			2.74		
Others-Wetland		31.75			11.23		

Source: Authors, 2023

3.3 Causative factors of wetland loss and its effects

3.3.1 Expansion of human habitats

Chattogram, like many urban areas worldwide, has undergone substantial expansion of human habitats driven by population growth, urbanization, industrialization, and economic development. Population growth, stemming from both natural increase and rural-to-urban migration, stands as a primary catalyst for habitat expansion in Chattogram(Mia, Nasrin, Zhang, & Rasiah, 2015; Rana, 2011). Urbanization, fueled by the pursuit of enhanced economic prospects and living standards, has fostered the emergence of new residential, commercial, and industrial zones. Notably, the city's port and industrial areas have attracted investments, leading to the establishment of industries and job creation, further propelling habitat expansion (Hassan & Nazem, 2016).

To accommodate the growing population and urbanization's demands, substantial infrastructure development has transpired, encompassing road networks, bridges, public transportation systems, and utility provisions such as water supply and sewage systems (Hassan & Nazem, 2016). Concurrently, the booming real estate sector in Chattogram has witnessed the development of numerous housing projects and apartment complexes, catering to the city's housing needs, ranging from city center high-rise apartments to suburban housing developments(Bony & Rahman, 2014; Darcy, 2013).

Table 5.6: Distribution of ponds according to their size in CDA over year 2010 to 2023.

Pond	2010	2015	2023
(Area in Acre)	No. of Pond		
Greater than 2.5	176	176	176
2.5 - 1.25	493	490	487
1.25-0.25	11192	11170	11134
0.25 - 0.125	8571	8564	8520
Less than 0.125	12098	12088	12035
Total	32530	32488	32352

Source: CDA, 2023

This overall trend has necessitated additional housing and infrastructure, inadvertently encroaching on wetlands to some extent (Abass et al., 2020; De Vos, Cumming, Moore, Maciejewski, & Duckworth, 2016; Mitra & Banerji, 2018; Zhou et al., 2014). This study reveals that the built-up area expanded from 5.48% in 2000 to 15.38% in 2022. Over the past two decades, approximately 28 km^2 of wetland has been converted into built-up areas. In Chattogram, several renowned residential areas have been developed through wetland reclamation. Figure 5.10 illustrates the transformation of a well-known pond into a residential area.

3.3.2 Siltation

The Gangabari canals in Chattogram city have experienced a significant loss of navigability primarily attributed to extensive siltation, the accumulation of refuse, and inadequate reclamation efforts, mirroring the conditions of numerous other canals in the vicinity of the city. Consequently, heavy rainfall during high tide events leads to severe inner-city flooding, exemplified by the inundation observed during the super moon event on August 11, as reported by The Daily Star in 2015. The

city becomes submerged due to the overflow of water from the river and nearby wetlands driven by the elevated tide. Moreover, siltation is progressively obstructing the flow of water in Chaktai Khal, a canal responsible for draining rainwater from various areas within Chattogram city into the Karnaphuli river shown in Figure 5.11. This ongoing siltation issue has significant implications for the navigability of the canal and is a concern for the Chattogram City Corporation.

পাহাড় জঙ্গল জলাশয় সাবাড়

ভূঁইয়া নজরুল, চট্টগ্রাম

২০০০ সালে স্যাটেলাইট চিত্র

গত ১৬ মে'র স্যাটেলাইট চিত্র

কাইপী দীঘি

প্রশাস্তি আবাসিক এলাকা

গত ৩০ বছরে চট্টগ্রাম মহানগরীতে সবুজায়ন কমেছে ২৯.৮২ শতাংশ

■ পুকুর-জলাশয় কমেছে ৮.৩৭ শতাংশে ■ বসতি বেড়েছে ৪৫ শতাংশ

Figure: 5.10: A renowned Kottali pond transformed into Residential area

Source: *Desh Rupantor*, 25 August 2023

Figure: 5.11: The photo shows a huge amount of silt deposited in the Chaktai Khal, one of the main canals which drains out rain water from the port city, is creating hindrance to smooth flow of water

Source: *Daily Sun*, 06 January, 2017

3.3.3 Indiscriminately Hill cutting

Based on field surveys and expert opinions, indiscriminate hill cutting leads to soil erosion and sedimentation in drainage systems and nearby wetlands, thereby disrupting natural water flow. The encroachment upon the natural drainage system is prevalent in Chattogram City, resulting in the disappearance or imminent degradation of most of its natural drainage channels due to unlawful activities. Evidence is also found in the newspaper illustrated in the Figure 5.10.

3.3.4 Illegal land encroachment

Wetland encroachment in Chattogram City, like in many urban areas, manifests through various unauthorized means. This typically involves individuals or entities engaging in activities such as land filling, wherein soil, debris, or waste materials are deposited into the Wetland without the requisite permits or legal sanction(Molla et al., 2021). Another prevalent method involves the unlawful construction of buildings, houses, or other structures on Wetland areas (Ukaogo, Ewuzie, & Onwuka, 2020). Illegal dumping of solid waste, construction debris, or industrial effluents can lead to Wetland degradation and, occasionally, land formation. Additionally, some unscrupulous individuals or groups fraudulently sell encroached land to unwitting buyers who are unaware of the illicit nature of the transaction. Field surveys have also revealed instances of industrial facilities encroaching upon Wetlands for operational expansion or to create space for storage and infrastructure. These

encroachers often employ political influence to circumvent regulatory processes and evade legal consequences. In certain cases, encroachment occurs gradually over time as individuals or organizations incrementally expand their properties into Wetland areas without drawing immediate attention. Furthermore, unauthorized dredging operations conducted without proper permits or environmental assessments can alter Wetland boundaries and disrupt aquatic ecosystems. Notably, the Chaktai canal has significantly diminished due to long-term encroachment, with illegal structures continuing to proliferate on both sides. This widespread encroachment has constricted the Wetland, impeding natural water flow (Alam, 2022).

The Chaktai canal, spanning 6.9 kilometers and serving as a primary drainage channel for Chittagong city, has suffered noticeable shrinkage due to indiscriminate waste dumping and rampant encroachment over the years. According to a report published in the Business Standard on February 2, 2022, multi-story buildings and various other structures have been constructed by encroaching upon the Rajakhali canal in Chattogram, despite regulations prohibiting construction within 12 feet of the canal, as illustrated in Figure 5.12. During the rainy season, these areas remain persistently waterlogged, causing considerable hardships for the approximately five hundred thousand residents living along the canal. The canal, along with eleven other canals such as Jamal Khan Khal, Mirza Khal, Hizra Khal, and Chatteswary Khal, plays a vital role in draining rainwater and sewage from a twenty-square-kilometer area of the port city into the river Karnaphuli and the Bay of Bengal. The canal is considered the backbone of the city's drainage system (The Daily Star, 2017).

Figure: 5.12: Multi-storied buildings and various structures have been built by occupying the Rajakhali canal in Chattogram even though no construction is allowed within 12 feet of the canal

Source: *The Business Standard*, 02 February, 2022

In our field survey, we have observed the precarious existence of various canals in Chittagong City, raising questions about their continued viability. Notably, wetland encroachment is a pervasive phenomenon in Chittagong City. The initial step in this encroachment process involves constructing buildings along the riverbanks and canal edges. To facilitate this, rows of bamboo posts are firmly placed in the waterbody's bed along the bank, extending into the main body of the canal. Subsequently, houses, huts, and shops are constructed atop these stilts. Subsequent land reclamation efforts are undertaken by the owners through earth filling and garbage dumping. The encroachments on the canals primarily consist of infrastructure, markets, and commercial establishments.

3.3.5 Industrial and urban waste disposal (Water pollution and disturbance of the natural water flow)

Industrial and urban waste disposal, commonly referred to as "land reclamation," is a significant driver of Wetland size reduction (Yozzo, Wilber, & Will, 2004). This reduction primarily occurs through land filling, where solid waste, construction debris, and other materials are deposited directly into Wetlands, progressively filling them over time (Ngoc & Schnitzer, 2009). Consequently, this process transforms natural Wetlands into dry land, effectively diminishing their size(Ngoc & Schnitzer, 2009; Yozzo et al., 2004). As urban and industrial areas expand, Wetlands within or adjacent to these zones undergo alterations to accommodate infrastructure such as roads, buildings, and factories. This often necessitates extensive land reclamation, leading to a reduction in Wetland size(Molla et al., 2021).

In coastal regions, the expansion of ports and harbors for industrial and shipping purposes frequently involves land reclamation, which can result in the filling or modification of nearby Wetlands, including estuaries and lagoons (Todd et al., 2019). Additionally, certain industrial or urban projects may require sediment dredging from Wetlands to create new land or deepen water channels. This dredged material is frequently repurposed to fill adjacent Wetlands (Templet & Meeyea-Aaendt, 1988). The direct disposal of hazardous or non-hazardous industrial waste, including chemicals and solid waste, into Wetlands can lead to water contamination and degradation of water quality. Over time, this pollution can render Wetlands unusable, transforming them into waste-filled areas. Wetlands, known for their crucial ecological functions, are often drained and filled for the purposes of urban development and agriculture(Clarkson et al., 2013). This process not only reduces the size of Wetlands but also contributes to the degradation or loss of these valuable ecosystems (Ferronato & Torretta, 2019). Some evidence are shown in Figure 5.11 and 5.13.

3.3.6 Ill-planned infrastructure like roads, Narrow culverts, and drains

Poorly planned infrastructure, such as roads, narrow culverts, and drainage systems, can have detrimental effects on wetlands. Inadequately wide culverts or bridges crossing wetlands can impede water flow, potentially causing upstream flooding and erosion. Ineffectively designed drainage channels fail to efficiently divert rainwater from urban areas into natural wetlands, leading to water accumulation on urban surfaces and contributing to flooding. Inadequate drainage systems can also allow sediments, debris, and pollutants to accumulate in wetlands, resulting in decreased water quality, disruption of aquatic ecosystems, and reduced wetland storage capacity (Rahman & Salehin, 2013) shown in Figure 5.14.

Furthermore, roads and culverts that alter natural flow patterns can disrupt wetland hydrology, affecting the timing and volume of water inflow and outflow. Expanding roads and highways may encroach upon wetlands, causing the loss of valuable wetland areas, ponds, or lakes (Clifton et al., 2018).

Figure: 5.13 (a): Industrial and urban waste is discharged into the Mirza Khal waterway located in the Chandgaon area of Chittagong city

Source: *Dhaka Tribune*, 05 Jun 2017

Figure: 5.13 (b): The Karnaphuli, the most important river in Chittagong, gets polluted by liquid and toxic waste

Source: *The Asian Age*, 06 August 2016

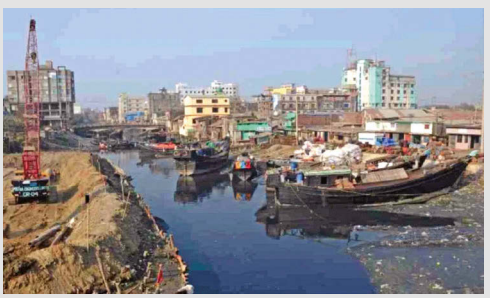

Figure: 5.13 (c): Canal in Chittagong, gets polluted

Source: *The Financial Express*, May 07, 2023

3.3.7 Land reclamation and expansion for Agriculture

Land reclamation and agricultural expansion, particularly in coastal regions like Chattogram City, can result in the reduction of wetlands. This process carries significant environmental and social implications. Land reclamation typically involves the filling or draining of wetlands, critical habitats for diverse plant and animal species (Chimner, Cooper, Wurster, & Rochefort, 2017). Consequently, it can disrupt the natural hydrology of an area, impacting water flow patterns and elevating the risk of flooding in nearby regions (Junk et al., 2013). Furthermore, it can induce fluctuations in groundwater levels, potentially affecting drinking water sources. In coastal zones like Chattogram, the elimination of natural buffers like wetlands during agricultural activities can obstruct natural water flow. Although agricultural land reclamation may enhance short-term production, it often compromises long-term sustainability (Iftekhar, 2008). Soil degradation, loss of natural buffers, and alterations in hydrology can exert adverse effects on agriculture over time (Issaka & Ashraf, 2017).

3.3.8 Fishing

The impact of fishing and shrimp cultivation on wetlands varies depending on management practices, with potential positive and negative outcomes(Gowing, Tuong, & Hoanh, 2006). Overfishing, especially when using destructive methods like trawling, can harm underwater habitats, including coral reefs, seagrass

beds, and sensitive ecosystems, resulting in biodiversity loss and water quality degradation(S D De Silva, Samarasekara, Thusyanthini, & D D De Silva, 2022). Shrimp cultivation often involves converting natural coastal wetlands, mangroves, and tidal areas into shrimp ponds, causing habitat loss and disruption to aquatic species and coastal ecosystems (PÁez-Osuna, 2001). The construction of extensive levees and dikes for shrimp ponds can alter coastal water flow, impacting tidal patterns and the health of nearby wetlands (S D De Silva et al., 2022).

3.3.9 Change of hydrological conditions in the watershed and climate change

Changes in hydrological conditions within a watershed, compounded by climate change, exert substantial and far-reaching impacts on various wetland ecosystems, encompassing rivers, lakes, ponds, wetlands, and coastal areas. These effects exert influence over water quantity, quality, and the overall health of ecosystems (Zunaira, Zhi Chen, Rehan, & Yinying, 2020). Alterations in precipitation patterns, coupled with heightened temperatures causing increased evaporation, are contributors to more frequent and severe drought occurrences(Adler, Gu, Sapiano, Wang, & Huffman, 2018). Diminished rainfall levels can lower water levels in rivers and lakes, thereby affecting water availability across multiple sectors, including agriculture, industry, and municipal supply (Instanes et al., 2016). Heightened rainfall intensity and shifts in runoff timing contribute to more frequent and intense floods, along with reduced low-flow periods during dry seasons. These modified flow patterns can induce changes in river channel morphology, potentially amplifying erosion and sedimentation, ultimately compromising water quality and aquatic habitats(Boix-Fayos, Barberá, López-Bermúdez, & Castillo, 2007).

Figure: 5.14 (a): Chittagong, Bakolia, Bangladesh

Source: ZUMA Press, Inc., 31 August 2023

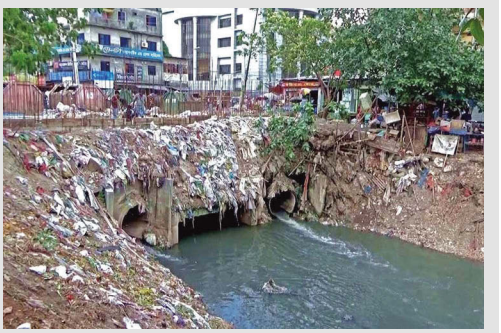

Figure: 5.14 (b):Unplanned culvert over a canal in Chattogram city

Source: The Financial Express, Nov 02, 2020

Furthermore, escalating sea levels attributed to climate change can prompt saltwater intrusion into coastal aquifers and estuaries, consequently degrading water quality and rendering freshwater resources in coastal zones less suitable for drinking and agricultural purposes (Chang, Clement,

Simpson, & Lee, 2011). Concurrently, changes in hydrological conditions, notably shifts in precipitation patterns, can result in the loss and deterioration of wetlands (Adler et al., 2018). These transformations affect waterfowl habitat, biodiversity, and the wetlands' capacity to mitigate pollutants (Adler et al., 2018; Zunaira et al., 2020). Heightened rainfall events may also escalate soil erosion within watersheds, culminating in increased sediment loads in rivers and lakes. This sedimentation process can lead to diminished water quality, harm aquatic ecosystems, and hinder navigation (Boix-Fayos et al., 2007; Fang et al., 2012).

3.3.10 No administrative jurisdiction for wetland management

Ineffective administrative jurisdiction inover wetland management can result in the degradation and loss diminishment and deterioration of various aquatic ecosystems, encompassing wetlands, rivers, lakes, and ponds (Lynch et al., 2016). Suboptimal governance and administrative supervision can give rise to a range of issues that detrimentally affect these wetlands. In the absence of clearly defined administrative authority and regulatory measures, wetlands may be excessively exploited for purposes like agriculture, industrial utilization, and urban development. This overuse of water resources can lead to wetland depletion and, in some instances, complete desiccation. The absence of administrative oversight can also foster encroachment and habitat destruction within wetland areas (Ramachandra T.V, Aithal, & Kumaret al., 2012). Processes such as urbanization, land development, and agricultural expansion may cause wetland drainage or filling, resulting in reductions in their size and ecological significance (LiYangfan et al., 2013). Insufficient enforcement of regulations pertaining to wetland preservation and water resource management can facilitate illicit activities, including land encroachment, unauthorized construction, and deforestation within and in the vicinity of wetland areas(Lynch et al., 2016; Ramachandra T.V et al., 2012).

4. Conclusion

This study presents a thorough examination of wetland dynamics within the Chattogram Development Authority (CDA) area spanning from 2000 to 2022, employing a multifaceted approach encompassing field surveys, remote sensing analysis, and a comprehensive literature review. The insights gained shed light on the evolving landscape of wetlands and the contributing factors to their alarming decline in this urban setting. The findings of this study reveal a concerning trend of wetland loss in the CDA area, with a drastic reduction from 14.82% of the total area in 2010 to only 6.77% in 2022. This loss is primarily attributed to diverse anthropogenic activities, including urban expansion, land reclamation for agricultural purposes, unplanned industrial and urban waste disposal, illegal land encroachment, and inadequately planned infrastructure development. Moreover, shifts in hydrological patterns induced by climate change and unregulated hill cutting have significantly compounded the degradation of these vital ecosystems.. Wetlands, serving as crucial contributors to ecological

balance, offer indispensable services such as water purification, flood regulation, and support for biodiversity. The diminishing extent of wetlands poses substantial threats to the local environment, escalating the risk of flooding and adversely affecting aquatic ecosystems.

In light of these challenges, effective wetland management strategies are imperative for the CDA area. This necessitates a comprehensive approach encompassing enhanced urban planning, sustainable land use practices, and robust regulatory measures to prevent illegal encroachment. Additionally, there is a pressing need for concerted efforts to raise awareness about the ecological significance of wetlands and their pivotal role in climate change mitigation. In conclusion, this study unequivocally underscores the urgent call for proactive measures to conserve and restore wetlands in the CDA area. These actions are not merely essential for local ecosystems but are also vital for the well-being and resilience of the communities reliant on these wetlands. The key messages for policymakers should center on these critical imperatives, emphasizing the urgency of safeguarding these invaluable ecosystems for the long-term sustainability of the region's environment and water resources.

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Annexure

List of wetlands in CDA

Types of Wetlands	Names of Wetlands	Types of Wetlands	Names of Wetlands
River	Karnaphuli Halda Sangu	Canal	Nizam Market Khal, Pabtoli Khal, 15no Ghat Airport Khal, Gupta Khal, Mirza Khal, Domkhali Khal, Joramtal Khal, Tripura Khal, Shitol Jorna Khal, Bor Digir Par Khal, Noa Khal, Jugir Khola Khal, Uttara Khal, Shoraichari Khal, Baizza Khal, Forest Khal, Soltgola Khal, Krishna Khal, Quaish Khal, Rajakhali Khal, Chagolnaiya Khal, Hijra Khal, Kumira Khal, Hizra Khal Part, Birza Khal Part, Unknown Khal, Bhatiyari, Chaktai Khal, Firingi Bajar Khal, Moriom Bibi Khal, Kola Bagicha Khal, Tek Para Khal, Mukundia Khal, Saikat Khal, Sadarghat Khal, Mogoltali Khal, Gaina Chara Khal, Mohesh Khal, Azob Bahar Khal, Chatteshwari Khal, 2No Ghate Khal, Bamon Shai Khal, Khandakia Khal, Chandrabil Khal, Rubi Cement Factory Khal, Mahesh Khal, Kumar Khal, Nasir Khal, Kattoli Khal, Kalir Chora Khal, Damoir Khal, Jamal Khal Khal, Sonaichari Khal, Madan Hart Khal, Khadem Para Khal, Dhamair Khal, Bhatiyari Khal, Sadarghaat Khal, Dunar Khal, Madari Khal, Parki Khal
Lake	Foy's Lake Vatiari Lake Korean EPZ Lake Sonaichari Lake (AKSML)	Coastal Wetland	Mangrove Forests and Salt Marshes
		Estuary	Karnaphuli Sangu
		Ponds	Approximately 32,352

Section

2

Wetlands Viewed through Socio-economic, Political and Environmental lens

Chapter 6

Political Economy of Wetland Protection in Dhaka

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1. Introduction

Dhaka once had an extensive network of rivers, lakes, canals, and waterbodies and was known as the "Venice of the East". Due to unplanned urbanization and development, unregulated industrialization and waste dumping, Dhaka's wetlands are now biologically dead (Larbi, 2022; Reuters, 2023). From 1967 to 2023, the total amount of permanent water bodies in Dhaka decreased from 20,686 hectares to 428 hectares (Habib et al., 2020; Islam, 2023; Islam et al., 2012; Karim, 2014; Tahsina & Esraz-Ul-Zannat, 2023). Dhaka experienced a reduction of around 75% of its wetlands over the past four decades (Dhaka Tribune, 2020a; Roy, 2018). Mismanagement of waterbodies significantly contributes to Dhaka's current ranking as the seventh least livable city in the world (Qayyum & Shawky, 2021; *The Daily Star*, 2023).

Wetlands are critical environmental components with immense ecological, economic, and socio-cultural importance (Abbas, 2010; Islam et al., 2010; TNH, 2012). It offers diverse benefits, including flood control, livelihood opportunities, food resources, rich biodiversity, recreational spaces, groundwater aquifers recharge and so on (Abbas, 2010; TNH, 2012). According

to the Bangladesh Water Act (2013), "Wetland means any land where water remains at the level of surface or close to it and which inundates with shallow water from time to time, and where grows such plants that may usually grow and survive in marshland" (Ministry of Law, Justice and Parliamentary Affairs, 2013, p. 2).

Wetlands can be viewed as a capital mainly encroached upon for economic purposes and are therefore always under serious threat (Sujauddin, 2020). As urban waterbodies are relatively inexpensive spaces, politicians, businessmen, and locals sometimes use these spaces for capital accumulation and profit maximization (Sujauddin, 2020). Despite having several rules and laws to protect wetlands, these spaces are steadily being encroached upon by earth filling and building structures on it. This indicates that existing rules are either not implemented, are weakly enforced, or have loopholes, and thus are ineffective in saving wetlands. Moreover, Dhaka's present wetlands' status reveals that industrial pollution and the actions of several public and private organizations and individuals pose significant threats to these spaces. Thus, in the case of Dhaka, it is necessary to understand how various political and economic processes influence wetland encroachment to protect these spaces.

Political economy theory has a close relationship with space, which helps to understand the distribution of power, capital, profits, and the influence of economic, political, and institutional factors in a particular sector (Haque, 2012; Jones & Carabine, 2013; Reis, 2015; Wan & Bramwell, 2015). It is a multidimensional theory that examines interrelationships between economic structure, political environment, and relevant public and private institutions in a particular country or sector (Bayliss et al., 2011; Hooks & Crookston, 2013; Kenton, 2022).

This chapter develops a theoretical base on wetland protection issues in Dhaka from political economy perspectives and examines the interplay of political, economic and institutional factors in protecting Dhaka's wetlands.

2. Methodology

2.1 Data Collection

Data for this chapter were collected from secondary sources. An extensive literature review was conducted to develop a theoretical base on Dhaka's wetland protection issues and to understand the influencing factors from political economy perspectives. A total of 210 pieces of literature were primarily obtained from reliable online sources. After excluding duplicate and irrelevant literature that did not meet the research objectives, 82 pieces of literature, including book chapters, news articles, journal articles, conference papers, theses, reports, documentaries, and policy documents, were selected for analysis. Except for the policy documents, all the selected literatures were published between 2008 and 2023.

2.2 Political Economy Analysis (PEA)

Political economy analysis (PEA) is the application of political economy theory that examines the interests and influences of

various stakeholders, formal and informal structures and processes, visible and hidden political, economic, and institutional factors regarding any problem, sector, or country (Kern et al., 2016; Mause, 2019; SDC, 2021). PEA adds new dimensions toward the improvement of any particular sector considering the prevalent economic structure, political environment, power dynamics, and institutional frameworks (Kooy & Harris, 2012; SDC, 2021). Defining wetlands as a sector of interest, sector-level components of political economy analysis were chosen for this study (Figure 6.1). The collected text data were extracted from the sources, and several broad themes were further identified and briefly explained using thematic analysis techniques.

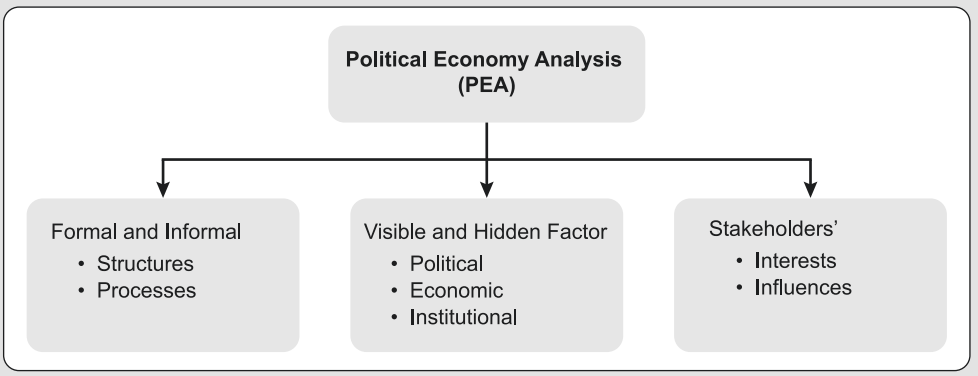

Figure 6.1: Components of political economy analysis used in this study

Source: Authors' construction from Kern et al., 2016; Mause, 2019; SDC, 2021

3. Results and Discussion

3.1 Major Wetland Encroachers and Their Motives for Encroachment

The majority of prior studies revealed that wetland encroachers mostly belong to some specific groups including real estate developers, public and private entities, local influential people and political leaders (Abdullah-Al-Faisal et al., 2019; Ahamad, 2020; Arifeen & Faisal, 2018; Azaz, 2023; Bangladesh Post, 2020; Chokdar, 2023; *Dhaka Tribune*, 2020b; Hossain, 2017; Islam, 2012; Islam, 2023; Jamuna TV, 2023; Kamol, 2020; Maasranga TV, 2024; Mahmud, 2017; Mamun, 2023; Mamun, 2018; New Age, 2023; *NEWS24*, 2017; Rakib, 2020; Roy, 2018; Tarannum, 2020; *The Business Post*, 2023; *The Business Standard*, 2023; *The Financial Express*, 2019). Wetlands are continuously being filled to develop housing, roads, factories and offices in the name of development (Abdullah-Al-Faisal et al., 2019; Arifeen & Faisal, 2018; *Dhaka Tribune*, 2020a; Hossain, 2017; Islam, 2023; Jahan, 2023; Kamol, 2020; Maasranga TV, 2024; *The Financial Express*, 2019; Ullah, 2017).

Figure 6.2: Major wetland encroachers found in the reviewed literature

Source: Authors' construction from prior studies, 2023

Figure 6.3: Purposes for wetland encroachment found in the reviewed literature

Source: Authors' construction from prior studies, 2023

Common wetland encroachers and their purposes for encroachment are depicted using two bubble charts where the circle size indicates the frequency of appearance of a particular word in the reviewed literature (Figures 6.2 & 6.3). Purpose-wise wetland encroachment and its encroachers are described in the subsequent sections.

3.1.1 Residential Purpose

Over 50% of Dhaka's wetlands have been lost due to several housing projects (The Business Post, 2023). Multi-storied residential buildings, slums, tin-shed houses, and thatched houses are some common ways of grabbing wetlands by real estate developers, public entities, local influential people and political leaders.

Real estate developers are mainly responsible for filling waterbodies, lowlands, and flood flow zones to develop lucrative housing for the elite class, such as model towns and high-class cities (Abdullah-Al-Faisal et al., 2019; Akhter, 2019; Hossain, 2017; Ishtiaque et al., 2014). They are mainly concerned about monetary profit and thus always search for cheap lands such as wetlands and open spaces. They disregard rules and regulations and jeopardize public interest to fulfil their profit-making motives. Some examples of grabbing wetlands by developers include Modhumoti Model Town, Chandrima Model Town, Silicon City, Zemcon City, Ashiyan City, Millennium City, The Babylon City, Dhaka Uddan Housing, Mohammadpur Housing, Bashundhara Housing, Mohammadia Housing, Pratyasha Housing, Aftabnagar Housing, Nabinagar Housing, and so on (Abdullah-Al-Faisal et al., 2019; Ahamad, 2020; Bangladesh Post,

2020; *Dhaka Tribune*, 2020a; Hossain, 2017; Mowla, 2011, 2014; Nature and Life, 2018; *The Financial Express*, 2019). Along with real estate developers, government agencies are also developing residential structures on wetlands. For instance, RAJUK, one of the responsible authorities for wetland protection, filled waterbodies for housing plots in Purbachal, violating the existing rules (Datta, 2020; Islam, 2023; Mowla, 2011; *The Business Standard*, 2023). Even a higher official of RAJUK facilitated several housing projects encroaching wetlands in Keraniganj (Maasranga TV, 2024).

Another government organization, the Civil Aviation Authority of Bangladesh (CAAB), filled a water body in Ashkona for housing development (*Daily Industry*, 2022; *The Daily Star*, 2022a). Law enforcement agencies, such as the Bangladesh Police Officers' Samabay Samity, occupied wetlands for their housing projects as well (Ahamad, 2020).

Other private entities, including local influential people, political leaders, and samities sometimes grab wetlands for building slums and informal housing, which are eventually converted into large residential complexes (*Dhaka Tribune*, 2020a; Jamuna TV, 2023; Maasranga TV, 2024; Tarannum, 2020).

3.1.2 Commercial Purpose

Several public and private entities are encroaching upon wetlands for commercial purposes. Permanent and temporary shops, industries, garments, energy plants, local markets, restaurants, hotels, brick kilns, amusement parks, and truck stands are some common establishments constructed by public and private entities on wetlands for economic benefits (Bangladesh Post, 2020; *Daily Industry*, 2022; *Dhaka Tribune*, 2020a; Ishtiaque et al., 2014; Jahan, 2023; Jamuna TV, 2023; Mamun, 2018; *NEWS24*, 2017; Rakib, 2020; Sujauddin, 2020; Tarannum, 2020). In the guise of development, EPZs and power plants are being developed along the riverbanks (Azaz, 2023; Chowdhury, 2023; Rahman et al., 2010). Influential locals and political leaders sometimes accept bribes and help the encroachers construct illegal commercial structures on wetlands (*NEWS24*, 2017).

Some of the wetlands that were encroached upon for commercial purposes include Adi Buriganga Channel, Tongi Khal, Begunbari Khal, Diabari Khal, Dwigun Khal, Bhatara Canal, Boalia Canal, Sutibhola Canal, Ramchandrapur Canal, Dumni canal, Kantasur canal (Bangladesh Post, 2020; Kamol, 2020; Rakib, 2020).

3.1.3 Development and Public Interest

Despite having several strong plans, policies and laws, wetlands protection projects were never a top priority for any of the governments in Bangladesh (Islam, 2019; Roy, 2023; *The Daily Star*, 2016). Instead, wetlands are continuously filled to construct roads, box culverts, embankments, pump stations, waste disposal sites, and power plants in the name of serving the public interest (Kamol, 2020; TRT World, 2023).

Approximately four to five large reservoirs were filled for the Dhaka Airport Third Terminal construction project, one of the priority projects of the ruling government (*Daily Industry*, 2022). Even some parts of the Hatirjheel water body are being filled without permission to construct another priority

project, the Dhaka Elevated Expressway (Rahaman, 2023). Rehabilitation projects and approach roadways to Purbachal were built by grabbing canals (Kamol, 2020). City corporations often occupy canals to construct roads, footpaths and drains (Bangladesh Post, 2020; Tarannum, 2020). Riverbanks and flood flow areas are also destroyed by BIWTA for walkway development projects (Hasan, 2021; Hossain, 2017; RDRC, 2022).

3.1.4 Religious, Educational and Administrative Purpose

One popular pattern of wetland encroachment is establishing a mosque or temple on it (Bangladesh Post, 2020; Ishtiaque et al., 2014; Kamol, 2020; Mahmud, 2017; *NEWS24*, 2017; Tarannum, 2020). The removal of these structures is very challenging due to its religious importance. Taking advantage of this opportunity, local influential people backed by political support start grabbing the entire waterbodies (Ishtiaque et al., 2014).

Educational institutions such as schools, madrasas and private universities are also found on wetlands. Some portions of Begunbari Khal, Diabari Khal, Bhatara Khal, Ramchandrapur Khal, and Kantasur canals have been encroached upon by several private universities (e.g., Uttara University, United International University, BGMEA University of Fashion Technology, University of Liberal Arts) (Bangladesh Post, 2020; *Dhaka Tribune*, 2020b; Kamol, 2020; Tarannum, 2020). In addition, wetlands are sometimes encroached on by government agencies and ruling political parties for administrative and political purposes. Prior studies found that government offices, political party offices, and ward councilor offices have grabbed some portions of the wetlands (Jamuna TV, 2023; Kamol, 2020; *NEWS24*, 2017).

3.2 Wetland Encroachment Processes

The wetland encroachment process begins with placing bamboo posts in the water channel substrate (Arifeen & Faisal, 2018). After that, the land is filled with sand, garbage, mud and pisciculture (Arifeen & Faisal, 2018; Ishtiaque et al., 2014; Rahaman, 2021; Sakib, 2022b; Tarannum, 2020). This initial step is common for all forms of wetland encroachment.

After landfilling, land grabbers sometimes manage lease agreements from the public authorities (Al Jazeera, 2022; Sakib, 2022b). In the majority of the cases, several residential, commercial, religious and educational structures, such as slums, stores, vegetable markets, truck stands, mosques, temples, and schools, were built on encroached land (Arifeen & Faisal, 2018; Ishtiaque et al., 2014; Marof, 2023; *NEWS24*, 2017; Sakib, 2022b; Tarannum, 2020). Then, after a few days, waterbodies are entirely filled, and large buildings are constructed on it (*NEWS24*, 2017; Rahaman, 2021; Rahman et al., 2010). These establishments often get legalized due to changes in land use as specified in the master plans and land records (Figure 6.4).

For instance, a large number of wetlands were converted to roads and other private uses in the City Survey/ Dhaka Mohanagar Survey (Independent TV, 2021; Jamuna TV, 2023; Maasranga TV, 2022). Some canals or parts of canals in Dhaka where unlawful establishments were legalized in this survey were the Shyampur Canal, Paribagh Canal,

Ramchandrapur Canal, Rajabazar Canal, and so on (Independent TV, 2021; Jamuna TV, 2023). Even in the case of national interest, the government cannot change the classification of these critical lands. However, the government did not take any permission to legalize these wetland encroachments (Jamuna TV, 2023). As a result, several public lands have been converted to private ownership, and a legal procedure is now required to recover these wetlands.

Moreover, the new DAP has introduced around 70% of changes in order to legalize landfilling on waterbodies (The Business Standard, 2022). It has allowed the construction of structures on flood flow regions and water retention areas (Habib et al., 2022; *The Daily Star*, 2022b, 2024). Figure 6.5 shows the discrepancies in proposed waterbodies between DAP 2010 and 2022. A large number of water bodies and water retention areas have been designated as residential, industrial, and mixed-use zones in Dhaka City, Gazipur, Narayanganj, Savar and Keraniganj.

Some common reasons for granting permission to change the use of waterbodies in the proposed DAP are: to reduce housing crises, there has been no incident of waterlogging or flooding in the past 15 years, the plot designated as a wetland has been filled with sand and multiple buildings have been constructed or are currently under construction (Ministerial Committee for DAP Review, 2014a, 2014b). In some cases, permission for wetland conversion has been given under certain conditions, including conservation and retrieval of water bodies and foreshore, and maintenance of canal connectivity and width.

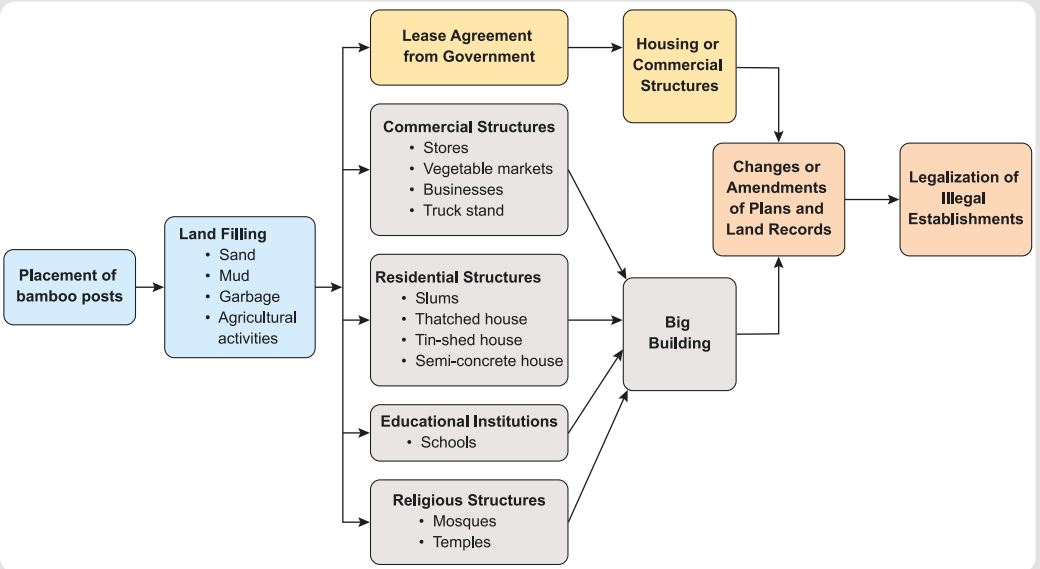

Figure 6.4: From illegal establishments to legal structures on wetlands

Source: Authors' construction from prior studies, 2023

Moreover, privately owned water bodies, up to 20 Kathas, that are not connected to the existing water flow network were excluded from the category of water bodies identified in DAP in the meeting of the Ministerial Committee (Ministerial Committee for DAP Review, 2014a, 2014b). According to the Town Improvement Act 1959, the inter-ministerial committee cannot amend the DAP. Still, they allowed housing projects, industries and commercial activities in wetlands (Hossain, 2020). This type of legalization of wetland encroachment in development plans is not a new scenario in the case of Dhaka. A study by Akther and Islam (2020) shows that the previous DAP 2010 also violated the policies of the Structure Plan 1995-2015 and the Waterbody Conservation Act 2000 and permitted the conversion of flood flow zones and water retention areas into built-up areas, particularly residential areas. Thus, it is evident from Figure 6.5 and prior research that the legalization of wetland encroachment to protect the interests of the rich and powerful is a common phenomenon for Dhaka.

3.3 Wetland Protection - Irregular Responses and Blame Game

In Bangladesh, wetland protection activities are mostly limited to preparing plans, undertaking large projects, and listing the identities of land grabbers (Kamol, 2020; Limon, 2020). Most organizations do not take strong, consistent measures to evict illegal wetland encroachers (*The Financial Express*, 2021). This critical issue cannot be permanently resolved by occasional efforts (Saif, 2023; *The Financial Express*, 2021). Even instructions from the highest authority of the government could not ensure the enforcement of law to protect the wetlands (Ahmed, 2023; USA Reporter, 2018; Sakib, 2021). Lack of accountability and negligence in completing duties also hinder wetlands conservation (Bangladesh Post, 2023; Jahan et al., 2008; Rahman et al., 2010). In addition, lack of cooperation and coordination among public agencies is one of the major problems in wetland protection (Hossain et al., 2014; Rahman et al., 2010; Sakib, 2022a). Though encroachers are highly organized, law implementers are not organized at all. RAJUK, City Corporations, BWDB, local governments, BIWTA, Department of Environment, DC office, DWASA, Ministry of Local Government, Rural Development and Co-operatives, Ministry of Land, Ministry of Environment, Forest and Climate Change, and Planning Commission, all are liable for wetland protection activities in Bangladesh. Instead of cooperating, these organizations often blame each other for the destruction of wetlands. For example, without approval from RAJUK, waterbodies were filled out for the construction of Dhaka Elevated Expressway Projects (Rahaman, 2023). It is interesting to note that the Department of Environment thinks RAJUK could approve it for the public interest (Rahaman, 2023). Similarly, DWASA blames DoE and City corporations for poor management of industrial and municipal wastes (Saha, 2021). City corporation again blames DWASA for water pollution as they are responsible for wastewater management in Dhaka (Limon, 2020). On the other hand, city corporations and NHA blame RAJUK for approving buildings without proper sewage treatment systems and grabbing wetlands for approach roads (Kamol, 2020; Saha, 2021).

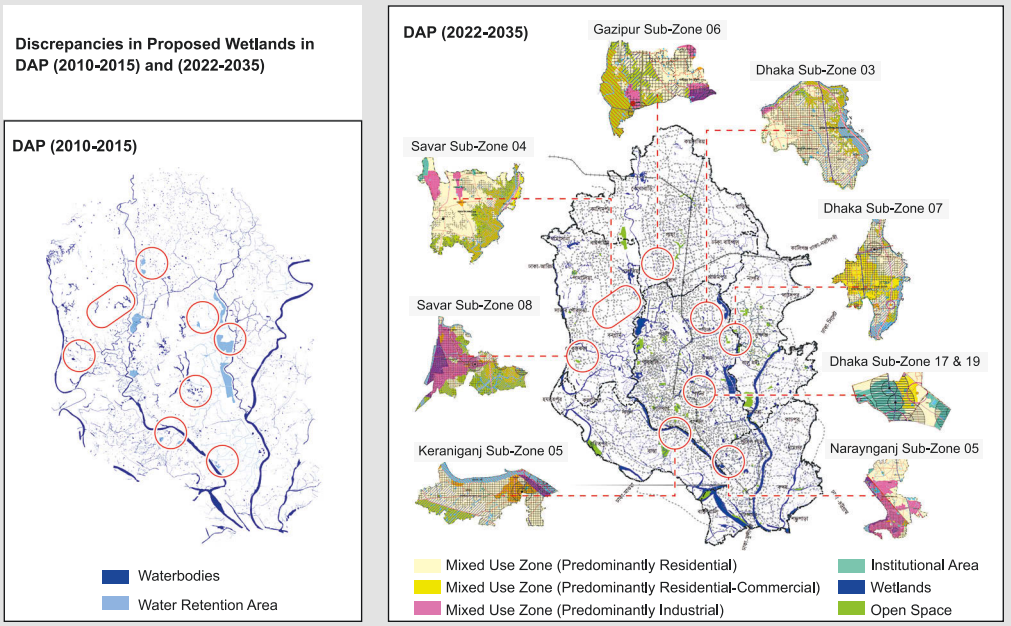

Figure 6.5: Discrepancies in proposed waterbodies and water retention areas in DAP 2010 and 2022

Source: Authors' construction from DAP 2010 and 2022

3.4 Loopholes in Rules and Regulations

In the case of wetland protection policies and regulations, Bangladesh has a strong policy framework, but unfortunately, these are only limited to papers (Arifeen & Faisal, 2018; Hossain, 2017; Jahan et al., 2008; Marof, 2023; TRT World, 2023). According to the Detailed Area Plan 2022-2035 and Waterbody Conservation Act 2000, no water bodies can be filled or utilized for other uses (Figure 6.6). Moreover, Bangladesh government declared rivers and wetlands as Ecologically Critical Areas and restricted all activities that degrade rivers and environment (MoEF, 2009; MoEFCC, 1997). In addition, the honourable high court declared wetlands, particularly all rivers, as living entities (Jahan, 2023; Majumder & Tahsin, 2019; Titumir, 2021). Bangladesh environmental laws also mandate that all industrial entities must use effluent treatment plants (MoEFCC, 1997).

However, the Environment Conservation (Amendment) Act 2010 provided a loophole, allowing restrictions on waterbodies to be relaxed for national interest (Figure 6.6). This provision contradicts other regulatory frameworks and should not be allowed. Moreover, the penalties for violating the Waterbody Conservation Act are very minimal, which is imprisonment for up to five years or, a fine of up to fifty thousand takas, or both. For wealthy, influential people and big industries, fifty thousand taka is not a problem at all. These laws are not strictly implemented, so people do not fear breaking those (Arifeen & Faisal, 2018; Hossain et al., 2014). Thus, filling waterbodies for housing and industries has become a common scenario in Dhaka (Islam, 2023).

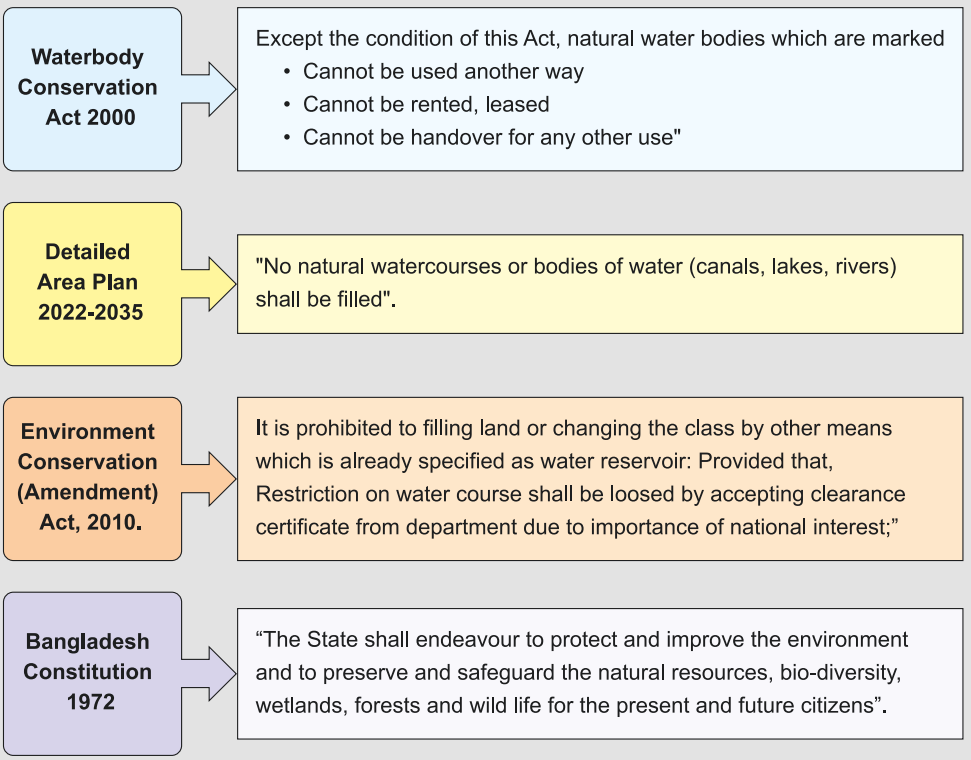

Figure 6.6: Wetland protection-related clauses in regulatory frameworks

Source: Authors' construction, 2023

3.5 Misuse of Power in Wetland Encroachment

Wealthy individuals and political personnel with good connections with ruling governments often encroach on wetlands for personal gain (Shemul, 2023; TRT World, 2023). Even the authorities sometimes ignore their duties and turn a blind eye to these acts of powerful people. For instance, BIWTA unduly constructed demarcation pillars in Buriganaga to save illegal projects of a previous ruling party MP who filled 54 acres of foreshore and flood flow zone (Kamol, 2021; *The Daily Star*, 2021). BIWTA transferred one of their officers who tried to demolish unauthorized structures (Kamol, 2021). Thus, power abuse and coordinated corruption of government agencies and influential are evident.

Using the power of a public agency, Dhaka City Corporation developed a garbage dumping depot in a flood flow zone in 2005 (Devnath, 2020; Hasan, 2020). They did not have any clearance certificate for dumping waste on this site (Hasan, 2020). Moreover, DNCC plans to develop a waste-to-energy plant on this site (Hasan, 2020; Mamun, 2021). Thus, in some cases, government agencies use their powers to breach regulations and avoid EIA and other regulatory measures. With the change of the

ruling party, the political personnel involved in wetland encroachment might change. However, the development of illegal housing projects destroying wetlands by other political parties and real estate developers continues (Maasranga TV, 2024).

Not only as an organization, but sometimes government personnel use their positional status to encroach upon waterbodies with the assistance of other public agencies. For instance, the Chief Engineer of WASA used his influence to convince the city corporation to construct a road in front of his residence, grabbing the Kallyanpur canal (Rakib, 2020). Likewise, some corrupt government employees receive money from the encroachers and assist them in these illegal land-grabbing activities (Alam, 2014; Khan, 2021).

In the case of private real estate developers, they are mostly big business entities and very organized. They use their economic powers and influence the decision-making process at national and local levels (Jahan et al., 2008). If any action is taken against them, they issue a writ and construct structures on the wetlands again (Marof, 2023; *NEWS24*, 2017; Sujauddin, 2020). Though local people suffer the most from the effects of wetland encroachment due to ignorance or lack of power, they cannot take any action (Sujauddin, 2020).

4. Conclusion

Wetlands are invaluable components that provide immense social, economic, and environmental benefits. However, these crucial spaces are being converted rapidly only for capital accumulation and profit maximization. This chapter provided a brief overview of wetland protection issues in Dhaka from political economy perspectives and discussed the interplay of several political, economic, and institutional factors in this regard.

The study revealed that the major encroachers of Dhaka's wetlands are real estate developers, public and private entities, local influential people and political leaders. Wetlands are mostly grabbed for residential and commercial purposes. In the guise of serving the public interest, wetlands are being filled for large-scale infrastructure projects such as roads, walkways, terminals, expressways, and economic zones. Government agencies disregard regulations in the case of encroaching wetlands for infrastructural development, using the greater public interest as justification. Power misuse and coordinated involvement of government agencies and influential individuals are observed to save illegal projects from demolition. Legalization of encroached wetlands in development plans is another critical issue which directly contradicts the Waterbody Conservation Act by allowing wetland conversion under certain conditions.

Most wetland protection activities are limited to plans, projects, regulations, and occasional demolition efforts. Though negligence is observed among all the responsible authorities, they always blame each other for the current condition of the wetlands. Among all issues, the most critical is the contradiction between regulatory frameworks, where one law prohibits all conversions while the other law loosens the restriction for the public interest. In conclusion, the factors that influence wetland encroachment are monetary

interest, misuse of political and economic power, loopholes in regulatory frameworks, inappropriate approaches to development, blame games among responsible agencies, and occasional and project-based initiatives for wetland protection.

Strong actions and political wills are required to prevent the influential encroachers. Punishment for wetland encroachment should be increased than the penalties specified in the law enacted in 2000. Modification of law should be ensured, and enforcement must be guaranteed regardless of encroachers' socio-political identity. Contradictions among regulatory frameworks must be addressed immediately. The responsible agencies should establish a separate wing to monitor wetlands protection activities and identify the encroachers. In addition, they must increase monitoring at the local level. Demolition of illegal structures on wetlands should be done immediately. Participation and empowerment of local people and community-based organizations can help in protecting and monitoring activities. Under the detailed area plan, area-specific action plans are required to determine the responsibility of stakeholders.

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Chapter 7

Hydrological Connectivity for Sustainable Urban Wetland Management

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1. Dhaka City – A Web of Rivers, Wetlands and Canals

Dhaka City, the bustling capital of Bangladesh, used to be intricately woven into a captivating tapestry of rivers, wetlands, and canals. Situated along the banks of the Buriganga River, its urban landscape was uniquely shaped by these interconnected waterways. The city's topography, characterized by a network of rivers and numerous wetlands, not only formed its geographical identity but also played a pivotal role in shaping its cultural and economic essence. This aquatic network, including canals crisscrossing the urban fabric, added to the city's natural charm. However, rapid, unplanned urbanization has severely disrupted Dhaka's hydrological connectivity, resulting in significant challenges for its residents. Despite these challenges, the existing water bodies present both opportunities and obstacles for sustainable urban development and environmental stewardship.

This disruption is particularly evident when examining Dhaka's surrounding hydrological system. Dhaka is encircled by four major rivers: the Tongi Khal to the north, the Buriganga River to the south, the Balu River to the east, and the Turag River to the west (Swapan et al., 2017). These rivers

are part of the Ganges-Brahmaputra River system, locally referred to as the Padma-Meghna-Jamuna system, which also includes the Old Brahmaputra River. The Buriganga, primarily fed by the Turag River, derives its water from local rainfall and overflows from the Jamuna River. The Lakhya River drains a significant catchment area between the central forested regions and the Old Brahmaputra, while the Balu River drains a smaller catchment area west of the Lakhya. During the dry season, the Dhaleswari-Buriganga-Lakhya-Balu river system, shown in Figure 7.1, becomes tidal due to minimal upstream inflows (RAJUK, 2015).

Again, Dhaka also features numerous lakes, channels, and khals connected to these rivers. The city's low-lying areas, canals, lakes, and ponds function as natural retention basins, playing a vital role in stormwater drainage (Figure 7.2A and 7.2B). Stormwater accumulates in these lowlands and flows through storm channels, known as khals, before being discharged into surrounding rivers. These wetlands historically stored stormwater, safeguarding higher land from rainfall-induced flooding (Halder & Majed, 2023). However, the drainage system's efficiency is heavily influenced by the water levels of the surrounding rivers, which remain high during the monsoon season. Consequently, the backwater effect from these rivers frequently causes flooding in Dhaka (RAJUK, 2015).

The city area is divided into Dhaka West and Dhaka East. Dhaka West contains 13 canals spanning over 31 kilometers, while Dhaka East has 27 canals totaling approximately 60 kilometers, which drain approximately 80% of its stormwater into nearby rivers (Mowla & Islam, 2013).

However, due to unplanned urbanization and encroachment, this number has dwindled to 26, with many in poor condition (Islam, 2024). The major Khal systems include:

- Degun-Ibrahimpur-Kallyanpur Khal System, draining into the Turag River;
- Dhanmondi-Paribagh-Gulshan-Banani-Mohakhali-Begunbari Khal System, draining into the Balu River;
- Segunbagicha-Gerani-Dholai Khal System, draining into the Balu and Buriganga rivers (J. U. Chowdhury et al., 1998).

The city's once-effective natural drainage network has been severely compromised by urban expansion and encroachment. The conversion of permeable surfaces into concrete structures has diminished the land's capacity to absorb and retain water, leading to increased surface runoff. The destruction of wetlands and retention areas further exacerbates this issue, as these natural buffers are critical for reducing flood risks. Dhaka's tropical monsoon climate, characterized by an average annual rainfall of 2,000 mm, compounds the problem. During intense rainfall events, the weakened hydrological connectivity results in overwhelmed drainage systems, frequent flooding of low-lying areas, and heightened vulnerability to urban inundation.

In response to these challenges, the Government of Bangladesh has constructed various flood control structures. Nevertheless, restoring Dhaka's hydrological connectivity remains a pressing concern for ensuring sustainable urban development and resilience against climate-related risks.

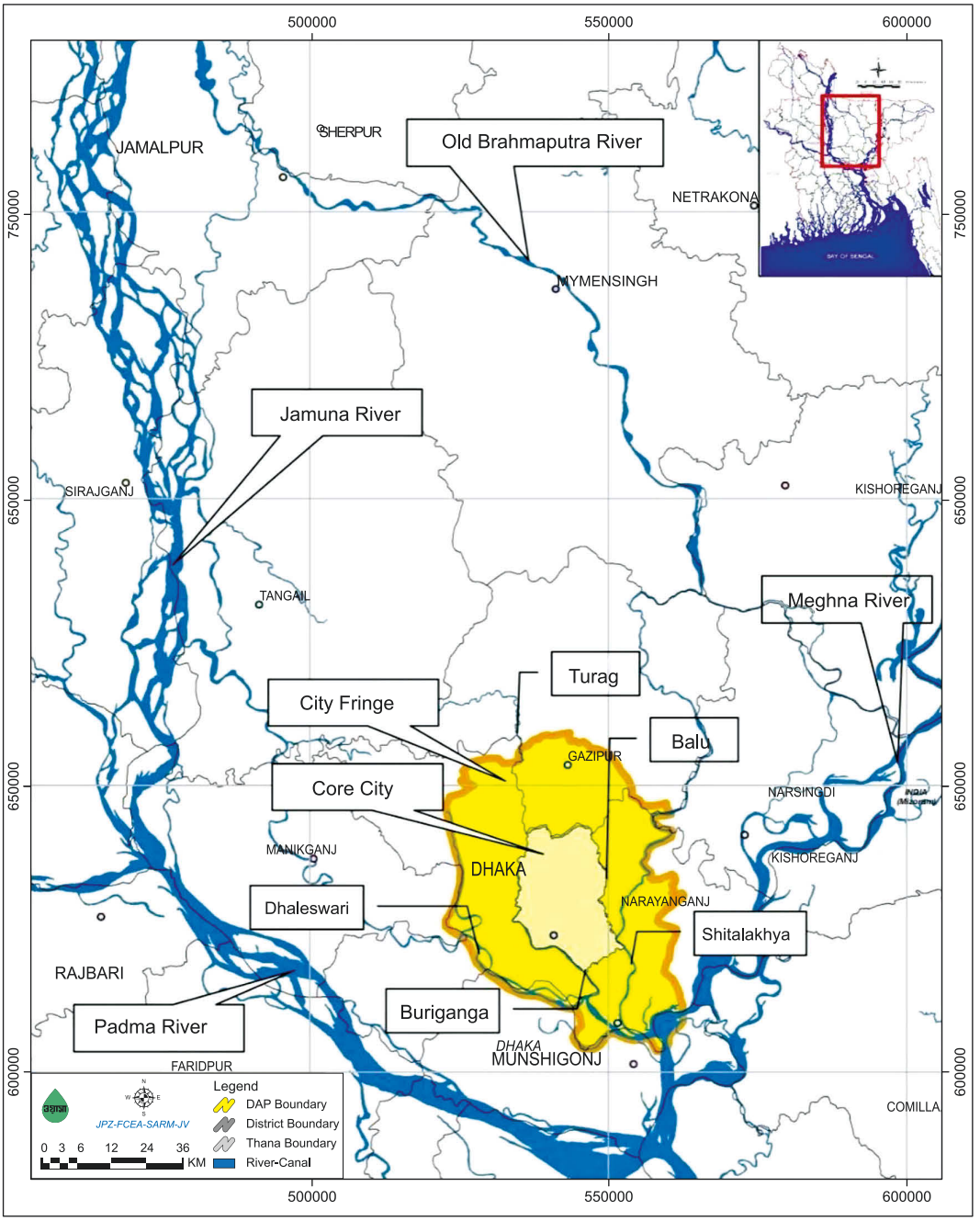


Figure 7.1: Dhaka City surrounded by major rivers, adopted from (DWASA, 2016)

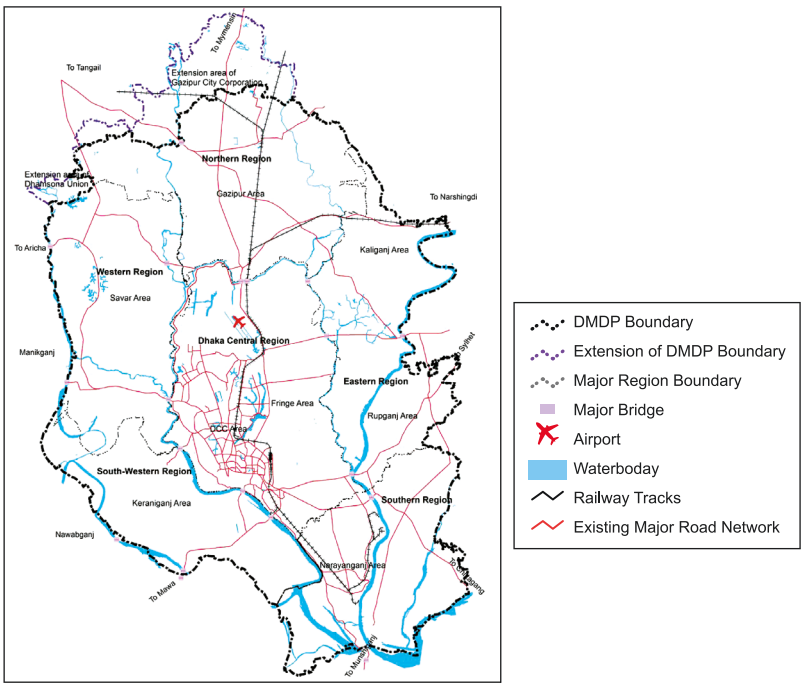


Figure 7.2A: Dhaka City crisscrossed with waterbodies (Khals, lakes, channels), adopted from (RAJUK, 2015)

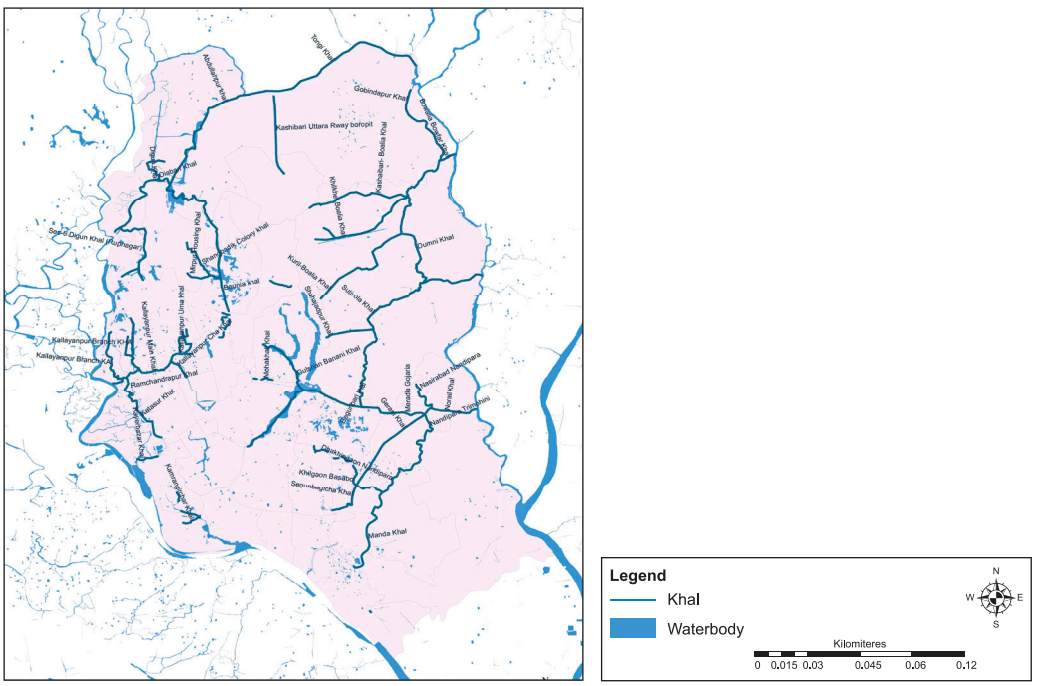


Figure 7.2B: Khals in Core City Area of Dhaka, adopted from (DWASA, 2016)

2. Raising Flood Control Works-Interruption of Connectivity with Rivers

The development of flood control infrastructure in Dhaka City has inadvertently disrupted its natural hydrological connectivity with surrounding rivers. Rapid and unplanned urbanization has driven the need for flood protection measures, but these interventions often come at the cost of the city's intricate aquatic network. Dhaka has a long history of flooding, with significant events recorded since 1954. The catastrophic flood of 1988, which submerged central areas of the city and paralyzed essential services, acted as a catalyst for extensive flood risk management initiatives at the national level (Fatemi et al., 2020). Given its critical importance, Dhaka became a primary focus for flood protection, leading to the construction of embankments, raised roads, and other structural measures to shield the city from riverine floods (Bala et al., 2009).

Key flood control structures were introduced after the 1988 flood, including approximately 30 kilometers of earthen embankments along the Tongi Khal, Turag, and Buriganga rivers. Additionally, 37 kilometers of raised roads and floodwalls were strategically built in densely populated areas, particularly in Old Dhaka, where further infrastructure development is constrained by existing urban layouts. These structures also include regulators and sluice gates designed to control water flow between the city's khals and the surrounding rivers, alongside pumping stations to manage rainfall-induced drainage within protected zones (Bala et al., 2009; JICA, 1991). The Greater Dhaka Flood Protection Project (FAP 8A), which focused on the eastern region, and the Dhaka Integrated Flood Protection Project (FAP 8B), which targeted the western region, were critical components of these flood management efforts. Both projects aimed to protect urban areas from flooding by implementing structural measures such as embankments and improved drainage systems (Das & Islam, 2010; JICA, 1991)

While these measures have provided effective flood protection for areas like Dhaka West, they have simultaneously severed vital hydrological linkages between the rivers and the city's internal water bodies. Embankments and floodwalls act as barriers, restricting the natural flow of water and sediment between rivers and wetlands, which play a crucial role in flood mitigation and ecological balance. The installation of regulators and sluice gates has further limited the natural exchange of water, while the reliance on pumping stations underscores the artificial nature of current drainage systems.

This disruption to hydrological connectivity has led to unintended consequences. The isolation of wetlands and khals from the rivers reduces their ability to act as natural retention basins, exacerbating waterlogging during heavy rainfall and increasing surface runoff. Additionally, the decreased interaction between rivers and floodplains has had detrimental impacts on aquatic ecosystems and sediment transport, further diminishing the city's resilience to floods and other hydrological challenges.

Although the Greater Dhaka Flood Protection Project and the Dhaka Integrated Flood Protection Project were intended to enhance the city's flood resilience, their implementation has underscored the trade-offs between flood prevention and maintaining hydrological connectivity. These interventions, while effective in reducing

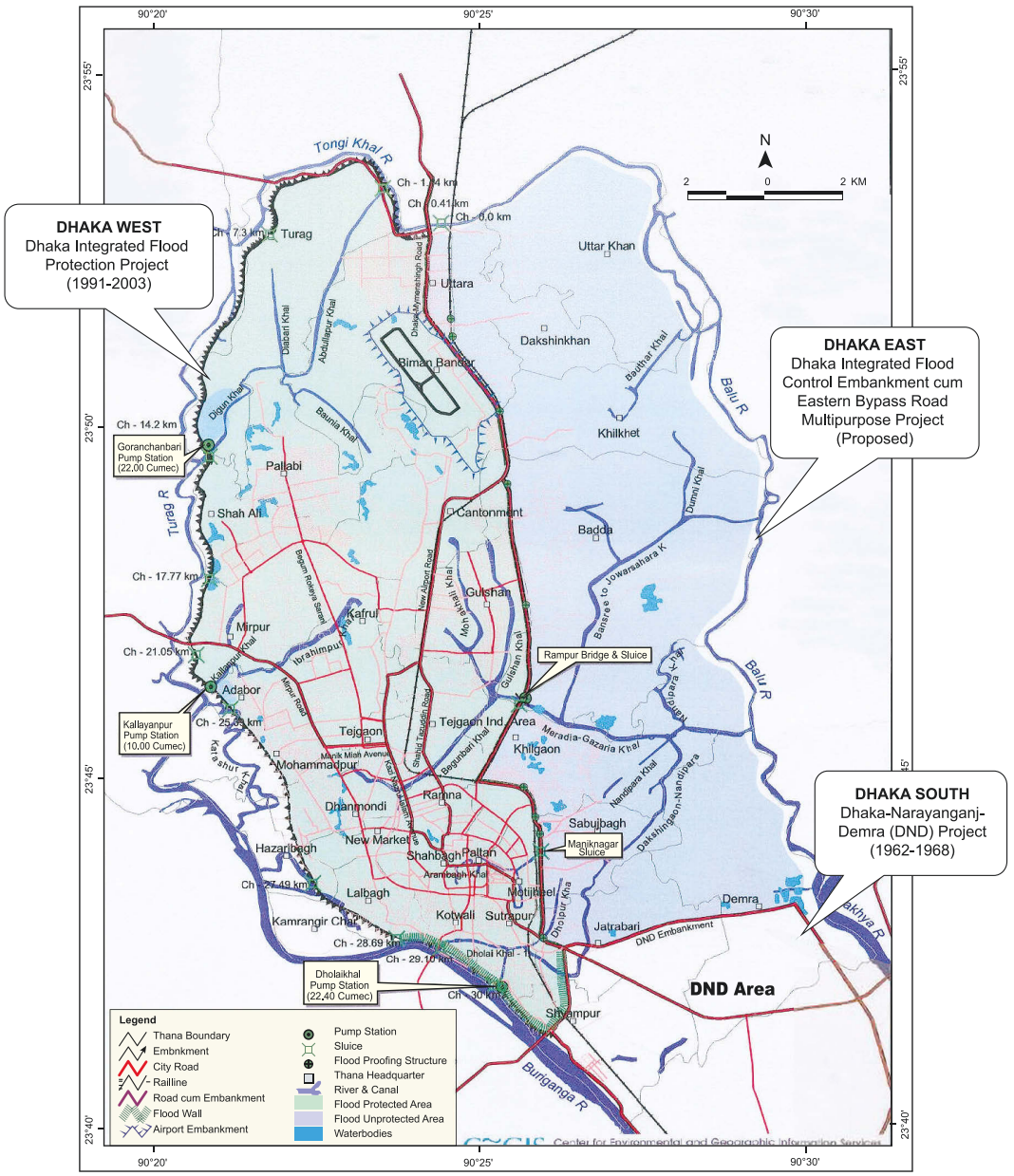


Figure 7.3: Dhaka city flood control and drainage map, adopted from (UN Habitat, 2009)

the immediate risks of riverine flooding, have created long-term vulnerabilities by interrupting the natural water flow and undermining the ecological functions of the city's rivers and wetlands.

As Dhaka continues to grow, balancing flood control measures with the restoration and preservation of its hydrological connectivity is essential. This requires a shift toward integrated water management approaches that consider the ecological and hydrological roles of rivers, wetlands, and khals while addressing the challenges posed by rapid urbanization.

3. Urbanization-loss of interconnectivity

Urbanization in Dhaka has significantly disrupted the city's hydrological connectivity, severing the natural linkages between rivers, wetlands, and groundwater systems. This disconnection, driven by rapid and unplanned urban growth, has altered the city's water systems, degraded its ecological balance, and increased vulnerability to waterlogging and flooding. Hydrological connectivity, defined as water-mediated linkages between landscape components, is critical for regulating water, nutrient, and sediment flows, as well as maintaining healthy ecosystems (Brooks et al., 2020; Covino, 2017). However, urban sprawl and the expansion of impervious surfaces have undermined this natural system, leading to severe environmental and infrastructural challenges.

3.1 Loss of Lakes and Wetlands

Figure 7.4 highlights the drastic reduction in Dhaka's lakes and water bodies between 1972 and 2020. Prominent lakes such as Uttara Park, Banani, Hatirjheel, and Dhanmondi have seen their areas shrink by 60–75%, primarily due to encroachment and landfilling for urban development (Nabila et al., 2023). For example, Uttara Lake's significant reduction mirrors the unchecked urban expansion in the northern parts of Dhaka, while the shrinking of Hatirjheel reflects similar patterns in the city's eastern areas. This loss of water bodies has exacerbated Dhaka's drainage issues, as these lakes historically served as natural retention basins that moderated stormwater runoff and reduced flooding risks.

The loss of water bodies also undermines the goals outlined in initiatives such as FAP 8B, which emphasized the importance of maintaining retention ponds and canals to mitigate flooding and sustain ecological balance (Das & Islam, 2010). Despite these recommendations, Dhaka has failed to implement adequate measures to preserve its lakes and wetlands. This failure has disrupted hydrological connectivity and led to severe consequences for flood management, water quality, and biodiversity.

3.2 Encroachment and Pollution

Dhaka's rapid and unregulated urbanization has destroyed many natural drainage systems. Encroachment on wetlands, illegal filling of water bodies, and pollution of khals and canals have exacerbated waterlogging problems. Figure 7.5 illustrates the deplorable condition of key water bodies, such as the Ramchandrapur Canal and parts of the Buriganga River, which have become dumping grounds for solid waste. Non-functional culverts and silted canals further hinder water flow, creating stagnant pools that promote mosquito breeding and increase the risk of vector-borne diseases such as dengue.

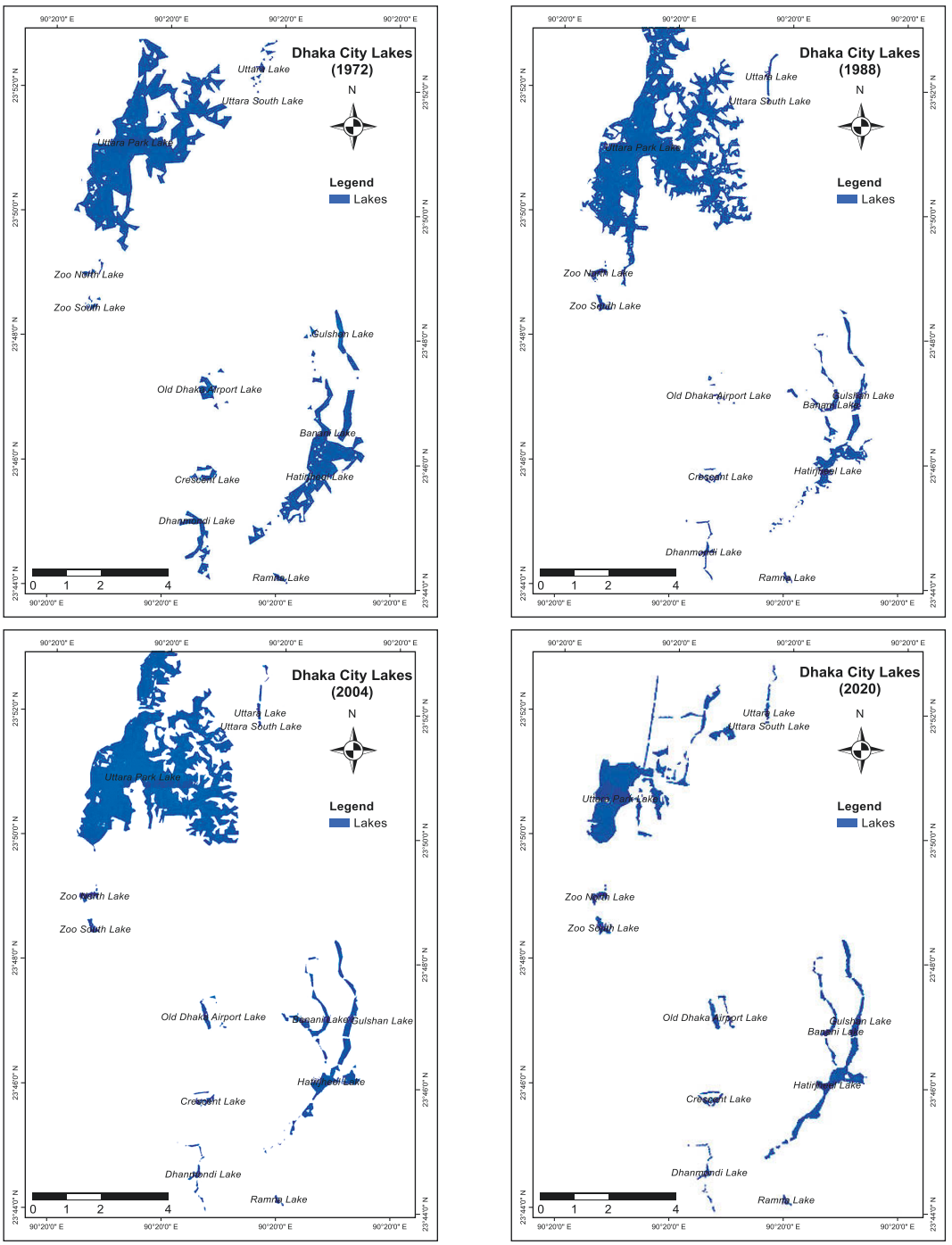


Figure 7.4: Changes of Areas in the Dhaka City Lakes from 1972 to 2020, adopted from (Nabila et al., 2023)

Figure 7.5: Dumped solid waste and sedimented Ramchandrapur Canal near Basila area (Upper right), Dumped solid waste in the old Buriganga riverside even after the dredging works (Lower right), damaged and broken culvert in Dhanmondi 32 (Left side)

3.3 Impact on Retention Ponds and Drainage

Retention ponds, critical for managing stormwater runoff, have also been significantly affected. The retention area at the Goran Chatbari pump station, though functional, has lost 40 acres due to infrastructure development (Alam, 2016). Similarly, the Dholaikhal retention area was destroyed in the 1990s to accommodate a box culvert, and the Kallyanpur retention pond is under threat from encroachment due to inadequate government intervention (Alam, 2016). These ponds, once essential for regulating water levels and mitigating flooding, are now insufficient to handle the city's drainage needs. The lack of a comprehensive storm sewer system further compounds the issue, reducing the city's water-carrying capacity and worsening drainage congestion during the rainy season.

3.4 Implications and the Need for Restoration

The diminishing lakes, wetlands, and retention ponds in Dhaka have far-reaching implications for hydrological connectivity and urban sustainability. The current waterlogging crisis, driven by the fragmentation of hydrological systems and the loss of retention areas, underscores the urgent need for comprehensive restoration efforts. Protecting the remaining water bodies and ensuring the implementation of FAP 8B's proposals for retention ponds and canals can help restore connectivity and improve the city's resilience to flooding and waterlogging.

4. Resultant Problems

The disruption of Dhaka's hydrological connectivity has exacerbated already precarious environmental conditions and heightened the city's vulnerability to flooding. Ineffective maintenance of river mouths, coupled with unchecked encroachment on designated flood flow zones, has restricted the natural drainage capacity of these areas. During the monsoon season, when river levels remain elevated, the reduced outflow capacity prevents proper drainage of the city's stormwater. As a result, urban roads and low-lying areas frequently become inundated, functioning more as open drains than functional transport routes. This situation is further aggravated when remaining vacant lands within the city's settled regions are developed without adequate hydrological considerations, thus eliminating essential permeable surfaces and retention areas.

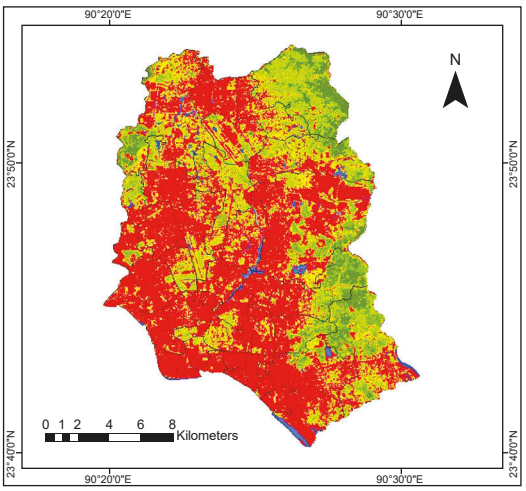
According to the Regional Development Planning (RDP) survey, the lack of effective oversight in implementing the Detailed Area Plan (DAP) has allowed encroachment on nearly 30% of the designated flood flow zones (RAJUK, 2015). This alarming encroachment not only diminishes natural flood storage capacity but also severs vital hydrological linkages between rivers, wetlands, and surrounding landscapes. The loss of these connections undercuts the city's resilience against flooding and reduces its ability to recharge groundwater and maintain ecological habitats.

Such widespread loss of hydrological connectivity poses significant challenges to establishing a sustainable urban environment. Without functional linkages, aquatic ecosystems become fragmented, and the benefits they provide—such as water purification, nutrient cycling, and habitat availability—are greatly diminished. Over time, these disruptions erode the city's natural defense mechanisms against climate-induced stresses, making Dhaka increasingly susceptible to intensified flooding, water quality deterioration, and ecological decline.

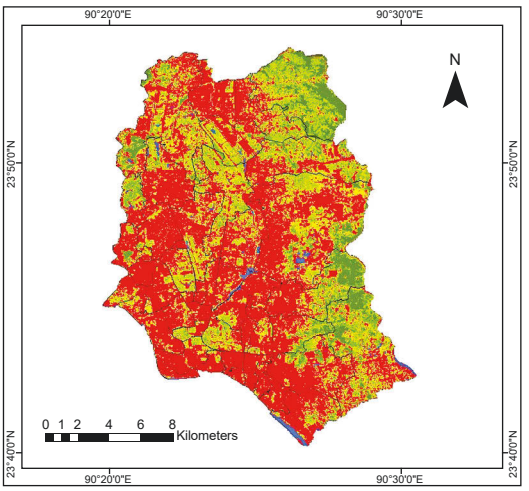
The present study's analysis — covering changes in land use and land cover (LULC), Normalized Difference Vegetation Index (NDVI) dynamics, urban expansion metrics, land productivity, above-ground biomass, and climate stress—offers a comprehensive perspective on the consequences of disrupted hydrological connectivity. By examining these interlinked factors, it is possible to better understand how rapid urbanization and encroachment-driven habitat loss combine with rising climate pressures to threaten not only Dhaka's current urban fabric but also its long-term sustainability and environmental integrity.

4.1 Land Use Land Cover Change

Examining land use and land cover (LULC) changes, along with variations in the Normalized Difference Vegetation Index (NDVI), is crucial for understanding how human activities shape the natural environment. Previous studies have demonstrated that analyzing LULC dynamics and NDVI patterns can provide insights into the extent and intensity of anthropogenic pressures on ecosystems (Hu et al., 2023). In particular, multi-temporal NDVI data facilitate automated detection of change, enabling timely responses to environmental alterations, especially in non-agricultural areas where transformations may be more subtle (Lunetta et al., 2022).



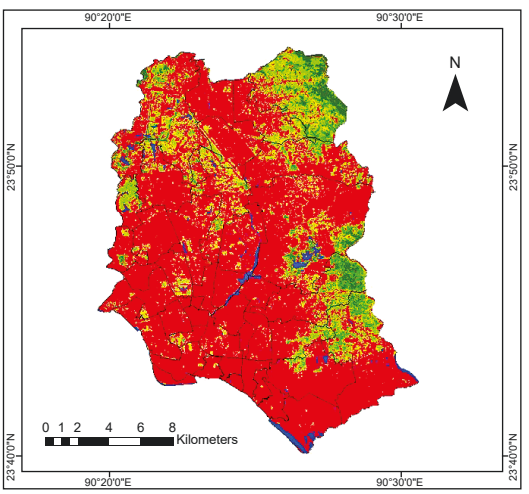
A. LULC in 2015



B. LULC in 2020

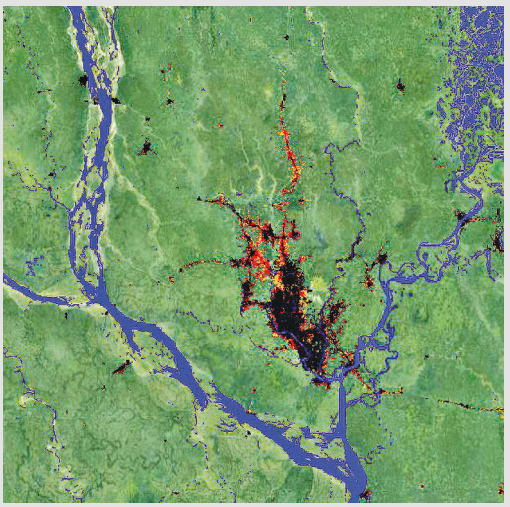
Land Cover and Land Use

- Water (-0.146 - 0.015)
- Builtup Area (0.015 - 0.14)
- Barren Land (0.14 - 0.18)
- Shrub and Grass Land (0.18 - 0.27)
- Spursed Vegetation (0.27 - 0.36)
- Dense Vegetation (0.36 - 0.74)

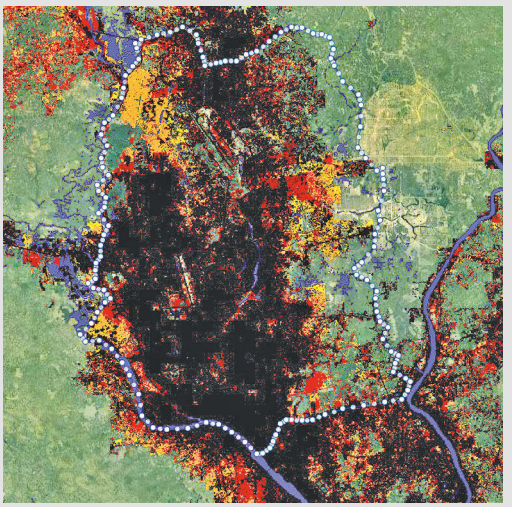


B. LULC in 2023

Figure 7.6: LULC Changes using NDVI for the year A. 2015, B. 2020, C. 2023



Dhaka City with major rivers



Dhaka City (bounded by white lines)

The maps are prepared considering the Impervious surface index value 10, Night time light index value 35 and water frequency 55

Figure 7.7: Built-up areas of Dhaka city

Through reclassification of NDVI values and the interpretation of satellite imagery, it is possible to identify both the nature and the drivers of these changes—factors such as population growth, rapid urbanization, and large-scale infrastructure development (M. Rahman et al., 2022). These analytical approaches offer valuable tools for researchers and policymakers, allowing them to monitor land use trajectories, evaluate landscape productivity, and implement targeted strategies for sustainable land management.In this study, a marked decline in high NDVI values signifies a severe reduction in healthy vegetation cover. Figure 7.6 illustrates the NDVI changes for the years 2015, 2020, and 2023. In 2000, NDVI values ranged from approximately −0.146 to +0.76, with the upper end of this range indicating the most productive landscapes—those dominated by forests and dense vegetation. In contrast, lower NDVI values identified areas of barren land, water bodies, or urban settlements, highlighting regions with limited vegetative growth.

By 2015, 53.8% of Dhaka's area had been converted into built-up zones, leaving only 2.1% for water bodies. The trend continued, with the built-up area increasing by an alarming 71.7% in 2023. This rapid urban expansion has come at the expense of wetlands and other critical water resources.

For instance, Dhaka lost over 49% of its wetland areas between 1960 and 2008, a finding supported by Islam et al. (2014). Although the proportions of water bodies in 2015, 2020, and 2023 remained relatively constant—ranging from 1.3% to 2.3%—these figures are far below the recommended 8.6% water body coverage deemed necessary for adequate groundwater recharge (Hossain, 2021).

The shortfall in maintaining adequate water resources has serious implications for Dhaka's sustainability and resilience. With current water body coverage at roughly one-quarter of the required threshold, the city faces mounting challenges in managing stormwater, sustaining aquatic habitats, and ensuring long-term groundwater replenishment. Ultimately, the observed decline in vegetation and the persistence of low water body percentages underscore the urgent need for integrative land use planning and proactive resource management aimed at restoring hydrological connectivity and fostering a more sustainable urban environment.

4.2 Urban Area Change Metrics

Understanding urban change requires an accurate definition of built-up areas, which represent regions dominated by human-made structures such as buildings, roads, and other impervious surfaces. For this study, three indices were employed to analyze the dynamics of urban expansion in Dhaka: the Impervious Surface Index, the Night time Lights Index, and the Water Frequency Analysis. These indices collectively provide insights into the extent, intensity, and progression of urbanization across the city.

The Impervious Surface Index measures areas covered by non-permeable materials such as concrete and asphalt, offering a clear indication of urban expansion and its impact on natural landscapes. Similarly, the Night time Lights Index highlights areas of human activity through artificial lighting, providing a proxy for urban density and development levels. Finally, Water Frequency Analysis tracks the persistence and coverage of water bodies over time, which is critical for assessing the loss of hydrological connectivity as urban areas encroach upon wetlands and rivers.

4.2.1 Analysis of Urban Change

Figure 7.7 demonstrates the spatial growth of Dhaka's built-up areas over time. The maps reveal that a substantial portion of the city was already urbanized before 2000, particularly in the central and western parts. Notably, some green spaces and open lands still existed in the eastern part of Dhaka during this period. However, the combined analysis using the Impervious Surface Index (value threshold of 10), Night time Lights Index (value threshold of 35), and Water Frequency Analysis (value threshold of 55) shows a marked increase in urban expansion across all sectors of the city, especially after 2000.

The **Impervious Surface Index** highlights the proliferation of built-up areas, with large-scale replacement of vegetative and permeable surfaces by infrastructure. This increase has significantly reduced the city's ability to absorb and manage stormwater, exacerbating flooding and waterlogging issues. Concurrently, the **Night time Lights Index** captures the growing concentration of human activity, especially in densely populated areas, indicating rapid urban densification. The decline in water frequency detected by satellite analysis suggests that urban development has encroached upon natural water bodies, further straining the city's drainage and groundwater recharge capacities.

4.2.2 Implications for Sustainability

The expansion of Dhaka's built-up areas has far-reaching consequences for its sustainability and resilience. The loss of permeable surfaces reduces natural water infiltration, increasing surface runoff and the risk of flooding during heavy rainfall. Encroachment on wetlands and rivers disrupts hydrological connectivity, depriving the city of essential ecosystem services such as water purification, flood regulation, and biodiversity conservation.

Moreover, the decline in water bodies highlighted by the Water Frequency Analysis underscores the urgent need to preserve these critical resources. As Dhaka's urban footprint continues to grow, unchecked expansion threatens not only the city's ecological balance but also its ability to support its burgeoning population with adequate water, sanitation, and infrastructure.

4.3 Land productivity

Land productivity (LP) refers to the capacity of land to support vegetation growth, which is a critical indicator of ecological health, ecosystem services, and sustainable land use. This study examined changes in land productivity across Dhaka city between 2001 and 2020, revealing significant degradation over time. Figure 7.8 highlights the spatial extent of these changes, showing a clear decline in LP across most parts of the city.

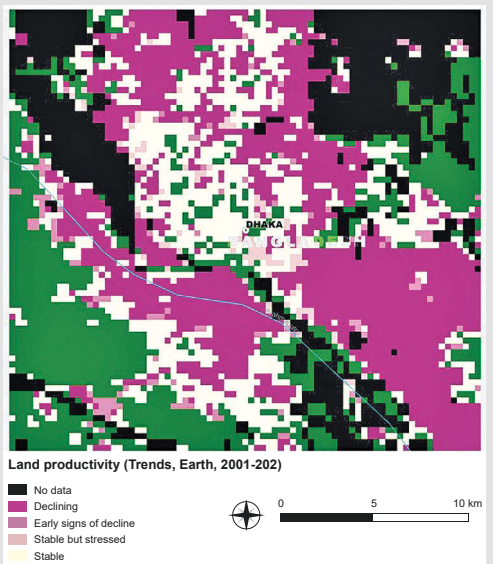


Figure 7.8: Land productivity changes over the period of 2001-2020 (Map is prepared by using Trends.Earth tool)

4.3.1 Decline in Land Productivity

The analysis found that 38.74% of Dhaka's land area experienced a decline in productivity, indicating a loss of vegetative cover and a reduction in the land's ability to sustain natural processes. An additional

25.60% of the land was identified as being under stress, largely attributed to anthropogenic activities such as rapid urbanization, infrastructure development, and encroachment on natural landscapes. This degradation of land productivity is a concerning trend, as it directly impacts the health of local ecosystems, biodiversity, and the availability of natural resources.

4.3.2 Linkages Between Land Productivity and Ecosystem Health

Land productivity is intricately connected to the overall health and functionality of an ecosystem. Declines in LP often signify disruptions in critical processes such as nutrient cycling, water retention, and carbon sequestration. In urban areas like Dhaka, reduced productivity not only diminishes the capacity of green spaces and wetlands to support flora and fauna but also exacerbates environmental challenges such as air pollution, heat island effects, and waterlogging.

The observed decline in LP is symptomatic of the pressures exerted by unplanned urban expansion and the conversion of vegetative and agricultural lands into impervious surfaces. These changes not only reduce the ecological resilience of the city but also limit its ability to adapt to climate-related stresses, including rising temperatures and erratic rainfall patterns.

4.3.3 Implications for Urban Sustainability

The degradation of land productivity in Dhaka has far-reaching implications for its sustainability. A significant portion of the city's land is losing its capacity to provide essential ecosystem services, such as regulating the microclimate, supporting groundwater recharge, and mitigating flood risks. This loss of functionality contributes to the deterioration of living conditions, particularly in densely populated areas where green spaces are already scarce.

Furthermore, stressed and degraded land exacerbates existing environmental problems by increasing surface runoff, intensifying soil erosion, and reducing the capacity for natural water absorption. These issues collectively undermine the city's ability to achieve sustainable urban development and ensure the well-being of its residents.

4.4 Above-ground Biomass (AGB)

Above-ground biomass (AGB) refers to the total mass of living vegetation above the soil surface, including the stems, branches, and leaves of trees and shrubs. It is a critical metric for understanding the role of vegetation in urban ecosystems, particularly in terms of carbon storage, climate regulation, and biodiversity conservation. Estimating AGB in urban areas like Dhaka is essential for urban planning, environmental management, and advancing sustainable development goals.

4.4.1 Findings on AGB in Dhaka

Figure 7.9 illustrates the AGB density (measured in megagrams per hectare, Mg/ha) in and around Dhaka city. The results reveal a concerning trend: the majority of Dhaka's urban areas exhibit near-zero AGB values. This indicates minimal vegetation coverage, with only a small section in the northeastern region showing moderate AGB values ranging from 60 to 100 Mg/ha.

The study's findings highlight the city's extremely low capacity for carbon storage, a critical component of climate regulation.

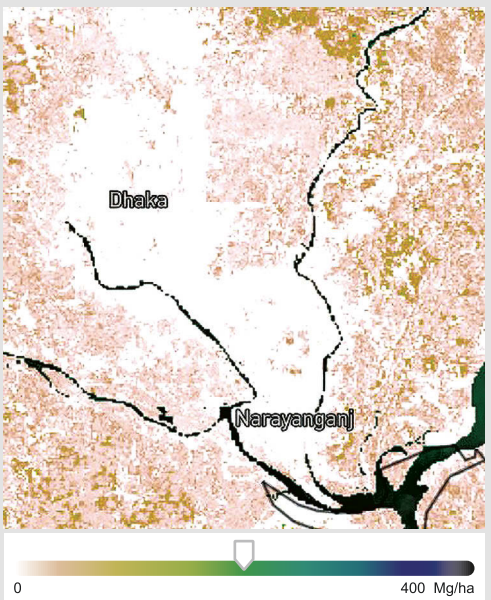


Figure 7.9: Above-ground biomass (AGB) density (unit: Mg/ha)

4.4.2 Implications of Declining AGB

The decline in AGB within Dhaka's urban ecosystem has several significant implications:

i. Loss of Carbon Storage: Vegetation serves as a natural carbon sink, sequestering atmospheric carbon dioxide and mitigating the effects of climate change. The near-zero AGB values across most of Dhaka indicate a severe reduction in the city's capacity for carbon storage. This undermines efforts to achieve a low-carbon urban environment, which is essential for climate resilience and sustainability (Hosni et al., 2022).

ii. Impact on Urban Microclimates: The conversion of natural forests and vegetative areas to urban land has diminished biomass density, canopy cover, and stem density in the city (Briber et al., 2015). This loss exacerbates the urban heat island effect, where cities become significantly warmer than surrounding rural areas due to reduced vegetation and increased impervious surfaces. Such warming not only affects the comfort of urban residents but also intensifies energy demands for cooling, further increasing greenhouse gas emissions.

iii. Decline in Carbon Sequestration Potential: Urban warming has a compounding effect on vegetation health and carbon sequestration. Studies show that rising temperatures in urban areas can reduce the carbon sequestration capacity of mature trees, leading to an estimated 12% decline in sequestration potential (Meineke et al., 2016). For a densely populated and rapidly urbanizing city like Dhaka, this reduction further diminishes its capacity to offset its carbon footprint.

iv. Biodiversity and Habitat Loss: AGB decline is directly linked to habitat degradation in biodiversity hotspots. As urban development encroaches on natural landscapes, the loss of vegetation biomass disrupts ecosystems, reduces biodiversity, and jeopardizes wildlife habitats. These impacts extend beyond local

ecosystems, influencing global carbon budgets and contributing to a broader environmental crisis (Khalil et al., 2016).

4.4.3 AGB and Urban Sustainability

The low AGB values in Dhaka underscore the urgent need to integrate green infrastructure into urban development plans. Restoring vegetation in the city through afforestation, green belts, urban parks, and vertical gardens can significantly enhance AGB and contribute to carbon sequestration. Additionally, protecting the remaining vegetative patches in Dhaka's northeastern region, which currently exhibit higher AGB values, is essential for maintaining ecological balance.

4.5 Climate Stress

Climate stress, driven by changes in rainfall and temperature patterns, is a critical factor impacting Dhaka's hydrological connectivity. This study analyzed rainfall and temperature indices using meteorological data to understand how these stresses influence the city's water systems and overall sustainability.

4.5.1 Rainfall Patterns and Their Impact

Analysis of rainfall indices revealed an increase in annual total rainfall and the Simple Daily Intensity Index (SDII), although the trends were not statistically significant (Figure 7.10). Additionally, a rise in consecutive dry days suggests Dhaka is experiencing short-duration, high-intensity rainfall events. This pattern is conducive to urban flooding, as intense rain over short periods overwhelm the city's compromised drainage infrastructure.

Extreme rainfall indices, including heavy precipitation days and prolonged dry spells, directly influence key hydrological parameters such as sediment load, flow regime coefficient, and flood frequency (R. K. Chowdhury & Eslamian, 2014). These factors affect the carrying capacity of watersheds and exacerbate waterlogging and urban flooding during the monsoon season. The encroachment of wetlands and increased built-up areas further strain the city's drainage network, making it difficult to manage stormwater effectively.

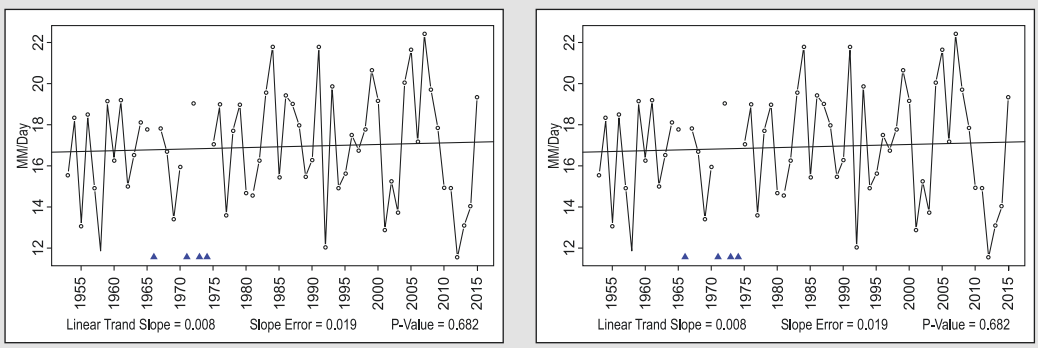
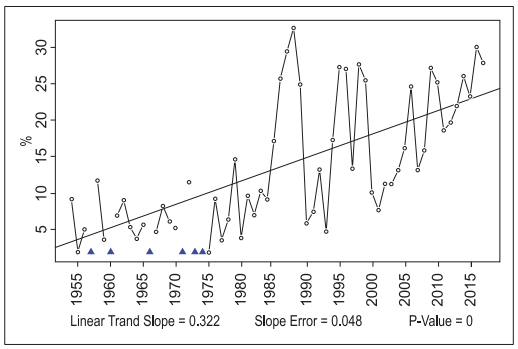
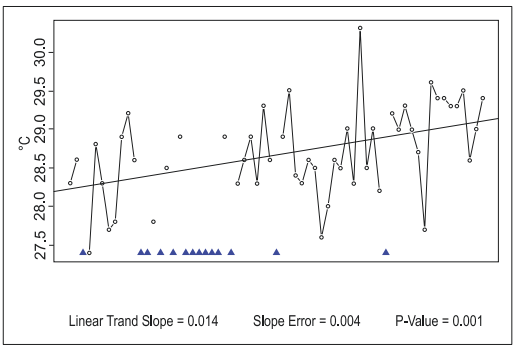


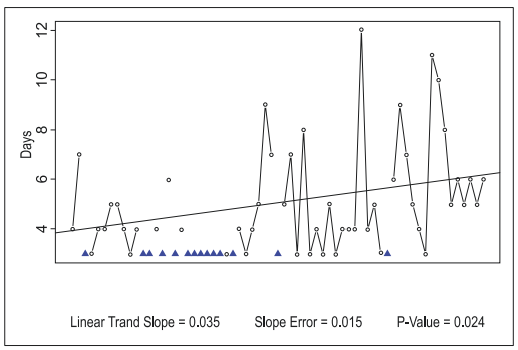
Figure 7.10: Simple Daily Intensity Index (Left side) and Consecutive Dry day (Right Side)



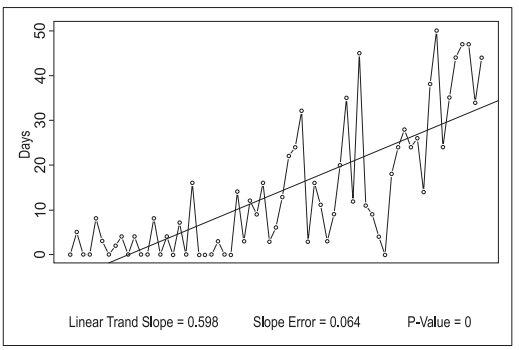
A. Annual Percentage of Days when Maximum Temperature > 90th Percentile



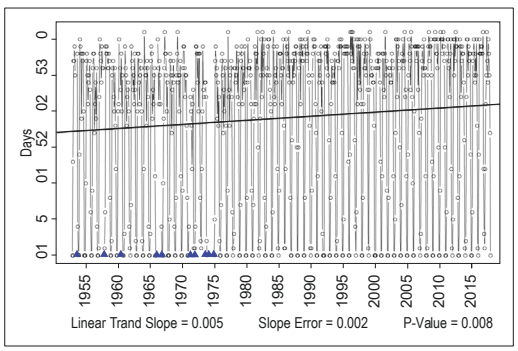
B. Heatwave Amplitude



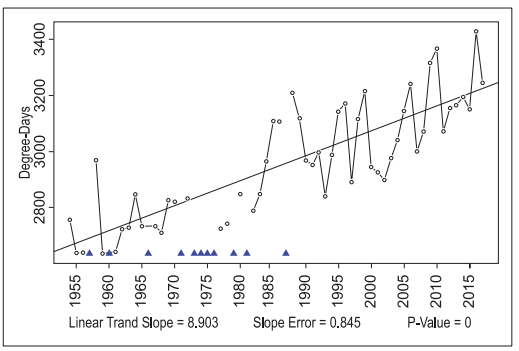
C. Heatwave Duration



D. Heatwave Frequency



E. Monthly Number of Days >=30◦C



F. Cooling Degree Days

Figure 7.11: Figure 7.11: Trend of Extreme Temperature indices for Dhaka City

Restoring natural canals and upgrading the drainage system are essential for mitigating the impact of extreme rainfall. Hydraulic structures designed to accommodate changing rainfall trends could significantly reduce the risk of flooding and enhance Dhaka's hydrological connectivity.

4.5.2 Temperature Trends and Implications

The study found more statistically significant changes in temperature patterns compared to rainfall. Key findings include an increase in maximum temperatures, the frequency and amplitude of heatwaves, and the number of days with temperatures exceeding 35°C (Figure 7.11). Cooling Degree Days, which measure the need for air conditioning, also showed a significant rise, reflecting the intensifying urban heat island effect.

These abrupt temperature changes can harm aquatic ecosystems, disrupt thermal regimes, and weaken the ecological health of urban water bodies (Griffiths & Singh, 2019; Ning Sun et al., 2019). Moreover, higher temperatures increase water demand, while urbanization reduces natural infiltration and the connection between surface and groundwater systems (Zahn et al., 2021). These impacts highlight the need for climate-sensitive urban planning and water resource management strategies.

4.5.3 Decreasing Diurnal Temperature Range

The study also observed a decrease in the diurnal temperature range (Figure 7.12), which reflects a narrowing gap between daily maximum and minimum temperatures. This trend, driven by urban heat retention at night, is another indicator of the urban heat island effect. Decreased diurnal temperature variability can alter evaporation rates and precipitation patterns, further affecting hydrological connectivity in Dhaka (Rajulapati et al., 2020).

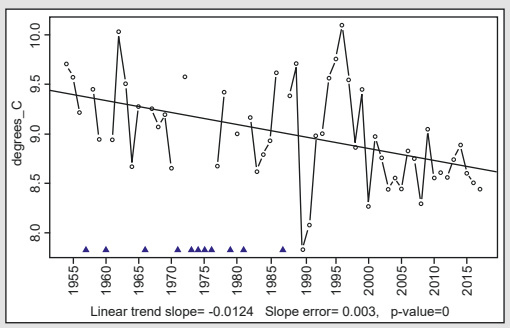


Figure 7.12: Temporal Change in Diurnal Temperature Range for Dhaka City

4.5.4 Climate Stresses and Hydrological Connectivity

Together, these findings underscore the critical role of climate stress in shaping hydrological connectivity. Increased rainfall intensity and prolonged dry spells strain the city's ability to manage stormwater, while rising temperatures and heatwave events impact water quality, aquatic ecosystems, and the reliability of water distribution systems.

To address these challenges, Dhaka must prioritize the integration of climate-resilient infrastructure and green solutions. Restoring wetlands, increasing urban vegetation, and adopting low-impact development

practices can help mitigate flooding, regulate temperatures, and strengthen hydrological connectivity. By aligning urban planning with climate adaptation strategies, Dhaka can better manage the impacts of rainfall and temperature stresses, ensuring a more sustainable and resilient urban environment.

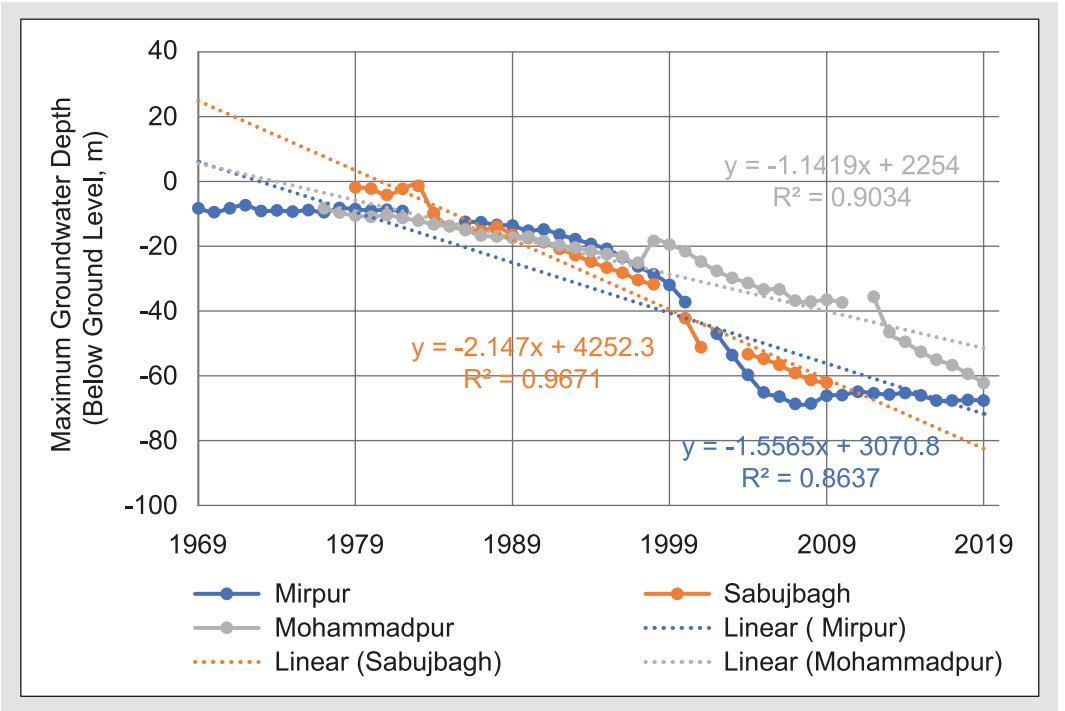


Figure 7.13: Groundwater table trend of Dhaka City

4.6 Impact of Groundwater Depletion on Hydrological Connectivity

The Groundwater depletion in Dhaka has emerged as a pressing issue, with significant implications for the city's hydrological connectivity. Analysis of long-term data (1969–2019) shows a sharp and consistent decline in the groundwater table, with regression analysis yielding high R^2 values ranging from 0.86 to 0.96, indicating a strong negative trend (Figure 7.13). This trend highlights the severity and persistence of groundwater depletion across the city.

4.6.1 Spatial Patterns of Groundwater Decline

Studies reveal that central Dhaka has experienced greater groundwater depletion compared to its peripheral areas (Hossain et al., 2021). This disparity can be attributed to the high population density and concentrated water demand in the city

center. Groundwater recharge mechanisms in Dhaka include lateral inflow, urban return flow, rainfall infiltration, and recharge from surface water bodies and wetlands (Tarek et al., 2022). However, overexploitation of aquifers across all zones has outpaced natural recharge rates, leading to a steady decline in groundwater levels (Baten et al., 2021).

4.6.2 Groundwater Depletion and Hydrological Connectivity

The declining groundwater table disrupts hydrological connectivity by altering the relationship between groundwater and surface water systems. Connectivity can shift between connected and disconnected states depending on factors such as aquifer characteristics, the presence of low-conductivity layers, and the hydraulic properties of sediments (Brunner et al., 2009). For instance, in depressional wetlands, the slope of the surrounding water table determines whether indirect groundwater discharge is feasible (Neff et al., 2020). In Dhaka, groundwater depletion reduces the interaction between aquifers and wetlands, leading to the desiccation of wetland ecosystems and diminished surface water availability.

4.6.3 Impact on Wetlands and Urban Sustainability

Wetlands in Dhaka rely on groundwater to maintain their water balance, especially during dry seasons when surface water inputs are minimal. As groundwater levels decline, these wetlands lose their ability to perform critical ecological functions, such as flood mitigation, water purification, and habitat provision. The loss of wetland connectivity further compounds the city's vulnerability to flooding, as these natural systems act as retention basins that regulate stormwater runoff.

Moreover, declining groundwater levels increase the risk of land subsidence, which can damage urban infrastructure and exacerbate waterlogging issues during heavy rains. The inability of the city's aquifers to recharge adequately also threatens the long-term availability of potable water, intensifying the challenges of sustainable water resource management.

4.6.4 Key Insights on Groundwater Depletion and Hydrological Connectivity

Groundwater depletion in Dhaka poses a severe threat to hydrological connectivity and urban sustainability. The consistent decline in the groundwater table disrupts the natural recharge mechanisms, especially in central Dhaka, where concentrated water demand exacerbates the issue. This loss of connectivity between groundwater and surface water systems impairs wetlands, reducing their capacity to regulate floods, purify water, and provide habitats. Additionally, groundwater depletion increases the risk of land subsidence, leading to intensified waterlogging and infrastructure damage. Addressing these challenges requires integrated water resource management, sustainable urban design to enhance recharge, and wetland conservation to mitigate the cascading impacts and ensure the resilience of Dhaka's water systems.

5. Recent Restoration Efforts

The restoration of urban wetlands in Dhaka has been limited and faces numerous challenges. Wetland loss, driven by rapid urbanization and encroachment, has significantly impacted the city's drainage systems, exacerbating waterlogging and environmental degradation. Although policies and legal frameworks exist to protect wetlands, their implementation has been weak, primarily due to institutional inefficiencies and a lack of coordination among relevant stakeholders. As a result, current restoration efforts have not been sufficient to halt or reverse the ongoing decline of these critical ecosystems.

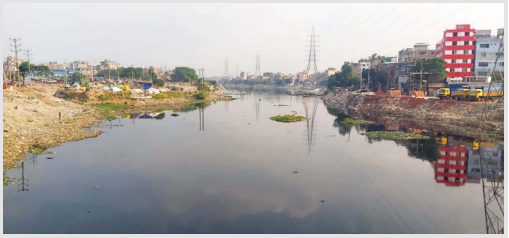
Efforts to address wetland loss and improve urban hydrology must overcome the complexities posed by population growth, environmental degradation, and competing demands for land. Successful restoration requires the combined efforts of stakeholders, including government agencies, local communities, and environmental organizations, alongside adequate funding, effective governance, and long-term commitment.

5.1 Restoration of the Old Buriganga Channel

One of the most notable ongoing projects is the restoration of the old Buriganga channel. The Dhaka South City Corporation (DSCC) initiated this project in three phases, with a budget of approximately Tk 22 crore (Haque, 2023). The project includes demarcation activities, eviction drives, re-excavation, and waste disposal. Once completed, the restored channel is expected to alleviate waterlogging in areas such as Hazaribagh, Lalbagh, Dhanmondi, and Kamrangirchar while improving navigation and reducing transportation costs.

As part of the first phase, efforts have focused on clearing silt, debris, and garbage from the sluice gate at the channel's endpoint in Islambagh. Of the channel's total 7 kilometers, 1,200 meters have already been excavated at an estimated cost of Tk 6.41 crore (Haque, 2023). The completed project will feature walkways and cycle lanes along the channel, enhancing accessibility and promoting sustainable urban mobility. In addition to this, approximately 52 kilometers of walkways are planned along the banks of the Buriganga, Turag, Shitalakshya, and Balu rivers, with further expansion of 148 kilometers set to begin in 2024 (Jibon, 2022).

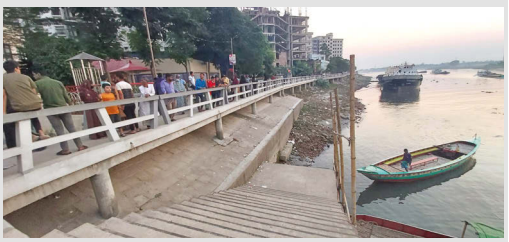
During a field visit in November 2023, the study team observed ongoing restoration activities, including dredging, walkway construction, and completed sections of infrastructure along the Buriganga River (Figure 14). These efforts signify progress but underscore the slow pace of project implementation due to administrative bottlenecks.



(i)

(ii)

(iii)



(iv)

Figure 14: (i) Dredged area in Kellar mor ghat where boats are used for navigation, (ii) Ongoing dredging work near Iron Bridge at Keraniganj, (iii) Ongoing Walkway construction at Jhauchar, Hazaribag of the main Buriganga river, (iv) Completed Walkway at Chand Uddan to Dhaka Uddan area at Basila of Buriganga river

5.2 Broader Efforts to Protect Dhaka's Rivers

To combat illegal encroachment on the four major rivers surrounding Dhaka—Buriganga, Turag, Shitalakshya, and Balu—the Government allocated Tk 850 crore in 2018 (Jibon, 2022) for the construction of ancillary infrastructure, such as boundary pillars, bank protection, walkways, and jetties. However, the Bangladesh Inland Water Transport Authority (BIWTA) has faced challenges due to inadequate planning, resulting in increased project costs and delays.

The project's original budget of Tk 848.55 crore was revised upwards by 39.21%, reaching a total of Tk 1,181.82 crore (Jibon, 2022). Despite these setbacks, progress has been made, including the installation of boundary pillars to mark riverbanks and ongoing eviction operations against encroachers. Nevertheless, the slow pace of implementation highlights the need for better supervision and coordination among involved agencies.

5.3 Challenges and the Way Forward

While significant financial resources are being allocated to restore wetlands and protect rivers, the effectiveness of these efforts is hindered by poor project management and insufficient oversight. Restoration projects such as the old Buriganga channel and riverbank protection initiatives have made progress but require sustained attention to meet their objectives.

To enhance the effectiveness of restoration efforts, the following measures are critical:

1. **Improved Coordination:** Strengthening collaboration among government agencies, such as DSCC, BIWTA, and the Ministry of Shipping, can streamline project implementation.
2. **Community Involvement:** Engaging local communities in restoration efforts can promote awareness and discourage encroachment.
3. **Enhanced Supervision:** Establishing robust monitoring frameworks can ensure timely and efficient project completion.
4. **Sustainable Urban Planning:** Integrating wetland conservation into urban development plans is vital for long-term hydrological balance and flood mitigation.

Restoration efforts in Dhaka offer a glimpse of what is possible but also reveal the gaps that must be addressed to ensure sustainable outcomes. By fostering stronger institutional frameworks and prioritizing ecological preservation, Dhaka can move closer to restoring its wetlands and rivers, creating a more resilient and livable city for its residents.

6. Discussion

Hydrological connectivity is fundamental to the sustainable management of urban wetlands in Dhaka. However, unplanned urbanization and rapid urban sprawl have significantly altered the city's hydrological systems, leading to profound environmental, social, and infrastructural challenges. Analysis of the land use and land cover (LULC) data reveals a rapid increase in built-up areas, now comprising 71.7% of Dhaka's total area, much of which was developed before 2000. This expansion has resulted in a substantial increase in impervious surfaces—such as roads, pavements, and buildings—which prevent water infiltration and exacerbate waterlogging and flooding during heavy rains.

The reduction of porous and pervious surfaces has further hindered groundwater recharge. The consistent decline in the groundwater table, as evidenced by high R^2 values ($\approx 0.86 - 0.96$) from regression analysis, reflects a persistent and severe challenge to the city's hydrological connectivity. Central Dhaka, bearing the brunt of this depletion, demonstrates how concentrated water demand in urban cores disrupts natural recharge mechanisms.

The loss of connectivity between groundwater and surface water systems diminishes the ecological and hydrological functions of wetlands, which are critical to urban sustainability. Wetlands lose their ability to regulate floods, purify water, and provide habitats, exacerbating the city's vulnerability to environmental and infrastructural challenges. Furthermore, reduced groundwater interaction increases the risk of land subsidence, intensifying waterlogging and threatening infrastructure..

The hydrological consequences of increased impervious surfaces are evident in the city's flooding challenges. High-intensity, short-duration rainfall events result in rapid surface runoff, overwhelming the drainage network and causing frequent

urban flooding. Dhaka's drainage system is further compromised by congestion and poor maintenance, leaving it unable to handle stormwater effectively. This situation is aggravated by the lack of adequate green space, which stands at a mere 7.5%, far below the recommended 20% for a healthy urban environment (K. M. A. Rahman & Zhang, 2018). The minimal green space correlates with negligible above-ground biomass (AGB) density, as shown in Figure 9, highlighting the city's diminished carbon storage capacity and ecosystem health.

The loss of green space has far-reaching implications. Between 1989 and 2020, Dhaka experienced an 88.24% decline in healthy green spaces (Rashid et al., 2023), leading to higher land surface temperatures, reduced humidity, and adverse effects on public health (K. Shakrullah et al., 2015). The biodiversity of the city has also suffered, with a rapid decline in species richness, particularly among butterfly populations in urban parks (S. Chowdhury et al., 2021). This degradation in green infrastructure not only impacts ecological balance but also undermines the city's resilience to climate change and urbanization pressures.

In addition, Dhaka's climate stresses, including rising maximum temperatures (>35°C), longer heatwave durations, and increasing consecutive dry days, exacerbate hydrological challenges. High temperatures contribute to urban heat island effects, altering stream temperatures and negatively impacting aquatic ecosystems (Griffiths & Singh, 2019). Concurrently, extreme rainfall events further stress the city's limited water management capacity. Together, these climatic extremes disrupt the hydrological regime, affecting biodiversity, water quality, and the functionality of freshwater ecosystems.

Land productivity (LP) in Dhaka has also deteriorated, with 38.74% of the area experiencing degradation and 25.60% under stress due to anthropogenic activities. Reduced hydrological connectivity contributes to this decline, affecting local ecology, agricultural potential, and the availability of ecosystem services. The cumulative impact of these factors underscores the critical role of hydrological connectivity in maintaining the city's ecological, economic, and social well-being.

7. Towards a Sustainable Future: Restoring Hydrological Connectivity in Dhaka

Dhaka faces significant threats to its hydrological connectivity due to anthropogenic pressures, including unregulated urbanization, encroachment on wetlands, and climate change-induced stresses. These factors have fragmented landscapes, disrupted biogeochemical cycles, and diminished essential ecosystem services. Addressing these challenges requires a comprehensive and integrated approach that prioritizes restoring and preserving hydrological connectivity through innovative solutions and collaborative efforts.

Restoring and preserving hydrological connectivity in Dhaka requires a comprehensive approach. An integrated water resource management framework is essential to enhance groundwater recharge, restore wetlands, and reduce impervious surfaces. Greening initiatives,

such as increasing green spaces and above-ground biomass (AGB) density, can mitigate urban heat, improve biodiversity, and boost stormwater absorption. Stakeholder involvement, encompassing local communities, policymakers, and environmental organizations, is crucial for fostering sustainable restoration efforts. Upgrading drainage networks to manage increasing rainfall intensity effectively will also play a pivotal role in combating waterlogging and urban flooding.

The restoration of sustainable hydrological connectivity in Dhaka must extend beyond fragmented and isolated projects to a cohesive strategy that recognizes the interconnectedness of the city's water systems. Rivers, wetlands, and canals—often referred to as blue infrastructure—are integral to the city's ecological and hydrological health. Restoring this infrastructure requires a careful balance between urban development goals and ecological preservation. The following Strategies can be taken to restore hydrological connectivity.

7.1 Controlled Flooding for Connectivity

Controlled flooding offers a viable solution to revitalize Dhaka's hydrological connectivity. Historically, Dhaka experienced regular riverine floods, which rejuvenated its floodplains and wetlands. With the advent of flood control works, these natural processes have been curtailed, leading to ecological degradation. By modifying the operation of existing flood control infrastructure, controlled flooding can reintroduce periodic inundation to floodplains, helping to sustain hydrological connectivity, enhance soil productivity, and support wetland ecosystems. For instance, selected low-lying areas around the Turag, Buriganga, and Balu rivers could be targeted for controlled flood interventions.

7.2 Floodplain Restoration

Much of Dhaka's floodplain has been lost due to urban expansion, yet these areas are critical for ecological balance and hydrological connectivity. The recently updated Detailed Area Plan (DAP) (RAJUK, 2022) emphasizes the need to protect the remaining floodplains, particularly in areas such as the eastern parts of the city near the Balu River. Rejuvenating floodplains can restore their role as productive ecosystems, acting as natural water retention basins, improving biodiversity, and supporting stormwater management.

7.3 Reestablishing Blue Infrastructure

Water bodies such as wetlands and canals play a key role in moderating urban heat, an increasingly pressing issue in Dhaka due to global warming and urban heat island effects. The restoration and maintenance of these water bodies can help reduce urban temperatures, providing a natural, cost-effective solution to heat adaptation. Initiatives like the Hatirjheel project demonstrate the potential of reestablishing blue infrastructure for both environmental and societal benefits. Expanding such efforts to other areas, such as the Gulshan Lake and Dhanmondi Lake, could further enhance heat moderation and improve urban livability.

7.4 Flushing and Pollution Mitigation

Dhaka's khals and wetlands are highly polluted due to stagnant water and waste dumping. Controlled flooding can facilitate natural flushing, cleansing these water bodies and improving water quality. Targeted flushing in areas like the Begunbari Khal and Ramchandrapur Canal could help remove accumulated pollutants and mitigate odor issues. Such efforts would also reduce mosquito breeding grounds, addressing public health challenges like the dengue epidemic.

7.5 Restoring Navigational Connectivity

The Government's efforts to reestablish navigational routes within the city, such as the Hatirjheel waterway, highlight the importance of hydrological connectivity for urban mobility. Expanding these efforts to include routes along the Turag, Buriganga, and Balu rivers could alleviate traffic congestion, promote sustainable transportation, and integrate Dhaka's waterways into its urban transport network. The restoration of navigational channels, such as the old Buriganga route, would serve as a key step in achieving this vision.

7.6 Disincentivizing Encroachment and Waste Dumping

The absence of flowing water in Dhaka's khals and canals has encouraged rampant encroachment and waste dumping. Reestablishing flow in these systems could deter such practices by restoring the ecological and aesthetic value of water bodies. Areas like the Kalyanpur and Segunbagicha canals could serve as pilot projects for this initiative, demonstrating the benefits of functional hydrological systems.

7.8 Integration of Green Infrastructure

Green infrastructure (GI) solutions that mimic natural flood responses can be integrated into Dhaka's urban planning to enhance sustainable hydrological connectivity. Techniques such as permeable pavements, rain gardens, and bioswales can attenuate stormwater and reduce the burden on conventional drainage systems. These solutions could be implemented alongside existing grey infrastructure, such as regulators and levees, to optimize floodplain restoration and improve urban flood resilience.

7.9 Research and Monitoring

While controlled flooding and green infrastructure offer promising solutions, further research and monitoring are essential to evaluate their long-term benefits and mitigate potential risks. Pilot projects in areas like the Hatirjheel-Begunbari canal network could serve as a test case for scalable interventions. Continuous assessment of these projects would provide valuable insights for refining restoration strategies and ensuring their success.

8. Conclusion

Restoring sustainable hydrological connectivity in Dhaka is critical for addressing the city's pressing water management challenges and ensuring long-term ecological and urban resilience.

Achieving this goal requires a comprehensive and integrated approach that harmonizes natural processes with urban infrastructure development. Dhaka's unique challenges, stemming from rapid urbanization, wetland encroachment, and climate-induced stresses, demand innovative solutions that prioritize ecological preservation while accommodating urban growth.

A multi-faceted strategy is essential to create a sustainable future for Dhaka. Controlled flooding in targeted low-lying areas can rejuvenate wetlands, enhance water quality, and support biodiversity, thereby restoring the ecological balance disrupted by years of unregulated development. Protecting and restoring wetlands and floodplains, particularly in vulnerable areas like the eastern wetlands and the Balu River floodplain, is vital for flood mitigation and maintaining hydrological connectivity. Additionally, implementing green infrastructure solutions, such as bioswales, rain gardens, permeable pavements, and urban parks, can effectively manage stormwater, reduce urban heat, and improve water retention, while green roofs and vertical gardens contribute to cooling and enhanced biodiversity.

To ensure the success of these initiatives, collaboration among government agencies, urban planners, and local communities is paramount. Strengthened governance, with centralized oversight for hydrological connectivity projects, can improve coordination and streamline efforts. Active community participation will foster a sense of ownership, reduce harmful practices like waste dumping, and promote long-term sustainability. Climate adaptation strategies, including the enhancement of drainage systems and increased vegetation cover, are also critical for mitigating the impacts of extreme weather events and strengthening the city's resilience to climate change.

Continuous research and monitoring are indispensable for evaluating the effectiveness of restoration efforts and refining strategies over time. Pilot projects in key areas, such as the Hatirjheel-Begunbari canal network and the Turag River floodplain, offer valuable opportunities to test scalable models for sustainable water management. These initiatives can provide insights into the long-term benefits of integrated approaches and help address potential risks.

By adopting these measures, Dhaka can unlock the immense potential of its blue and green infrastructure, improving both ecological health and urban quality of life. A coordinated effort that prioritizes hydrological connectivity will enable Dhaka to transition toward a more resilient, sustainable, and livable urban future, where its natural and built environments coexist in harmony.

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Chapter 8

Impact of Wetland Loss on the Surrounding Local Communities: A Case Study of Peri-Urban Dhaka

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1. Background of the Study

Bangladesh is blessed with approximately 7.5 to 7.8 million acres wetlands of different types (Rahman & Begum, 2011). It offers a variety of positive economic, social, and environmental benefits (Islam, 2010; Kibria, 2013). The majority (70%) of the nation's daily protein supplements come from the wetlands, which are home to about 260 species of freshwater fish (Yousuf Haroon & Kibria, 2017). Over 60 million people in Bangladesh are dependent on aquatic resources every day, including a million full-time and part-time fisherfolk (Yousuf Haroon & Kibria, 2017). The fishery and agriculture sectors employ 5% and 64.5% of the country's total workforce, respectively (Yousuf Haroon & Kibria, 2017). Livelihood of people living around those area depends on these resources.

Urban wetlands also contribute to the livability of cities in many important ways. City dwellers are more or less dependent on wetlands for ecological resources and ecosystem services over the years. These wetlands provide habitats for flora and fauna, store floodwaters, facilitate urban drainage systems, support the need for food and water for local livelihood, and provide urban green spaces, and recreation (Alikhani et al., 2021). However, the contributions of

wetlands are noteworthy, the impetuous loss of wetlands for satisfying the demand of the growing population in recent years cannot be overlooked.

Dhaka city is surrounded by mainly by six peripheral rivers (Turag and Buriganga on West, Balu and Sitalakhya on East, Tongi Khal to the North, and Dhaleshwari to the South. But unfortunately, there is a trend of deterioration of wetlands in Dhaka. A total of 18.72 km^2 of rivers and *khals* were lost during the 30 years interval from 1978 to 2009 which was about 64.55% of Dhaka Metropolitan Area. Dhaka lost more than 28% of its water bodies from 1988 to 2020 (Pasha et al., 2022). Some wetlands are converted to agricultural lands while others are changed to fulfill the housing demand of people. Moreover, pollution, illegal encroachment, sedimentation, and industrial development near water channels are some common phenomena in Bangladesh. Studies find that local people are affected both economically and socially due to the loss of wetlands as they are the primary user of wetlands (Adhya & Banerjee, 2022; Bhatta et al., 2016; Hempattarasuwan et al., 2021; Madebwe & Madebwe, 2005; Mao et al., 2018; Rahman & Begum, 2011). Due to loss of wetlands, they are losing their professions and switched towards new one which would require new skills, new experiences and new markets. In this context, local people cannot easily cope with the emerging scenario.

Different government agencies and NGOs are working to ensure their water rights and keep the inherent nature of water bodies. Several legal frameworks like the Wetland Conservation Act, Environmental Conservation Act, and Environment Conservation Rules are in practice. The views of local wetland users, their dependency on wetlands, demand regarding conservation practice, and responses towards changing the behavior of wetland characteristics are not documented. However, their participation in decision-making regarding conservation, restoration, and effective use of the remaining wetland resources has been considered crucial (Aazami & Shanazi, 2020; Adhya & Banerjee, 2022; Bhatta et al., 2016; Hempattarasuwan et al., 2021; Kabumbuli & Kiwazi, 2009; Kevin O. Obiero, 2012; Rahman & Begum, 2011). Different studies on the haors and coastal areas of Bangladesh have explored the social, economic, and environmental impacts of wetland loss on the livelihood of the local people (Al-Amin et al., 2021; Hossain et al., 2013; Rahman & Begum, 2011; Rana et al., 2009; Yousuf Haroon & Kibria, 2017). However, none have studied these livelihood and social impacts in the context of the capital city Dhaka and its surrounding areas. Wetlands are also vital in achieving SDGs 1, 2, 6, 8, and 11 which aim to build the resilience of the poor and vulnerable to different climatic. economic, social, and environmental shocks and disasters and ensure sustainable food production systems, ecosystems, tourism, and economic growth. Considering the aforementioned context, this study investigated the experiences of local communities due to the loss of waterbodies in peri-urban areas of Dhaka city. Under this aim, the change in the social and economic condition of local communities over time due to livelihood loss was explored, and strategic measures are recommended through a community lens to minimize the adverse impact of loss on local communities.

2. Methods

This research follows a sequential process to reach the findings engaging the selection of study area and data collection methods, identification of participants of focus group discussions, collection of data and analyzing information acquired from study area.

2.1 Selection of Study Area

Firstly, the areas where the higher amount of wetland loss occurred from 2010 to 2022 have been identified by comparing the GIS database of waterbodies in the Detailed Area Plan 2010 and satellite image of 2022. As this paper focused on peri-urban areas of Dhaka city, three areas have been considered as case areas to be studied: Baralu, Tongi and Kamrangir Char, shown in Figure 2.1. These areas are mainly located adjacent to the Shitalakhya, Turag and Buriganga rivers. The surrounding communities in case areas have been selected for data collection to attain the objectives.

2.1.1 Boralu-paragao village (Shitalakshya river)

The Boralu-paragao village is situated at the bank of Balu River, which is a tributary of the Shitalakshya River. The 44-km long Balu River passes through the wetlands of Beel Belai and Dhaka before its confluence with the Shitalakshya at Demra. This village is a suitable area for case study as it has witnessed the loss of this river very closely. The river has played significant role in the life of the local people in the past (Figure 8.1). Due to loss of wetland, these occupations are no longer an option for the local people. The impact of wetland loss on their livelihood will be discussed in the following section.

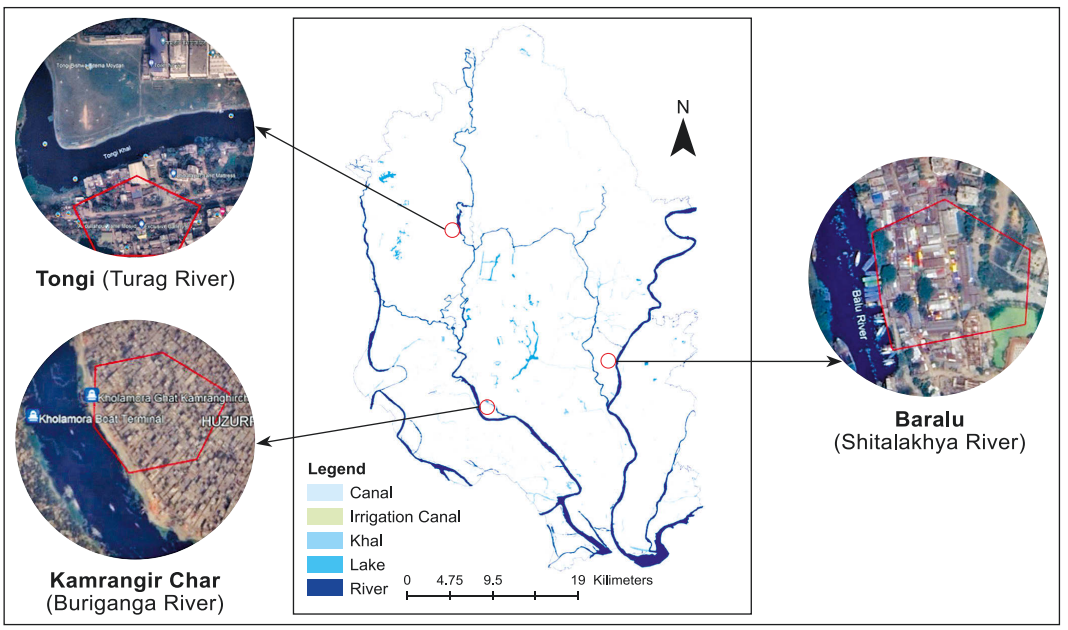

Figure 8.1: Map of the study area
Source: Authors, 2023

2.1.2. Tongi, Turag River

Tongi Khal connects both Turag and Balu rivers which has lost its appeal long ago (Figure 8.1).

2.1.3. Kamrangir Char, Buriganga river

Kamrangir char is a prominent ghat of Buriganga river and has a diverse livelihood culture (Figure 8.1).

2.2 Data Collection and Analysis

The data have been collected through community focus group discussions. Participants of each discussion were around seven to ten persons from the surrounding communities. They have been selected from different age groups and occupations and it has been tried to keep a member who is residing in the study area more than fifteen years to get the comparison of past and present context. They were asked to answer the queries regarding their socio-economic characteristics and livelihood pattern, historical timeline of their wetland loss, how this event happened gradually. They were also their view on what are the responsible factors for the existing situation and if is there any effect on their livelihood and social condition. The community's response towards wetland loss and how different social groups are getting affected is also investigated. The measures taken by different stakeholder regarding waterbodies and what should be done in the future to minimize the adverse impact and conserve the remaining portions of wetlands.

A number of Participatory Rural Appraisal (PRA) tools have been employed to analyze the collected data. Events of local areas which are historically significant and have direct or indirect impacts on wetlands are illustrated using the historical timeline. The strength of the communities and local livelihoods are studied through resource mapping. Socio-economic impacts on the surrounding communities are shown through developing the cause-effect diagram where root causes and effects including secondary effects on communities are represented. Among the local problems that are more dominating are notified through pair-wise ranking of problems. Based on the findings of these PRA tools the existing condition of local communities and solutions to mitigate the adverse impacts are revealed.

3. Results and Discussions

Wetlands are important resources as they provide different ecological, social, economic, and commercial services. Thus, the loss of wetlands affects both human lives and the environment. The affected ones are the local people surrounding the wetlands. Because these wetlands become an integral part of their lifestyle as livelihood means, daily necessities, and activities. So, the loss of wetlands is critical for them and needs to be investigated in detail.

3.1 Root causes of wetland loss

Wetlands are very important natural resources from which we receive different benefits from time to time. But the wetlands of our country are disappearing rapidly to the point that one day they might not exist at all. The loss of wetlands is occurring due to various reasons. The main reason identified by the local people is the illegal landfilling and land encroachment at the rivers.

Different entities are forcefully and illegally occupying the riversides and landfilling those areas. As a result, rivers are losing their navigability and the surrounding lands are losing their fertility. The rivers can no longer support the diverse ecosystem of different types of flora and fauna and fisheries which has a great impact on the economic and social condition of the local people of these river areas. Another reason for this loss of wetlands is pollution. There are thousands of industries along these rivers that are using the river water for their production and dumping toxic chemical wastes and wastewater into the rivers indiscriminately. Many of these industries do not have any treatment system and there is little monitoring on this issue. Moreover, the pollution from the upstream tributaries is also transferred to the rivers which adds to the pollution level. As a result, rivers are getting more and more polluted making them unusable for cooking, drinking, agriculture, and fishing.

3.2 Economic impact of wetland loss

The wetlands of Bangladesh are rich with resources that provide livelihood means and employment to a large section of our population especially the people living in the surrounding areas. There is scope for cultivating different types of crops and vegetables which offers livelihood for a lot of people. The production is used for both domestic use and economic purposes. The surrounding areas were self-sufficient with all kinds of rice and vegetables. But, due to the loss of wetlands, there are no longer lands available for agricultural production or the lands lost their fertility Fishing is one of the major professions for the local communities as well as food. During the rainy seasons, they caught different types of fish from the beels and rivers one/two times a year. However, due to illegal landfilling, river pollution, and the subsequent loss of wetlands, there is hardly any scope for fishing. Water transport such as boating was very common in wetlands previously and some people used to earn their livelihood as boatman which is also disappeared with the disappearing wetlands. People used to cross the by boats in all seasons when but now boats are not required anymore as there is no high-water level except for the rainy season. Also, different industries have been established near the rivers in our country as rivers could provide different materials like water, sand, silt, etc. for production. These industries have generated many employment opportunities, especially for the local people. Due to the loss of wetlands and different social and political factors, different industries have been closed over the years making lots of people unemployed. So, the local people have lost their main sources of income due to the loss of wetlands and many of them had to change their occupations. However, they did not have the capability or experience of other professions. So, people who own lands choose to earn money by selling their lands without thinking about its further consequences. But they could not even get the right price for their lands. As a result, the land of the local people got into the hands of the real estate developers easily, and the local people were not even part of those developments. If this trend continues, the local community will be completely displaced from their homeland. In many areas, any local residents no longer live there.

The development projects are going through without any consideration of the wetlands and further progress the loss of wetlands. Those who shifted occupations mainly did small businesses like corner shops and drove three-wheelers like autorickshaws or CNG. But those are not really profitable for them. Those people who did not have any land and also did not have the resources to shift occupations became unemployed. Older people have especially been reluctant to these changes in occupation and become unemployed due to a lack of suitable skills. The loss of income and employment has resulted in the migration of the local people. Young people who can afford migrates to abroad and others tend to move to Dhaka city. Overall, the loss of wetlands has a great impact on the economic condition of the local community and further results in the migration of local people.

3.3 Social impact of wetland loss:

The loss of wetlands has a great impact on the social condition of the local communities as well. The rivers become an integral part of the life of the local people in every aspect. Almost all of their daily activities somehow revolve around the river. The river water used to be a source of drinking water as it was very fresh back in the day. It was also used for cooking and bathing purposes as well. Due to pollution from the surrounding industries and other sources, the river water is not clean anymore. The water has a visual change in color and there is a bad odor. The river water cannot be used for drinking, cooking, and bathing anymore as there is a high number of pollutants and odors. The nearby residents are suffering badly due to the smell as it becomes really difficult to bear the bad smell. They had to stay indoors with windows locked in the summer season just to escape the smell. This situation is more difficult for women as they stay at home all day. The children also used to swim in the river before the pollution but they are unable to learn to swim in this polluted water now. This has increased the risk of the lives of children falling into rivers who live nearby. The parents are very worried about this situation too. The loss of wetlands has also resulted in the rise of different insects and mosquitos which threaten the health of the local people. People are not connected anymore to the rivers due to the loss of wetlands which would only aggravate the disappearance of wetlands in Dhaka.

3.4 Case Studies

3.4.1 Boralu-paraggao village, Shitalakshya river

Shitalakshya is one of the most important rivers in our country now dying due to human interference. The Shitalakshya River is famous for its clean water (Figure 8.5). The water from this river was also said to have healing powers and people used to visit to collect it. The water was so clean that people could see what was one foot beneath the water. The river was the source of different types of livelihoods like fishing, farming, etc. for the local people (Figure 8.4). There are many industries including City Company, Mir Cement, Partex Group, Karim Jute Mill, Ahmed Textile, Latif Jute Mill, etc. (Figure 8.2). Some of these mills closed 3/5 years back which has increased unemployment in the local people.

Figure 8.2: Industries along the Shitalakshya River

Source: Authors, 2023

Figure 8.3: Landfillng of the beels

Source: Authors, 2023

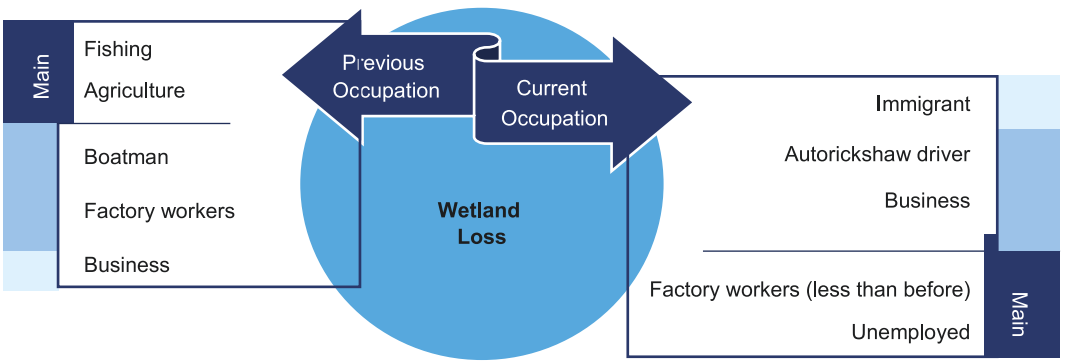

Figure 8.4: Change in occupation of local people due to loss of wetland

Source: Authors, 2023

The pollution from these industries and the upstream water of the Balu River have contaminated the river severely. Now the river water is not suitable for any domestic use and other commercial uses that used to be livelihood for the local people (Figure 8.4). This situation is deteriorated because of the illegal land grabbing and landfilling by the Real estate companies from two years back (Figure 8.6). Many people have lost their lands at their hands without getting any remuneration. The local people are afraid of taking any action against them due to their political influence. They could not get any help from the local law enforcement or other agencies. Sadly, there is no initiatives to save this river from the government or any other organizations. As a result, the river is losing its navigability and quality and if this continues, this river might disappear as well.

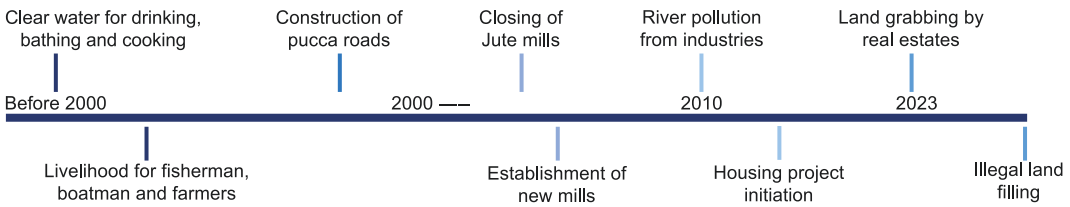

Figure 8.5: Timeline of changes along the Shitalakshya River

Source: Authors, 2023

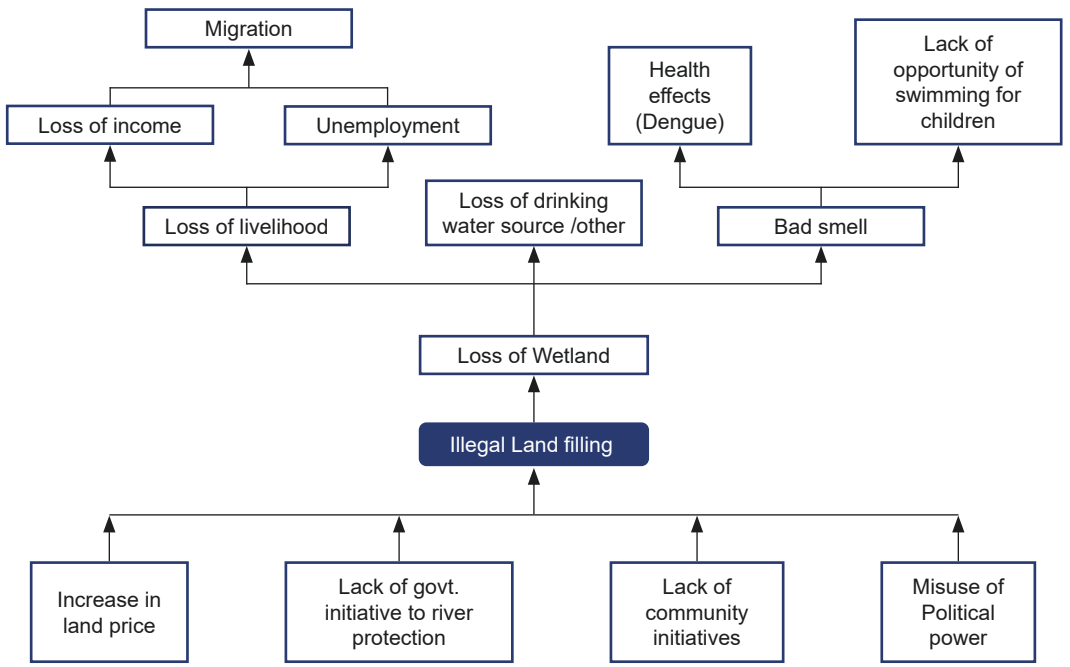

Figure 8.6: Cause-effect diagram of loss of wetlands in Shitalakshya river

Source: Authors, 2023

3.4.2 Tongi, Turag River

Turag river, a major river flowing besides Dhaka is now one of the most polluted rivers of the world. This river used to flood both of its bank during the rainy season. This river is a narrow one, but it looks like a massive river during the inundation period. This river was source of different types of fish which was the livelihood of the majority of the local people. Major occupations for the local people were fishing and Boatman. But after the land acquisition of RAJUK, there has been development of building, roads and industries. Many of the local communities moved after this as didn't have any lands. Those who had some lands got some plots and their income source is now the rent from those plots. Due to pollution from the adjacent industries specially textile industries, fishes are decreasing and there is hardly any scope for the fisherman (Figure 8.8). The water has turned completely black and so no longer can be used for domestic purposes (Figure 8.7). There is also bad odor which makes it harder for people to stay on the water. There is also the issue of land grabbing at the shore of the river which has seen no govt. intervention or other initiatives to stop it (Figure 8.9). As a result, the river is almost dead and the local people have lost their homes.

Figure 8.7: Polluted Turag River

Source: Authors, 2023

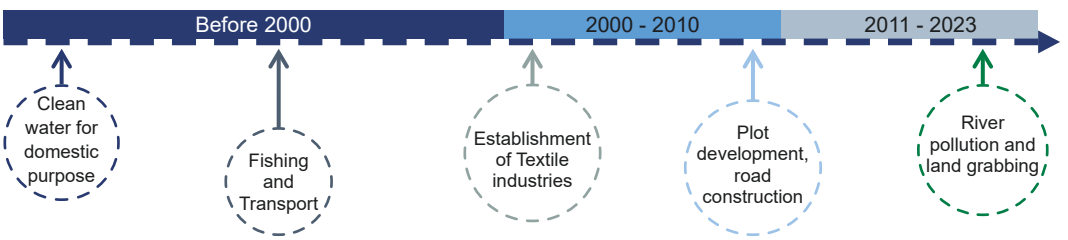

Figure 8.8: Timeline of changes along the Turag River

Source: Authors, 2023

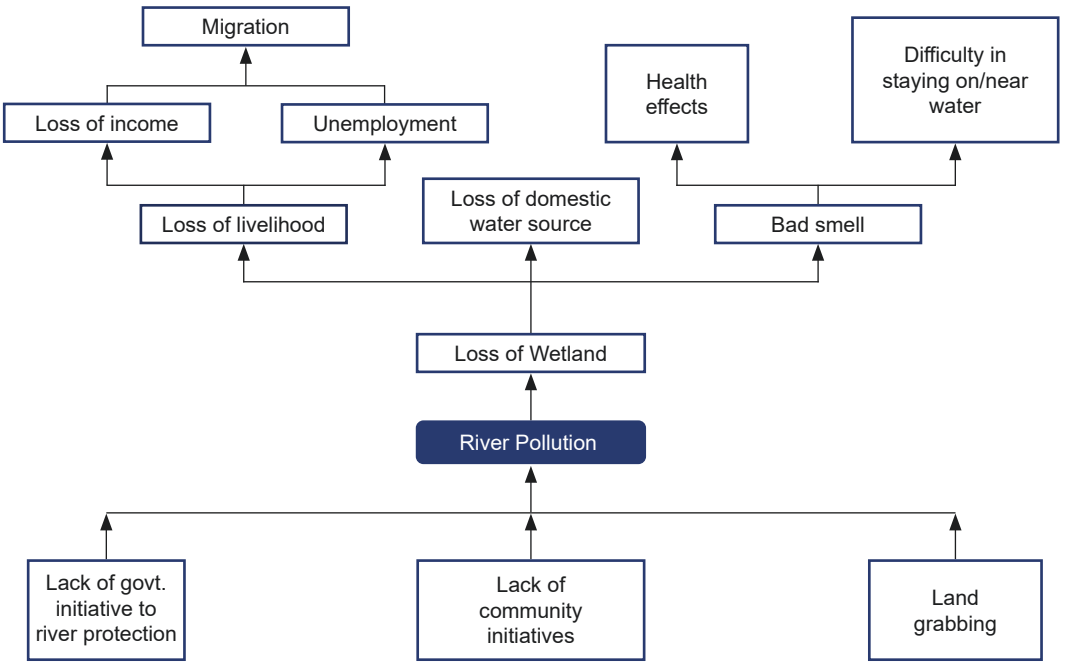

Figure 8.9: Cause-effect diagram of loss of wetlands in Turag River

Source: Authors, 2023

3.4.3 Kamrangir char, Buriganga river

Buriganga river has been a prominent river of Bangladesh for its importance in trade. But is now of the most polluted rivers in the country due to unregulated waste dumping from the industries. This river had high water level and used to flood both of its bank during the rainy season. As the river was a source of trade, the transport of goods was the main occupation of the people here. This river had different types of fish which was the livelihood of many of the local people. Major occupations for the local people were fishing and Boatman. But establishment of different industries like dying, tanning, pharmaceuticals, mills and factories along the river has made it an untreated waste dumping ground. Many mills and factories dump their unprocessed waste in the river without following any govt. regulations. As a result, the river is heavily polluted and the river water actually biologically and chemically dead (Figure 8.13).

As a result, fishes are decreasing and there is hardly any scope for the fisherman (Figure 8.12). The water has turned completely black and have really bad smell specially in winter (Figure 8.12). Also, the river has lost its flow and diminished in length which has impacted the livelihood of the boatman. The bad odor also makes it harder for people to live near the water. There is also the issue of land grabbing at the shore of the river which has seen no govt. intervention or other initiatives to stop it. Many local people have migrated

from this area due to the loss of livelihood options. Now-a-days, most people are working in the industries nearby or involved in different types of business-like markets, shops as their previous occupations are no longer viable (Figure 8.10). But workers of the industries and the people living nearby are suffering from different health impacts due to pollution. Very few people have continued their occupation of boatman as it does not have demand (Figure 8.11). This is how the once mighty economic hub of our country has turned into a dead part because of lack of govt. regulation in industrial and other waste treatment and there has been hardly any effective initiative to control the pollution. It is high time to protect these wetlands of high importance to ensure the hydrological, ecological and economic balance in the country.

Figure 8.10: Livelihoods of the local people of Buriganga river

Source: Authors, 2023

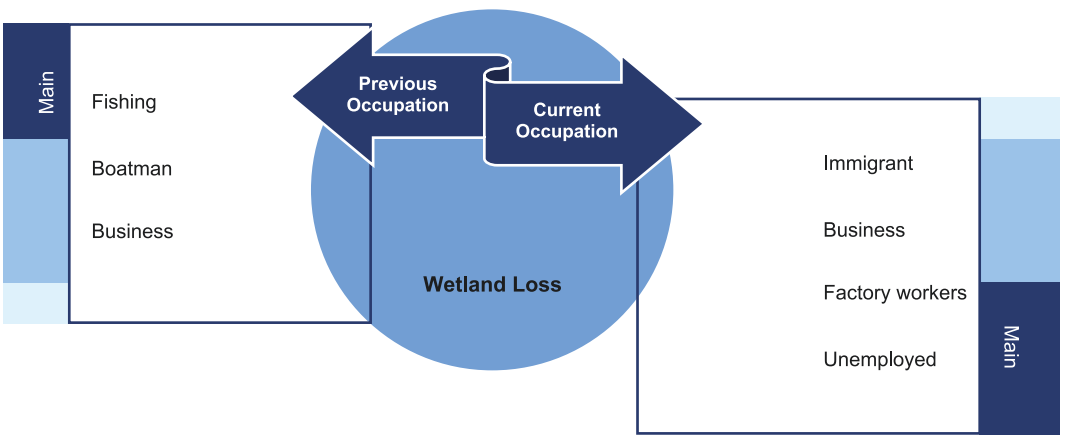

Figure 8.11: Change in occupation of local people due to loss of wetland

Source: Authors, 2023

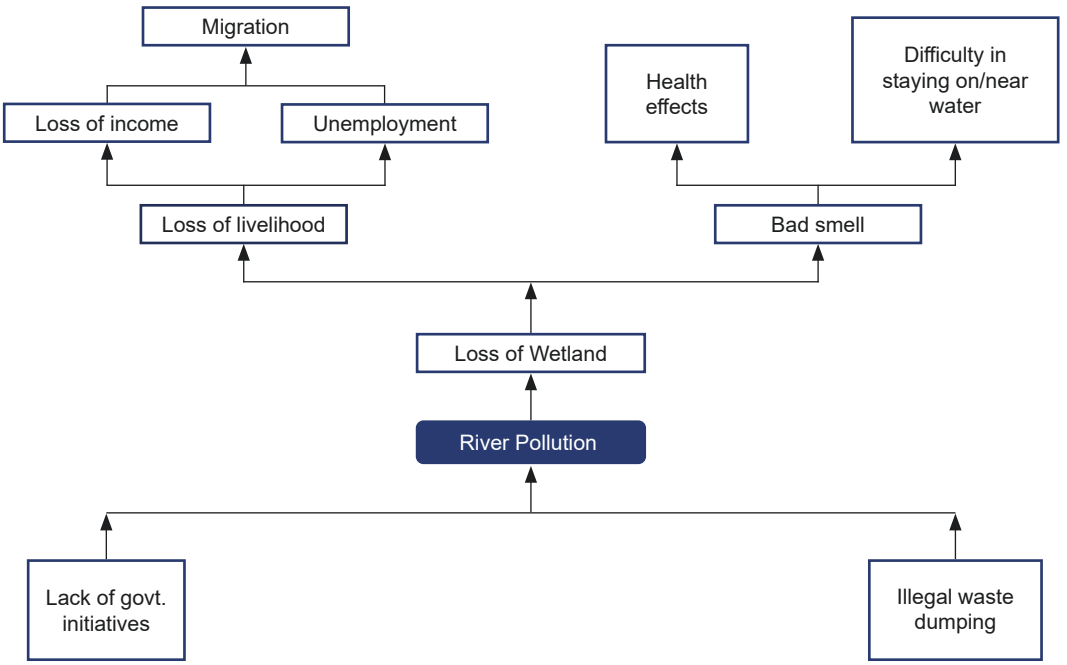

Figure 8.12: Cause-effect diagram of lWoss of wetlands in Buriganga River

Source: Authors, 2023

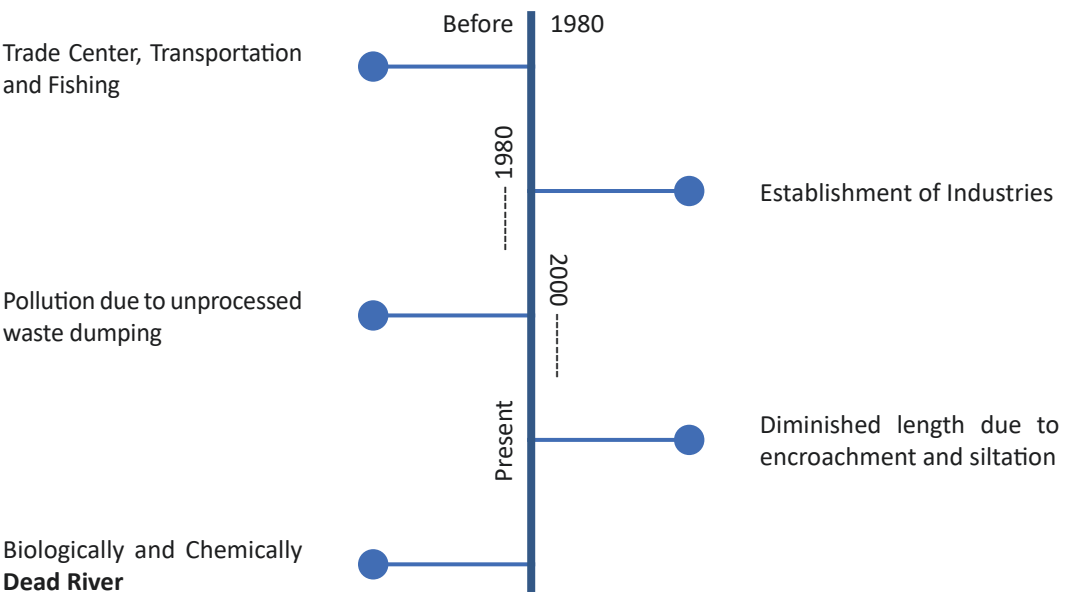

Figure 8.13: Timeline of changes along the Buriganga River

Source: Authors, 2023

3.5. Livelihood Framework

The livelihood framework is an incredible way to understand the gaps and prospects in the existing livelihood situation. To understand the impact of wetland loss on the social and economic aspects, a livelihood framework was made (Figure 8.14). As wetlands are disappearing due to various vulnerabilities, it is affecting the capital assets of the local people. As the wetlands were rich with many natural resources, it has heavily impacted the natural capital of the surrounding communities resulting in loss or change in livelihood. This has consequently affected their financial and physical capitals. Change in livelihood and income has forced local people to relocate or reinvent their lifestyle which has impacted their human and social capital. To address these impacts on local communities, there is need of policy interventions and formulation of necessary strategies regarding the loss of wetlands. That's how, we can reduce the vulnerability of those people and empower them.

3.6. Recommendations

The loss of wetland has massive impact on the lives of surrounding local people. To mitigate these impacts and improve the lives of surrounding communities following measures are recommended –

- ***Community strengthening to prevent land grabbing:*** Land grabbing by illegal means has been a major concern in losing wetland by the local communities. Community strengthening is the most fitting process to prevent land grabbing. There have been instances where some waterbodies were protected through collective effort of community people. They fought against the encroachers as a community and even withstand physical altercations. But with time these confrontations become more gruesome due to political influences and more people were forced to sell or vacate their lands. Land encroachers like real estate developers buys land near the waterbodies and later landfills in name of construction. That is how the wetlands are disappearing from country. But these can be stopped by empowering the surrounding communities of these wetlands. If they are united, it will be harder for encroachers to seize these lands or force people to leave their lands. Community people can raise awareness among themselves and be aware of such activities. They can form teams to protect their lands against encroachers and take different initiatives. There is also need of assistance from government and non-government organizations to the communities in protecting the wetlands. Thus, the community could be the key in protecting and nurturing our wetlands.
- ***Identification of stakeholders and their role to mitigate pollution:*** It is important to understand the sources and relevant patrons of pollution of our waterbodies to protect them. One of the main reasons of loss of wetlands is sever pollution from different sources. The main sources of pollution are –

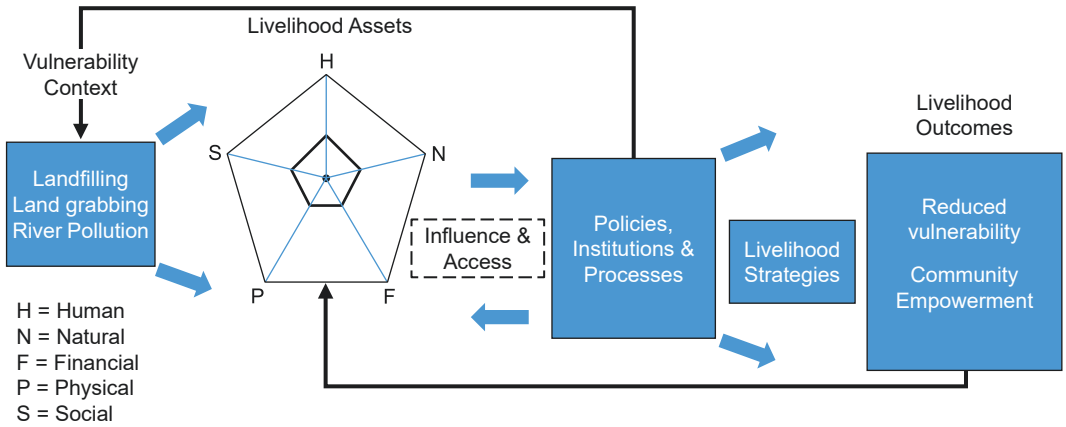

Figure 8.14: Livelihood Framework

Source: Authors, 2023

untreated industrial waste and stormwater. Different industries have been developed along the rivers as industries require large amount water. But they misuse this valuable resource and dump untreated industrial wastes in the river and consequently pollute the rivers. Also, untreated stormwater from city areas is dumped into the rivers and pollutes rivers. There is need of understanding their role in the pollution to take appropriate measure. So, to reduce pollution, industries should be held responsible to the pollution and authorities should take strict action regarding those. Also, proper stormwater treatment and management should be maintained by the relevant organization to reduce the pollution.

- ***Reclamation of wetlands:*** Wetlands are vanishing all over our country due to various reasons. A major approach in this could be the reclamation of our disappearing wetlands. That way, wetlands will be recovered and return in their true form. Relevant government agencies should take steps to recover the encroached or filled wetlands and manage these accordingly. That way, local communities will once again have access to the resources wetlands has to offer and improve their living condition.

4. Conclusion

Wetlands are vital to the human well-being as the source of enormous resources providing economic growth and protection from environmental crisis. For this purpose, the Ramsar Convention aims to ensure the conservation and wise use of wetlands which is also integrated into the sustainable development goals. As the signatory of these global commitments, Bangladesh needs to take appropriate measures to protect the wetlands of this riverine land. Sadly, even though there are different national policy

and guidelines for wetland protection, those are not implemented properly. There is misuse of power and disobedience to the regulations leading to illegal landfilling, land grabbing and river pollution. The ultimate result of which is the loss and disappearance of our precious wetlands. The main victim of this process are the local people who lost their livelihood and source of income, land and other assets, connection to their community and beloved rivers. The local communities are forced to migrate for alternative economic opportunities and they are not better off. So, it is high time to take strict action to stop the loss of wetlands and formulate strategies to support the local people in this transition of life. Otherwise, the wetlands would become a myth for the future only to be imagined.

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Section

3

Planning, Legislative and Institutional Framework

Chapter 9

A Study on the Evaluation of Urban Wetland Management of Bangladesh Regarding the Ramsar Convention

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1. Introduction

Wetlands are dynamic ecosystems that provide numerous ecological services. These wetlands contribute to the sustainability and resilience of cities by reducing the risk of flooding, replenishing drinking water sources, and improving water and air quality (Ramsar Convention Secretariat, 2018). Beyond their ecological functions, urban wetlands significantly contribute to enhancing the quality of human life by providing recreational spaces and serving as a source of income for local communities (Ramsar Convention Secretariat, 2018). However, worldwide rapid urbanization has resulted in an increased demand for land, posing a significant threat to urban wetlands. 64-71%, wetlands of the world was lost in the 20th century were about which was even notably higher for Asia (Davidson, 2014). Considering the projected increase in urban population to 68% by 2050 (Ramsar Convention Secretariat, 2018), urgent measures are necessary to address this issue and prevent further degradation of urban wetlands.

Several international conventions focus on wetland conservation, recognizing their functional values including biodiversity,

water purification, flood control, and climate regulation. Among them, the Ramsar Convention is the first international environmental agreement dedicated to the conservation and sustainable use of wetlands. It has recognized the challenges posed by urbanization on wetlands. The Convention has encouraged development of policy and practical principles for the planning and management of urban and peri-urban wetlands all over the world. These principles provide contracted parties with a valuable framework for guiding the actions of urban planning and management alongside the wise use of wetlands (Ramsar Convention Secretariat, 2012). Additionally, the establishment of "wetland cities" as a concept and the subsequent accreditation process within the Ramsar Convention demonstrate the growing importance placed on urban wetland protection and highlight the need to integrate wetland conservation into urban planning and management practices (Ramsar Convention Secretariat, 2023).

As one of the fastest-growing urbanizing countries, Bangladesh faces significant challenges in relation to its urban wetlands like many other countries. Rapid urbanization has posed threats to these wetlands, leading to their disappearance and loss of valuable ecological functions (Bala, 2018). As a contracting party to the Ramsar Convention, Bangladesh recognized the importance of its wetlands in urban and peri-urban environments and to implement appropriate measures for their conservation and protection. In other words, Bangladesh has given hard commitments, that are not just promises or intentions but are enforceable and carry significant accountability. The government of Bangladesh has developed various national policies and plans across different sectors that address wetland management. However, despite these efforts, urban wetlands continue to decline. For instance, Dhaka and its surrounding areas witnessed a loss of approximately 23% of wetland areas between 2010 and 2019 (Sakib, 2022). To address these challenges effectively, it is crucial for Bangladesh to deliver the dual goals of wise use of wetlands and sustainable urbanization in the policy framework.

While wetland management policies provide a framework for conserving and managing valuable wetlands, their successful implementation depends on their integration into the broader urban development plan-ning process. The development authorities of Bangladesh formulated many urban development plans, such as master plans and strategic development plans that provide a conceptual layout to guide future growth and development. For example, Master Plans have been prepared for 223 Paurashavas under the project "Upazila Town (Non Municipal) Master Plan Preparation and Basic Infrastructure Development Project (UTMIDP)" by LGED. The project was started in 2018 and is intended to be completed within 2025. Since, paurashavas, one notable consequence of rapid urbanization, are still in the process of establishing stable urban identities

(Morshed, 2022), there is an opportunity to envision and develop them as sustainable living spaces that prioritize wetland conservation. A review of these master plans presents an opportunity to protect wetlands and work towards obtaining "Wetland City Accreditation."

In this context, the primary goal of the study is to evaluate the national policy framework of Bangladesh in relation to the principles of planning and managing urban and peri-urban wetlands, as outlined by the Ramsar Convention. This evaluation aims to provide an understanding of how well the policy framework aligns with the principles and guidelines established by the Convention for urban wetlands. Additionally, the study seeks to assess the master plans of upazilas, considering the criteria for wetland city accreditation. It will evaluate the integration and implementation of wetland conservation principles and guidelines within the urban development plans at the local level.

2. Ramsar Convention and Urban Wetlands

Historically, the Ramsar Convention on Wetlands of International Importance primarily focused on wetlands in rural areas, with limited attention given to wetlands in urban environments (Sirakaya, Cliquet, & Harris, 2018). However, this scenario changed over the years (Figure 9.1).

The change started through Resolution X.27, adopted at the Conference of Parties in 2008, where the issue of "wetlands and urbanization" was emphasized. This led to the establishment of "principles for the planning and management of urban and peri-urban wetlands" through Resolution XI.11 in 2012. The resolution outlined five policy recommendations, accompanied by practical principles for sustainable urban development and wise use of wetlands. The governments of the signatory countries should consider these policy recommendations when developing policies that address urban planning and wetland conservation. The principles emphasize the following five areas (Table 9.1).

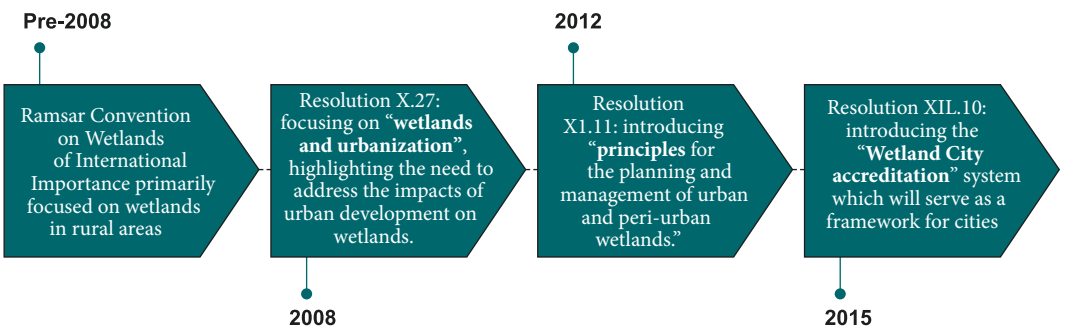

Figure 9.1: Timeline of Ramsar Convention regarding Urban Wetlands

Source: Scientific & Technical Review Panel (STRP) et al., n.d.

Table 9.1: Principles for the planning and management of urban and peri-urban wetlands

Policy Recommendation	Practical Principle
Wetland Conservation	Urban development should prioritize the preservation of wetlands and avoid their destruction whenever feasible.
Wetland Restoration and Creation	Wetlands should be regarded as a vital element of urban planning and water management systems to ensure restoration and creation, thereby improving ecological integrity and maximizing the delivery of ecosystem services. Prioritizing restoration of existing wetlands above the establishment. Wetlands should only be created in situations when there are no other options, and they are connected to social and economic projects that take ecosystem services into account. This should be done in accordance with the legislation of each Contracting Party.
Understanding the Value of Wetlands	There is an urgent need to explore opportunities to alleviate urban poverty by effectively utilizing wetland ecosystem services in a sustainable manner, following the principles of wise use. It is essential to consider the trade-offs related to livelihood options and the equitable distribution of economic benefits, which involve both market dynamics and state intervention. Incentive mechanisms, such as payments for environmental services, should be implemented within urban settings and beyond to safeguard wetland ecosystems. The significance of wetlands must be clearly articulated to urban planners to aid in their decision-making processes, including making the costs associated with wetland loss and degradation transparent within urban development plans.
Stakeholder Engagement	Urban development and wetland management should embrace principles that prioritize inclusivity, empowerment, and active participation of indigenous and local communities. The governance of urban development and wetland management should involve a participatory approach, engaging all relevant stakeholders and decentralizing authority to the lowest feasible level.
Integrated Planning	Thematic planning should be used as an essential tool to safeguard wetlands and their ecosystem services both within and beyond urban settlements. Integrating the consideration of wetlands into urban planning requires a comprehensive approach that incorporates broader aspects of spatial planning, such as Integrated River Basin Management, water resource management, transportation infrastructure development, agricultural production, and fuel supply. Alternative sites must be identified for planned urban developments to prevent the degradation or loss of wetlands and other natural ecosystems.

Source: Scientific & Technical Review Panel (STRP) et al., n.d

Additionally, the Ramsar Convention introduced the voluntary Wetland City accreditation system through Resolution XII.10 in 2015 (Figure 1), which serves as a framework for cities to enhance biodiversity preservation, ecosystem services, and the sustainability of urban environments. According to the resolution,

An accredited Wetland City (urban or rural) is one which, through its inhabitants, its local government and its resources, continuously promotes the conservation and wise use of any Ramsar Site(s) and other wetlands within or nearby the limits of the city, respecting its physical and social environment and its heritage, while supporting the development of a sustainable, dynamic and innovative economy as well as educational initiatives in connection with these Wetlands.

To be formally accredited as a Wetland City by the Ramsar Convention, a candidate city should meet specific international criteria, which include:

- Having one or more Ramsar Sites or other wetland conservation sites partially or fully located within its jurisdiction that provide a range of ecosystem services to the city.
- Adopting measures to conserve wetlands and the ecosystem services they provide.
- Implementing wetland restoration and/or management measures.
- Considering the challenges and opportunities of integrated spatial/land-use planning for wetlands within its jurisdiction.
- Raising public awareness about the values of wetlands by delivering locally adapted information and facilitating the participation of local stakeholders in decision-making processes.
- Establishing a local committee with appropriate knowledge and experience on wetlands, as well as representation and engagement with stakeholders

Embracing and meeting the accreditation criteria is essential for the long-term preservation of biodiversity, the provision of valuable ecosystem services, and the development of sustainable and resilient urban environments. By integrating wetland conservation into urban planning and decision-making processes, cities can foster a positive relationship with wetlands, ensuring benefits for the present and future generations.

3. Policy Framework of Bangladesh related to Wetland

The Constitution of Bangladesh, adopted in 1972, ensures fundamental human rights, including the Right to Life. Through a legal interpretation in 1997, this right has been expanded to encompass the Right to Environment under the Right to Life. The Constitution has incorporated the provisions on environment and natural resource management, which states that the state shall endeavor to protect and improve the environment and to preserve and safeguard the natural resource, biodiversity, wetland, forests and wildlife for the present and future citizens through the 15th amendment (Ministry of Water Resources, 2016). This recognition highlights the country's commitment to protecting the environment as an essential aspect of safeguarding the well-being and livelihoods of its citizens.

There is no specific national policy on wetlands in Bangladesh. However, several ministries have developed numerous national policies and plans for various sectors that incorporate guidelines for wetland conservation and management. These policies and plans encompass sectors such as environment, water, fish, forest, and agriculture, which are closely linked to the wetlands in Bangladesh. They are designed to be applied nationwide and are intended to be incorporated into sector-specific policies and plans. The wetland section of these policies and plans has often been generalized and inconsistent in defining and categorizing the wetlands. This gap results in inadequate addressing of wetland management in master plans,

leading to poor implementation and lack of wise use of wetlands. However government is now trying to change the scenario. Recent initiatives by the government, such as the preparation of Haor Master Plan and Classification of Wetlands by the Bangladesh Haor and Wetland Development Board (BHWDB) under the Ministry of Water Resources, demonstrate these efforts.

4. Methodology

4.1 Data Collection

This research is based on secondary data. For the purpose of evaluating national policies concerning the practical principles of planning and managing urban and peri-urban wetlands in Bangladesh within the framework of the Ramsar Convention, the selection of policies for review is centered around environment, water, fisheries, and agriculture sectors, as these are intricately linked with wetlands. Additionally, recent policy documents of national significance and a strategic paper on sustainable development are included in this analysis. These documents (Table 2) have been collected from relevant official government websites.

To evaluate the master plan of urban areas in alignment with the criteria for Wetland City Accreditation, the study focused on the master plans of three specific Paurashavas: Singra, Chhatak, and Rohanpur (Figure 2). Among the 223 upazila-level pourashavas covered by the Master Plan (2011-2031) prepared by the Local Government Engineering Department (LGED), These Paurashavas were selected for as they have significant areas of wetland within their territorial boundaries. For example, the selection of Singra Paurashava was influenced by the presence of the renowned Chalan Beel wetland (Figure 4) area traversing through it. Chalan Beel is one of the country's largest wetlands, encompassing a network of depressions interconnected by various channels, forming a contiguous expanse of water during the rainy season. Chhatak in Sunamganj (Figure 3) was chosen because the northeastern region hosts the majority of the country's wetlands, rendering it highly pertinent for this study. Finally, Rahanpur was incorporated into the study due to its position in a floodplain area and also to address the occasional oversight of wetlands in the northern region. (Table 3) provides a quick overview of general information about the Paurashavas.

4.2 Data Analysis

Since several studies around the world have applied qualitative thematic analysis techniques for analyzing policy documents (Minatto, et al., 2023; Ruhode, 2016; McGrath, 2008), This approach has been used in this study. This method helps identify common themes within texts (Naeem, et al., 2023). In this study, at first, the principles of planning and managing urban and peri-urban wetlands (as outlined in section 2) were extracted. The selected national policy documents were examined to determine whether they included references, strategies, or actions related

to identified principles. This involved a thorough reading and analysis of relevant sections of the documents. The second objective involved the creation of a matrix based on the Wetland City Accreditation criteria (also mentioned in section 2). These matrices proved essential for evaluating the alignment between existing policies-plans and the Ramsar Convention, providing a structured approach to analyzing the policy landscape and master plans.

5. Alignment of National Policy Documents with Ramsar Convention Principles

5.1 Comparison of the Definition of Wetlands

Wetlands have been defined in various ways by different organizations because of their dynamic character (Maithya, 2011). Dugan in 1990)notes that there are more than fifty definitions in current use. It is vital to understand what a wetland entails to ensure optimal management of wetlands and protection of their resource (Lemine, 2018). Ramsar Convention, 1971, Article 1.1 defines wetlands as: "Wetlands are areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters." (Ramsar Convention Secretariat, 2016). This definition captures a wide variety of wetland habitats including rivers, lakes, ponds, marshes, coastal areas, estuaries, bogs, and coral reefs. Furthermore, this definition explicitly includes manmade wetlands such as canals, reservoirs, and aquaculture ponds. Because of its larger extent, countries can adapt or modify this definition to fit their specific biogeographic conditions (Kruchek, 2003). Rivers, floodplains, lakes, *Haors*, baors, jheels, ponds, low-lying areas, etc are generally perceived as wetlands in Bangladesh (Ministry of Water Resources, 2016). According to the Ministry of Water Resources (2016), a definition of wetlands in the context of Bangladesh is quoted as follows,

> *Wetlands are defined as the areas of land surface which are flooded seasonally or remain under water permanently, either naturally or artificially, they may perform some known functions such as water reservoir, ground water recharge, capture fishery area, aquaculture fish sanctuary, wildlife sanctuary, navigation channel, cultivated area etc.*

The Bangladesh Water Act, 2013 defines wetlands in a narrow aspect focusing on wetlands as a land reserving water at the level of surface or close to it which overflows with shallow water from time to time and where such plants grow that survive naturally in marshland. Considering the importance and context of wetlands in Bangladesh and definition provided by Ramsar convention, the wetlands of Bangladesh are classified into four groups by Bangladesh Haor and Wetlands Development (Ministry of Water Resources, 2016).

Table 9.2: List of Reviewed Policy Documents

Category of the document	National Policy and Planning Document	Prepared by
Policies	National Environmental Policy 1992	Ministry of Environment and Forest
	National Fisheries Policy 1998	Ministry Of Fisheries and Livestock
	National Water Policy 1999	Ministry of Water Resources
	National Agriculture Policy 1999	Ministry of Agriculture
	National Land Use Policy 2001	Ministry of Land
	National Environment Policy 2018	Ministry of Environment, Forest and Climate Change
	National Agriculture Policy 2018	Ministry of Agriculture
Plan	National Environment Management Action Plan 1995	Ministry of Environment and Forest
	National Water Management Plan 2004	Ministry of Water Resources
	Bangladesh Delta Plan 2100	Bangladesh Planning Commission
	National Adaptation Plan of Bangladesh (2023-2050)	Ministry of Environment, Forest and Climate Change
Strategic paper	National Sustainable Development Strategy 2010-2021	Bangladesh Planning Commission

Table 9.3: General Information related to the Paurashavas

	Chhatak	Singra	Rohanpur
Upazila	Chhatak	Singra	Gomastapur
District	Sunamganj	Natore	Chapai Nawabganj
Area in acres	2495.764	2703.74	3577.42
Percentage of water bodies	14.67%	12.85%	5.80%
No. of Wards	9	12	9
Projected gross population density	201 person per acre	26 person per acre	13 person per acre

Source: Ministry of Local Government, Rural Development & Cooperatives, (2015a, 2015b, 2015c)

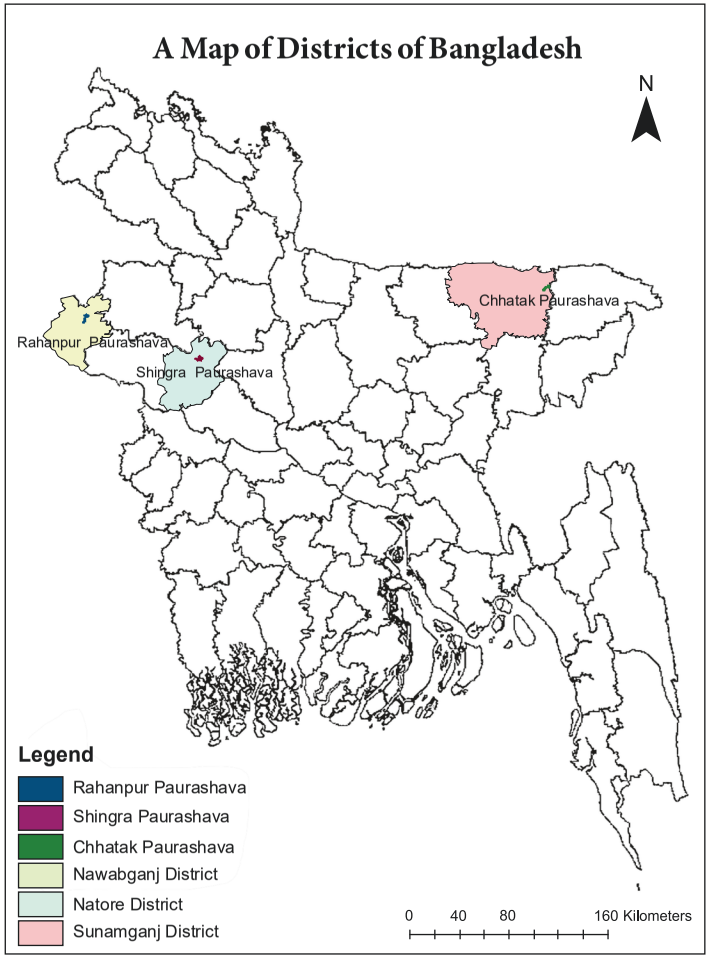

Figure 9.2: A map of Bangladesh showing the study area

Source: Author, 2023

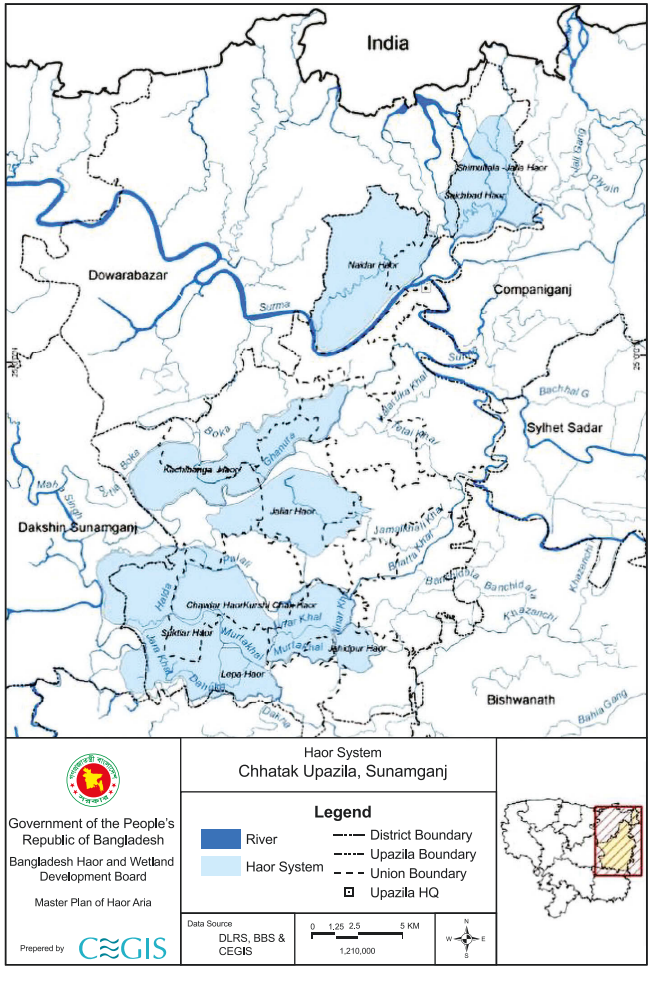

Figure 9.3: Haor system of Chatak Upazila

Ministry of Water Resources, 2016

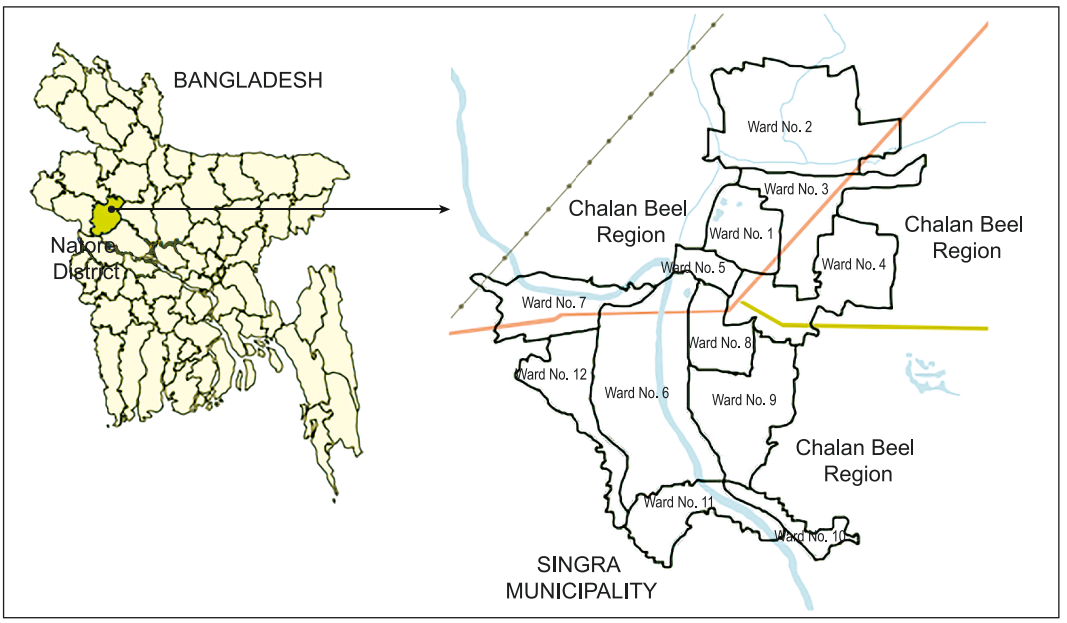

Figure 9.4: Location of Singra within the Chalan Beel

Source: Singra Municipality, Bangladesh, 2022

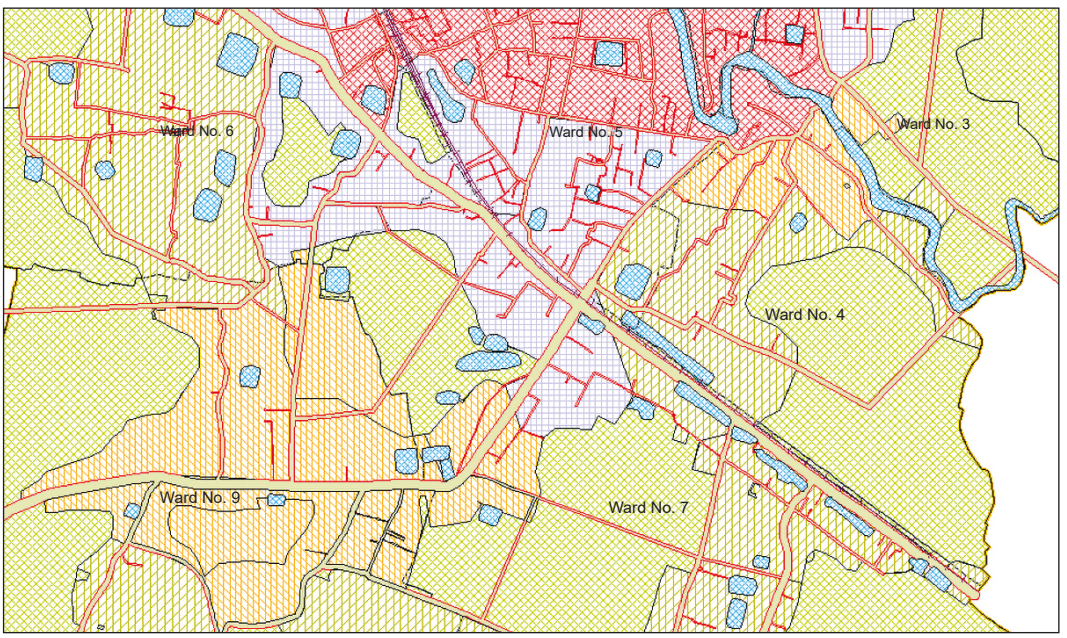

Figure 9.5: Portion of water bodies (blue hatched) of Rohanpur Paurashava

Source: Ministry of Local Government, Rural Development & Cooperatives, 2015b

These are coastal wetlands, inland wetlands, human-made wetlands, and reversible wetlands. The recently gazetted Detailed Area Plan of Dhaka (2022-2035) has classified rivers, canals, lakes, and ponds as wetlands and has explicitly marked them for conservation. Since there are various definitions in Bangladesh, it often leads to confusion and ultimately rarely followed. However, one of the positive sides of these definitions is emphasizing the functional aspects of wetlands.

5.2 Strengths and Weakness of the Policy Documents

Throughout time, policies have transformed how they deal with urban wetlands, as illustrated in figures 6 and 7.

Since Environment Policy 2018, Bangladesh Delta Plan 2100, and National Adaptation Plan of Bangladesh (2023-2050) are currently in action and the most relevant documents, they are further reviewed to get a comprehensive picture of urban wetland management.

The Environment Policy 2018 emphasized wetland protection, along with ensuring vital ecosystem services. The policy calls for wetlands to be considered in land-use decisions and measures to prevent contamination of urban wetlands. Moreover, it aligns wetland management with climate resilience strategies. Bangladesh Delta Plan 2100, as a long-term plan, provides a comprehensive, long-term strategy for wetland conservation and climate resilience. It promotes the integration of wetlands into broader water management systems and prioritizes the restoration and rehabilitation of degraded urban wetlands. Additionally, it emphasizes the role of wetlands in mitigating climate change impacts and advocates for the inclusion of wetlands in urban planning and development processes.

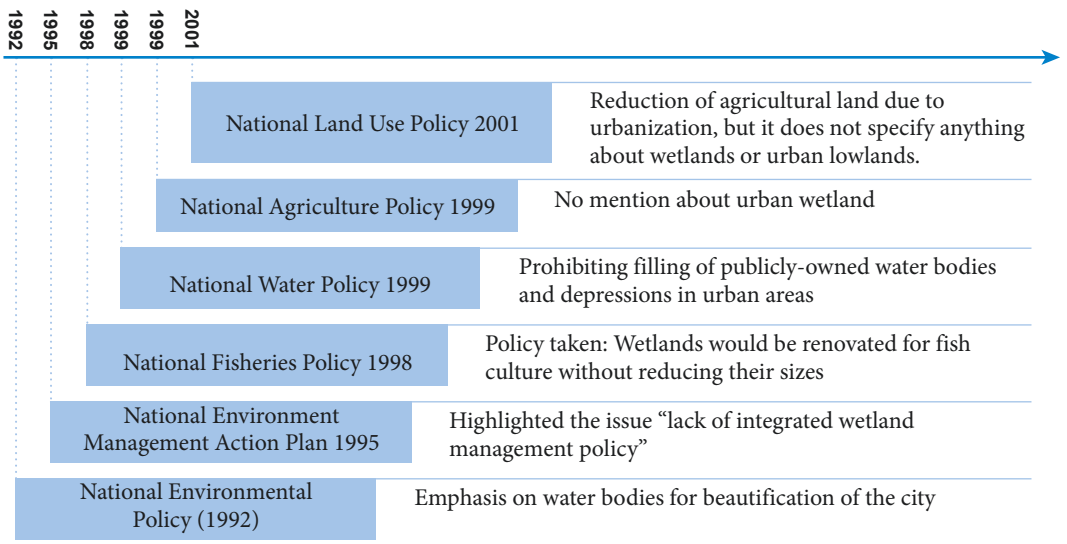

Figure 9.6: Timeline of National Policy Documents in the 20th Century

Source: Author, 2023

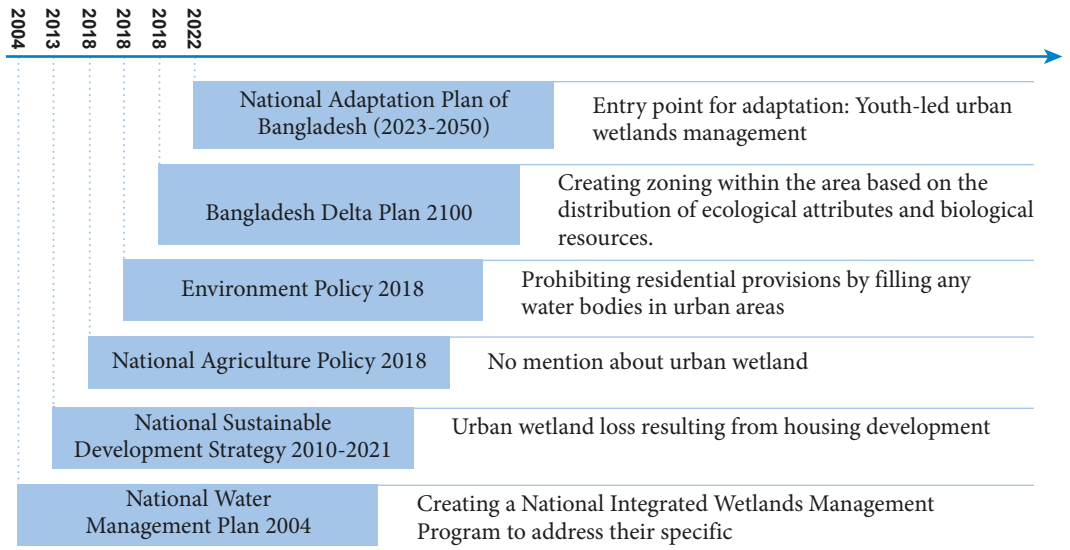

Figure 9.7: Timeline of National Policy Documents in the 21th Century

Source: Author, 2023

Lastly, similar to the Delta Plan, the National Adaptation Plan of Bangladesh (2023-2050) prioritizes wetlands as key components in urban climate resilience strategies and promotes the use of wetlands in ecosystem-based approaches to enhance urban resilience. Recognizing the significance of a bottom-up management system, these three documents encourage public involvement and awareness in urban wetland management efforts.

On the other hand, rapid urbanization makes it difficult to implement wetland conservation policies effectively, as profitable developments such as expanding infrastructure and housing developments often encroach upon wetland areas. A clear commitment to balance the development is missing. The policy documents do not adequately address the financial and technical resources needed for effective wetland management. Without clear guidance on securing these resources, urban areas may face challenges in implementation, leading to incomplete or ineffective outcomes.

The policies lack strong monitoring and enforcement frameworks. This weakens accountability and can lead to the degradation of urban wetlands despite formal protections. the coordination challenges posed by the involvement of multiple government agencies is not addressed in the policy documents which may lead to inefficiencies and delays in implementation.

5.3 Policy Alignment

To evaluate the extent to which the principles outlined in Resolution XI.11, "Principles for the Planning and Management of Urban and Peri-urban Wetlands," have been addressed in the reviewed policy documents (mentioned in Table 1), a linkage assessment has been conducted (Figure 8).

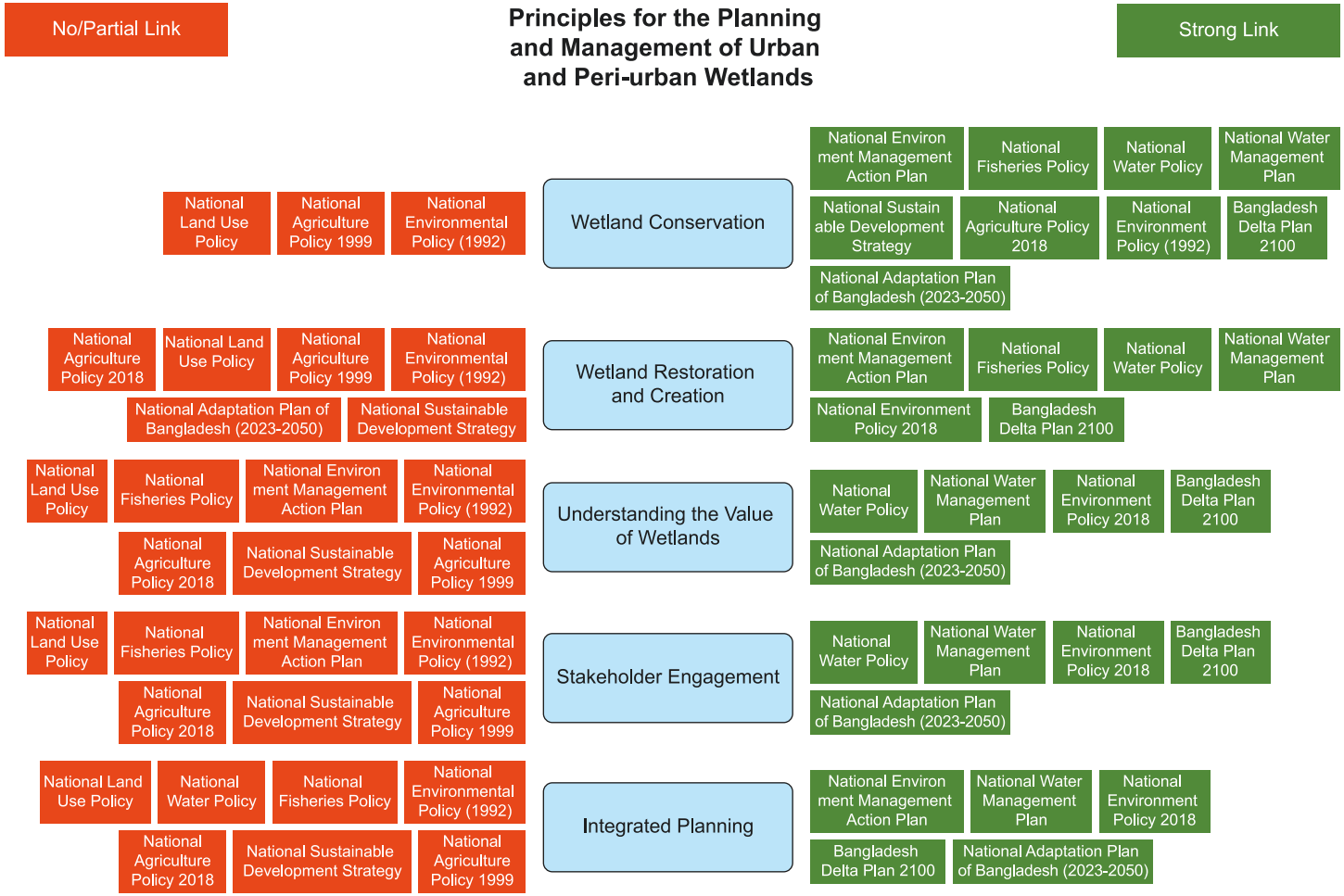

Figure 9.8: Linkage Assessment of Policy Documents

Source: Author, 2023

The linkage assesses the alignment between the principles and the content of the policy documents, providing insights into the incorporation of these principles in the policy framework.

Bangladesh has made commendable efforts in recognizing the significance of wetlands through its Playground, Open Space, Park, and Natural Water Reservoir Conservation Act of 2000, which lays the legal foundation for wetland conservation. This led to an early recognition of the importance of urban wetland conservation in the country's policy papers related to the water sector (National Water Policy 1999 and National Water Management Plan 2004) by integrating the five principles of managing urban and peri-urban wetlands before the Ramsar Convention began emphasizing them in 2008. This indicates a proactive approach to addressing the unique challenges and opportunities presented by urban wetlands in the country. Given Bangladesh's unique geography and heavy reliance on water resources, the water sector takes precedence. Therefore, the recognition and protection of wetlands through legal frameworks have been and will remain crucial.

However, the analysis also reveals a mixed picture in terms of the consistent application of these principles across different policy documents during that time frame. The National Sustainable Development Strategy 2010-2021, the first document published after the establishment of the "Principles for the planning and management of urban and peri-urban wetlands" in 2013, primarily emphasized safeguarding wetlands and natural ecosystems in urban areas.

The Sustainable Development Strategy document is a response to the crucial environmental concerns tied to the country's progress. These challenges emerge when development projects fail to sufficiently account for their environmental consequences, resulting in problems like degraded agroecosystems, declining rivers and wetlands, urban and coastal environmental degradation. Despite the NSDS being a comprehensive document with the potential to tackle wetland issues from various perspectives, it only emphasized safeguarding wetlands due to housing development. In 2018, three key policy documents were released in Bangladesh: the National Agriculture Policy, the Environment Policy 2018, and the Bangladesh Delta Plan 2100. While the National Agriculture Policy primarily focused on the overall conservation of wetlands, the other two policies, the Environment Policy 2018 and the Bangladesh Delta Plan 2100, took a more comprehensive approach by incorporating all five principles for managing urban and peri-urban wetlands. By incorporating all five principles, these policies demonstrate a commitment to sustainable wetland management and conservation in urban areas.

6. Analysis of Master Plan regarding Wetland City Accreditation Criteria

To be considered for wetland city accreditation, the city needs strong legal or policy instruments, backed by appropriate regulation and enforcement, to demonstrate its commitment to preserving wetlands and avoiding their degradation. Having a master plan for the paurashava initiates the first step towards meeting the criteria.

6.1 Overview of the Master Plans

The Master Plan for the Paurashava in Bangladesh comprises three tiers: The Structure Plan for 20 years, the Urban Area Plan for 10 years, and the Ward Action Plan for five years. The Structure Plan outlines the conceptual framework and strategies for planned development based on the potential of the paurashavas. Within this plan, the paurashavas are divided into various zones, including a designated water body zone. The Urban Area Plan is a phased illustration of the Structure Plan, spanning 10 years and comprising two phases for development initiatives. This plan includes components such as Land Use Plan, Transportation and Traffic Management Plan, Drainage and Environmental Management Plan, and Urban Services Proposals. Lastly, the Ward Action Plan delineates implementation proposals for the initial five years, aligned with the Structure Plan.

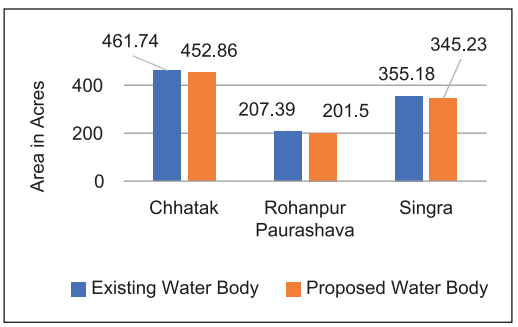

Figure 9.9: Comparison between Existing and Proposed Area of Water Body

Source: Ministry of Local Government, Rural Development & Cooperatives, (2015a, 2015b, 2015c)

The studied Pourashavas displayed a varied land use pattern, with water bodies playing a pivotal role. Consequently, these water bodies are distinctly highlighted zones in the master plan, with specified strategies outlined for their management. However, the proposed water body zone area is smaller than the existing ones (Figure 9). Table 4 illustrates strategies proposed for each Paurashava, accompanied by their respective strengths and weaknesses.

6.2 Gaps in the Master Plans

As discussed earlier, the implementation of these policies involves formulating and implementing the master plans. One prominent concern within the selected Master Plans is the lack of uniformity in defining water bodies, providing an opening for certain opportunistic individuals to potentially exploit this vital natural asset. This concern aligns with the findings of the study of Turner, et al. (2000) which highlighted the critical importance of a standardized and legally binding definition for water bodies. Considering that the Playground, Open Space, Park, and Natural Water Reservoir Conservation Act of 2000 explicitly defines natural wetlands, it is sensible to follow to this established definition. The land use plan under the Urban Area Plan specifically takes wetlands into account, which are the central focus of the study, when defining water bodies under the Proposed Land Use Categories. This decision was made after extensive consultations between Paurashava personnels and project consultants, highlighting the importance of including public opinions. Notably, the floodplain and low-lying areas within the Paurashava are not designated as water bodies in the plans. This stands in contrast to the "Playground, Open Space, Park, and Natural Water Reservoir Conservation Act,

2000," which incorporates flood flow zones and rainwater catchment areas within its definition of natural wetlands. In areas like Dhaka, where preventing encroachment of flood flow zones remains a formidable challenge despite their demarcation in the Detailed Area Plan, safeguarding these zones at the paurashava level would prove even more challenging without their explicit demarcation in the master plan.

All three paurashavas seem to adopt similar strategies for managing water bodies. This implies a lack of differentiation based on the unique characteristics or requirements of each specific area.

Table 9.4: Suggested strategies for Water Bodies in the Master Plans

	Suggested Strategies	Loopholes	Strong Points
Chhatak Paurashava Master Plan: 2011-2031	• Preservation of 180 ponds (≥ 0.25 acres) outlined in the Structure Plan, while the Urban Area Plan recommends the conservation of 142 ponds (≥ 0.20 acres). • Vesting all natural canals within the Pourashava under its jurisdiction for proper maintenance and use as drainage canals.	• Advocating water body preservation and simultaneously planning infrastructure for recreational purposes (Fishing club, utility lines, water parks, and memorial structure) within government wetlands, ponds, and ditches. • Transfer of responsibility to private sector management, with fixed charges for maintenance risks prioritizing business over water body conservation, potentially leading to commercial development near these vital ecosystems.	• Environmental management plan recommends several actions including officially designating ecologically important ponds on the Master Plan Map, avoiding wetland areas when planning roads, halting developments involving wetland filling, and raising public awareness against such practices
Rohanpur Paurashava Master Plan: 2011-2031	• Designating 180 ponds, each with an area equal to or greater than 0.25 acres, as retention areas to ensure strict prohibition against their filling. • The Paurashava to take ownership of all natural canals within its jurisdiction, ensuring their maintenance and appropriate use as drainage channels.		• The permitted land uses in the zone of water body include aquatic recreation facility without structure.
Singra Paurashava Master Plan: 2011-2031	• 171 ponds with an area equal to or greater than 0.25 acres have been designated as retention areas to ensure sustainability in the drainage and water supply of the Paurashava		-

Source: Ministry of Local Government, Rural Development & Cooperatives, 2015a, 2015b, 2015

The regulations and strategies seem to apply only to a specific number of ponds that are explicitly marked as water bodies in the master plan. This raises a concern that other potentially valuable water bodies might not receive the same level of protection or planning. In contrast to paurashavas in Bangladesh where areas smaller than 0.2 acres are not designated as water bodies, Liangping, a recognized Wetland Accredited city, has introduced a pioneering model for conserving and restoring small-scale wetlands. This approach showcases over 400 model micro-wetlands and has gathered global recognition. Similarly, in the coastal region of Shandong Province in eastern China, Jining boasts 32 wetland towns, 56 wetland villages, and 124 micro-wetlands (Xinhua, 2022).

The Master Plans primarily emphasized the utilization and preservation of water bodies for retention purposes, with some allocated for recreational use. However, it's important to recognize that wetlands hold a far broader

potential beyond these designated roles. Examining accredited cities provides valuable insights into innovative approaches. For instance, Liangping, China, involves the integration of organic industries, local guesthouses, and ecological tourism within wetland areas.

Lastly, since there is no single entity available to manage wetlands in Bangladesh, the activities are widespread among different organizations. Some of the identified implementation agencies include the Ministry of Land, Paurashava, NGOs and CBOs, and the water development board. However, the directives for their coordination are not explained

6.3 Wetland City Accreditation

The three chosen Paurashavs meet the initial criteria required for Wetland City Accreditation as they possess wetland conservation sites within their administrative boundaries. In Singra, the substantial contribution of wetlands, the presence of the Atrai and Gurnai rivers, along with various canals, aligns with this criterion. Similarly, Rohanpur, situated in the floodplain of Padma River and Punarvaba River, and the flood-prone areas with numerous ponds and canals, also fulfills this condition.

Moreover, to be considered for wetland city accreditation, the city needs strong legal or policy instruments, backed by appropriate regulation and enforcement, to demonstrate its commitment to preserving wetlands and avoiding their degradation. Having a master plan for the paurashava initiates the first step towards meeting the criteria.

The following table (Table 5) has been generated to further assess the master plans of three paurashavas to determine how effectively they integrate and address the criteria for wetland city accreditation.

It is evident that the criteria for wetland city accreditation have not been effectively addressed in master plans. The crucial elements of spatial planning and integrated city management, the establishment of a local committee, as well as the principles of inclusivity, empowerment, and participation of local stakeholders, along with raising public awareness about the value of wetlands, have been overlooked in this translation process.

7. Conclusion

The critical role played by urban wetlands in delivering essential ecological services, bolstering city sustainability, and enhancing the urban quality of life is known to all. The swift pace of urbanization, however, poses a significant threat to these dynamic ecosystems, necessitating the establishment of robust policy frameworks. This initiative serves as a tangible connection between Sustainable Development Goal 11: "Foster inclusive, safe, resilient, and sustainable cities and communities", and SDG6 "Guarantee availability and sustainable management of water and sanitation for all." Focusing on Bangladesh, a country experiencing rapid urbanization, our study evaluated its national policy framework and master plans for urban and peri-urban wetland management. This assessment was guided by the principles set forth by the Ramsar Convention. While our investigation revealed notable efforts, including the integration of wetland conservation principles in water sector policies, we identified a crucial gap in translating these policy principles into tangible master plans. This study calls for urgent action, urging policymakers and urban planners to bridge the divide between policies and master plans. This crucial step is imperative for ensuring the sustainable preservation of urban wetlands, which are irreplaceable elements of our urban landscapes. The following recommendations would be invaluable for policymakers in ensuring effective urban wetlands management.

Table 9.5: Linkage assessment matrix

Criteria	Chhatak	Singra	Rohanpur
Wetland conservation site that is fully or partly in the city administrative boundaries	✓	✓	✓
National and/or local policy, legislative or other appropriate measures and regulatory instruments	✓	✓	✓
Restoration and creation of wetlands	✓	✓	✓
Spatial planning and integrated city management	✗	✗	✗
Established a local committee	✗	✗	✗
Principles of inclusivity, empowerment, and participation of local stakeholders	✗	✗	✗
Raised levels of public awareness about the value of wetlands	✗	✗	✗

Source: Author, 2023

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7.1 Adopting a Standardized Definition and Classification of Wetlands:

It is essential to develop a standardized definition and classification system for wetlands that will be followed countrywide for every master plan. This standardization will provide a clearer understanding of wetland types, functions, and services, facilitating more effective conservation strategies. This definition and classification must be imposed over all the existing policy documents to ensure consistency in wetland management.

7.2 Developing Comprehensive Wetland Management Guidelines

Though all the existing policy documents have addressed the management aspect of wetlands, the information is fragmented and often complex to refer to. Therefore, there should be a dedicated wetland management guideline, mentioning the key stakeholders, their roles, responsibilities, and management mechanisms. This guideline must be adaptable to local environmental and socio-economic conditions, providing clear directives for the coordination among government agencies, local communities, and stakeholders. Moreover, it must address financial and technical resources necessary for effective urban wetland management.

7.3 Incorporating Innovative and Sustainable Practices

Innovative and sustainable practices should be integrated into wetland management, taking into account the local geographic uniqueness, such as topography, climate, biodiversity, and hydrological dynamics of different regions of Bangladesh. Local knowledge, indigenous practices, and adaptive management techniques should be incorporated to create context-specific solutions that enhance the ecological health of wetlands while supporting local livelihoods.

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Chapter 10

Wetland Protection: Gaps in Legal and Regulatory Framework

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1. Introduction

Wetlands in Bangladesh are essential ecosystems that provide a range of critical environmental, social, and economic benefits, such as groundwater replenishment, flood mitigation, biodiversity preservation, and livelihood support. Despite their importance, Bangladesh's wetlands are under constant threat, driven by factors such as population growth, intensive agricultural practices, overfishing, siltation, pollution, unplanned urban development, and illegal land occupation. As a result, the country's wetlands have been rapidly deteriorating, with adverse effects on biodiversity, local communities, and traditional cultural practices associated with wetland management. The management and conservation of these vital ecosystems are becoming increasingly urgent. Bangladesh ranks poorly among South Asian nations, holding the 112th position globally in the field of wetlands management, according to the Yale Environmental Performance Index (EPI), with a low score of 33.70.

A key issue is the lack of dedicated, comprehensive legislation for wetlands conservation. The existing legal frameworks in Bangladesh offer limited protection, primarily focusing on the declaration of

"ecologically critical areas" when they are already in distress. This reactive rather than proactive approach is inadequate in preventing the ongoing degradation of wetland ecosystems. Furthermore, while there are several laws that govern water resource management, wetlands are often treated as part of broader categories of water bodies, which results in their unique ecological and socioeconomic roles being overlooked. In practice, the enforcement of these laws remains weak, exacerbated by challenges such as poor institutional coordination, inadequate resources for monitoring and enforcement, and a lack of public awareness regarding the importance of wetlands conservation.

The chapter explores the current state of wetlands conservation in Bangladesh by examining the existing legislative measures and protections, evaluating how these laws and regulations impact the protection and management of wetlands. It also identifies the gaps and weaknesses in the current legal and policy frameworks that hinder effective conservation efforts. Moreover, the chapter emphasizes the need for a holistic approach to wetland management, integrating political, economic, social, and technological dimensions. Effective wetland management requires collaboration between government institutions, local communities, and civil society, with active citizen participation playing a key role in ensuring compliance with conservation efforts.

A significant recommendation of this chapter is the development of specific, dedicated legislation for wetland conservation, which would provide a more proactive and comprehensive framework for the sustainable management of these ecosystems. The absence of such legislation has left wetlands vulnerable to unregulated exploitation, leading to significant biodiversity loss and degradation. By establishing stronger laws focused on wetland sustainability, it is possible to create clear guidelines for the protection, restoration, and sustainable use of wetlands, along with defined roles and responsibilities for public authorities, local governments, and other stakeholders.

In addition to the creation of dedicated legislation, the chapter calls for significant improvements in the enforcement mechanisms of existing laws. Enhanced coordination between governmental agencies, improved monitoring and compliance mechanisms, and the use of modern technologies for data collection and analysis can improve the effectiveness of current regulations. Moreover, raising public awareness through education campaigns and community engagement efforts is crucial to increasing compliance and fostering a sense of shared responsibility for wetland conservation among citizens.

Another critical recommendation is the integration of wetlands management into broader water resource management frameworks. Wetlands are a unique category of water body with distinct ecological functions, and their conservation should be addressed within the context of both water resource and biodiversity management policies. By ensuring that wetlands are recognized as a vital component of national water management strategies, Bangladesh can better protect these ecosystems and promote their sustainable use.

Finally, the chapter underscores the importance of developing a more robust understanding of the ecological and socioeconomic roles of wetlands and highlights the urgent need for reform in the legislative and institutional frameworks governing wetlands in Bangladesh. The existing laws and policies are insufficient to halt the ongoing degradation of these vital ecosystems, and without comprehensive legal reforms, wetlands will continue to decline, threatening biodiversity and the livelihoods of millions of people. Effective legal frameworks must be grounded in scientific research and data, ensuring that policies reflect the latest knowledge of wetland ecosystems and their value to both the environment and local communities. This understanding should inform the design of laws, policies, and management plans, guiding decision-makers toward solutions that balance environmental, social, and economic considerations. Furthermore, a multi-faceted approach, incorporating legal, social, and economic dimensions, is necessary to safeguard Bangladesh's wetlands and ensure their sustainable management for future generations.

The primary objectives of this chapter are:

- To analyze how wetlands, as a unique category of water body, are currently integrated within the legal frameworks that govern water resource management in Bangladesh whether directly or indirectly and to assess the adequacy of these frameworks in addressing the specific needs of wetland ecosystems; and
- To recommend necessary legal reforms aimed at improving the conservation and management of wetlands, with a particular focus on strengthening enforcement mechanisms, enhancing public awareness, and developing a comprehensive legal structure dedicated to wetland protection.

2. Definition of Wetlands

Wetlands are ecosystems typically found in low-lying areas where the groundwater level remains at or near the surface. They encompass regions such as marshes, fens, bogs, floodplains, and shallow coastal zones. Functioning as transitional areas between terrestrial and aquatic environments, wetlands often have a shallow water table, and the land may experience periodic inundation. Wetland can be categorized into Estuarine and Freshwater zones, which are further divided based on soil types and plant life. According to the Ramsar Convention (1971), wetland encompass areas of marsh, fen, peat land, or water - natural or artificial, permanent or temporary featuring static or flowing water that can be fresh, brackish or salt, including marine water with a low-tide depth not exceeding six meters. Thus, wetlands include a diverse array of habitats such as fluvial, estuarine, coastal and marine habitats. Globally, 39 different categories of wetlands are recognized based on their biological, physiological, and ecological characteristics, with 30 being natural and the remainder artificial. According to the Ramsar definition, over two-thirds of Bangladesh could be classified as wetlands.

3. Legal Protection for Wetlands

3.1 International

Wetlands are recognized for their ecological and economic importance in international law. Consequently, various international agreements have established legal obligations for their protection and restoration. The Stockholm Declaration on the Human Environment (1972) and the World Charter for Nature (1982) serve as key pillars of international environmental law. Principle 2 of the Stockholm Declaration emphasizes the need to safeguard natural ecosystems, highlighting that conserving wetland benefits both current and future generations. The 1982 Charter underscores the necessity of preserving nature to protect its vital processes, which aligns with the hydrological understanding of wetlands. These principles apply to both terrestrial and marine environments, encompassing various ecosystems and species. According to Principles 4 and 10(a) (b) it is also expected that:

> Ecosystems and organisms, as well as the land, marine and atmospheric resources that are utilized by man, shall be managed to achieve and maintain optimum sustainab le productivity, but not in such a way as to endanger the integrity of those other ecosystems or species with which they coexist.
>
> Living resources shall not be utilized in excess of their natural capacity for regeneration.
>
> The productivity of soils shall be maintained or enhanced through measures which safeguard their long-term fertility and the process of organic decomposition, and prevent erosion and other forms of degradation.

The Rio Declaration of 1992 marked a transition from prioritizing the protection of the human environment, as outlined in the 1972 Stockholm Declaration, and from the conservation of nature highlighted in the 1982 World Charter for Nature. Instead, it focused on the concept of sustainable development. This approach seeks to harmonize economic, social, and ecological dimensions of natural resources and the environment. Principle 1 of the Rio Declaration states:

> Human beings are at the center of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature.

The Convention on Wetlands of International Importance Especially as Waterfowl Habitats, known commonly referred to as the Ramsar Convention, uniquely emphasize the term "wetlands" within the context of an environmental treaty, thereby establishing a critical connection between terrestrial and aquatic ecosystems. Its primary objective is to protect threatened wetlands, enhance their resources, and ensure their preservation and improvement. The Ramsar Convention promotes the conservation and sustainable use of wetlands through both national and international collaboration, contributing to global sustainable development. Key strategies include restricting access to most wetland areas and educating the public to counter the misconception that wetlands are wastelands. Bangladesh ratified the convention in 1992 and is committed to formulating national wetland policies tailored to its political and administrative context, aimed at promoting wise use and

addressing challenges related to wetlands (UNESCO, n.d.).

There are several other international conventions that influence the management of wetlands. These include—

- **Convention concerning the Protection of the World Cultural and Natural Heritage 1972 (UNESCO 1972):** Similar to the Ramsar Convention, this Convention also includes a list of protected sites, but it encompasses both cultural and natural heritage (as established in Article 2), covering natural features, geological formations, and significant natural sites. Bangladesh accepted the convention in 1983 (UNESCO, n.d.).
- **Convention on International Trade in Endangered Species of Wild Fauna and Flora 1973 (CITES 1973):** This international agreement aims to ensure that trade in wildlife does not threaten the survival of species. Bangladesh ratified the convention in 1981 (CITES, n.d.).
- **Convention on the Conservation of Migratory Species of Wild Animals 1979 (CMS 1979):** This treaty focuses on the global conservation and sustainable use of migratory species and their habitats. It encourages collaboration among Range States which are the countries through which migratory animals travel, to promote coordinated conservation efforts. Bangladesh became a party to this convention in 2005 (CMS, 2020).
- **Convention on Biological Diversity 1992 (UNEP 1992):** This Convention aims to protect global biodiversity, covering ecosystems, species, and genetic resources. Its three primary goals are the conservation of biological diversity, sustainable use, and equitable sharing of benefits derived from resources (Article 1 and the Preamble). Bangladesh ratified the convention in 1994 (CBD, n.d).
- **Convention to Combat Desertification 1994 (UNCCD 1994):** This legally binding framework addresses desertification and drought, emphasizing principles of participation and partnership to protect and restore land to ensure a safer, just, and more sustainable future. Bangladesh ratified the convention in 1996 (UN, n.d).
- **Convention on the Law of the Non-Navigational Uses of International Watercourses 1997 (U.N. 1997):** This Convention governs the use of international watercourses for purposes other than navigation, focusing on the protection and management of these water resources (Article 1). Although Bangladesh voted in favor of the convention in 1997, it has not completed the ratification process for unspecified reasons.

Moreover, effective wetland protection and management are crucial for achieving Sustainable Development Goals (SDGs), particularly SDG 6, which aims to ensure the availability and sustainable management of water and sanitation for all by 2030. Enhanced water management also supports various other goals, including Goal 15, which focuses on the protection, restoration, and

sustainable use of terrestrial ecosystems. Given their vital importance to both nature and society, wetland preservation should be a fundamental component of national strategies to fulfill the SDGs.

3.2 National

In addition to international frameworks for wetland conservation, national legislation plays a critical role in environmental protection. There are notable similarities among various countries in how their environmental laws have developed and which issues are prioritized. In Bangladesh, while specific laws for wetland protection are lacking, indirect protections exist through various conservation acts. However, these laws have emerged in an ad hoc manner, leading to gaps, overlaps, and inconsistencies that create uncertainty for stakeholders. The situation is further complicated by conflicting sectoral policies, legal frameworks, and institutional priorities, which contribute to a convoluted legal and institutional landscape that increases the likelihood of inter-sectoral policy inconsistencies. To promote the sustainable use and conservation of wetlands in Bangladesh, it is essential that policies, strategies, and management plans are informed by a thorough understanding of the ecological and socioeconomic functions of these ecosystems.

From a legal enforcement perspective, environmental rights can be categorized into two types: substantive and procedural. A substantive environmental right pertains to an individual's stand-alone entitlement to a quality environment, while a procedural environmental right encompasses three key elements: access to information, participation in decision-making, and access to environmental justice (Wadud, n.d). Although the Constitution of Bangladesh does not explicitly recognize these categories of rights, it includes a provision (Article 18A; Fifteenth amendment to the Constitution of Bangladesh), added in 2011, stating that the State shall endeavor to protect and improve the environment, as well as to safeguard natural resources, biodiversity, wetland, forests and wildlife. This provision is significant because it not only recognizes the importance of environmental health but also creates a legal obligation for the government. This can be leveraged by citizens and environmental advocates to hold the state accountable for environmental degradation and to promote policies that align with sustainable development. Article 7 establishes that the Constitution is the supreme law, which underpins all legal authority in Bangladesh. In terms of environmental protection, this means that any laws or policies regarding the environment must align with constitutional principles. If any law conflicts with the Constitution, it is rendered void. Thus, if environmental laws are deemed insufficient or ineffective, citizens and courts can challenge them based on constitutional supremacy. Further, Article 21 emphasizes the responsibility of citizens and public servants to uphold the Constitution and protect public property. In the context of environmental protection, this can be interpreted as a civic duty to engage in sustainable practices and to advocate for environmental stewardship. Public servants, in particular, have a duty to prioritize the well-being of the environment

in their decision-making processes. The right to protection under the law (Article 31) ensures that all individuals have access to legal remedies against actions that may harm their life, liberty, or property. In environmental terms, this means that individuals can seek legal recourse if their health or property is adversely affected by environmental hazards, such as pollution or deforestation. This provision empowers citizens to claim their rights in the face of environmental degradation. Article 32 reinforces the notion that every individual has the right to life and personal liberty, which can be interpreted to include a healthy environment. The degradation of the environment can lead to health risks, thus implicating the right to life. This connection strengthens the argument for environmental protection as essential to safeguarding citizens' rights.

The constitutional provisions of Bangladesh provide a framework that emphasizes the importance of environmental protection alongside individual rights and the rule of law. The High Court Division clarified this perspective in the landmark public interest litigation case, Dr. Mohiuddin Farooque Vs. Bangladesh and Others (1996), where it affirmed that the constitutional right to life extends to encompass a right to a safe and healthy environment. In another significant ruling, Dr. Mohiuddin Farooque Vs. Government (the Industrial Pollution Case; Writ Petition No. 891 of 1994), the court elaborated on constitutional interpretations of the right to life and environmental rights. It referenced the preamble of the Constitution, which underscores the commitment to establishing a society where the rule of law, fundamental human rights, and dignity are upheld for all citizens. The High Court Division asserted that Articles 31 and 32 safeguard the environment and ensure a healthy ecological balance, free from pollution, as well as sanitation criteria crucial for a meaningful life. Any violation of these rights would be considered an infringement of the right to life.

Bangladesh has a wide range of laws aimed at safeguarding the environment and preserving natural resources. The first significant legislation that focused specifically on environmental protection and conservation was the Environmental Conservation Act (ECA) of 1995, followed by the Environmental Conservation Rules (ECR) in 1997. In addition to these, there are around 200 other laws in the country that, while not always directly targeting environmental pollution or natural resource management, are relevant to various environmental concerns. These laws can be applied to diverse areas such as pesticide use, land use, public health, urban infrastructure and facilities, public services, etc. (Farooque & Hasan, 1996).

Environmental laws in Bangladesh can generally be categorized into two main groups:

(a) Laws with a non-sectoral approach (i.e. Environmental Conservation Act (ECA) of 1995 and Environmental Conservation Rules (ECR) of 1997)

(b) Sectoral - specific laws (i.e., land-use laws; agriculture and irrigation laws; water resource laws; fisheries laws; forestry laws; wildlife laws; energy laws; health laws; food and consumer protection laws; transportation laws; local government laws; urban and rural development laws)

The protection and management of wetlands are addressed and guided by a combination of laws that directly and indirectly regulate the use, protection, and conservation of these ecosystems. While there are specific laws for water management, wildlife conservation, and pollution control that protect wetlands, the integration of wetland management into broader environmental, disaster, and biodiversity policies has been critical. The country's legal and regulatory frameworks continue to evolve, with increasing recognition of the importance of wetlands in sustaining environmental and economic resilience.

Below are some of the key laws and provisions that impact wetland management:

3.2.1 The Canals Act, 1864 (Act No. V of 1864)

Though primarily aimed at improving and maintaining waterways for navigation and toll collection, its provisions have significant implications for wetland ecosystems, both positive and negative, especially in regions like Bangladesh, where wetlands and water bodies are interwoven with broader environmental concerns. The Act allows the government to levy tolls on canals and other navigable waters. It empowers government authorities to clear natural and man-made obstructions that hinder the navigation of waterways, dig waterways to make them wider or deeper, and even construct new canals or routes. Wetlands depend on stable hydrological conditions. Any alteration in the flow of water through canals and rivers, including deepening or widening of channels, can change the seasonal flooding patterns and water retention in wetland areas. These changes can affect the plant and animal species that rely on specific water levels for breeding, feeding, and migration. In extreme cases, some wetlands may dry up or become overly saline or acidic due to changes in water flow. Wetlands provide essential ecosystem services such as water filtration, flood control, and carbon sequestration. The Canals Act's emphasis on improving navigability could lead to the destruction of these services if waterways are modified in ways that reduce the quality of wetland areas. However, if managed carefully, canal improvements could also help mitigate flood risks and improve water quality in wetlands, enhancing their ecosystem services.

Under the Act, the government is authorized to acquire land for the construction and improvement of canals. This provision could affect wetlands and floodplains, which are often areas that lie along the natural course of rivers or are near canals. The process of acquiring land for canal expansion may involve draining wetlands or diverting water from natural systems which can have long-term effects on local biodiversity, hydrology, and the overall environmental quality of an area. Moreover, land acquisition for canal construction could affect local communities dependent on these wetlands for agriculture, fishing, and other livelihoods. Displacement of these communities or changes in local water management could lead to conflicts and social unrest. By carefully managing the construction and maintenance of canals and water routes, the Act can be harmonized with wetland conservation goals, ensuring that these vital ecosystems are preserved while also fulfilling the needs of transportation and economic development.

3.2.2 The Irrigation Act, 1876 (Act No. III of 1876)

It is a significant piece of legislation that governs the management, conservation, and utilization of irrigation infrastructure in Bangladesh. While its primary focus is on ensuring an adequate water supply for agricultural purposes, the provisions of this law also have important implications for the management of wetlands. Wetlands are inherently linked to water management, as they are often affected by irrigation practices, water distribution, and flood control measures. The Act places the responsibility for the construction, maintenance and management of irrigation systems, which include canals, channels, and reservoirs, with the government. Since the government is tasked with ensuring the maintenance of these irrigation works, it can also implement measures to safeguard wetlands by regulating the design of irrigation systems to avoid encroaching on or damaging wetland areas. The Act allows for the construction of water channels, such as village channels, to supply water directly to agricultural fields. This provision highlights the role of local communities in water management, especially at the grassroots level. Wetland ecosystems that are adjacent to agricultural lands may be affected by the construction of village channels, as the diversion of water into these channels could alter the hydrology of nearby wetlands. In such cases, the Act requires the approval of landowners and tenants who own the land where these channels are to be built. While the Act emphasizes the importance of landowner consent for channel construction, it also creates an opportunity for wetlands to be

Laws Relating to Wetlands

- The Canals Act, 1864
- The Irrigation Act, 1864
- The Forest Act, 1927
- The Tanks Improvement Act, 1939
- The Non-Agricultural Tenancy Act, 1949
- The Protection and Conservation of Fish Act 1950
- The State Acquisition and Tenancy Act 1950
- The Acquisition of Waste Land Act, 1950
- The Embankment and Drainage Act, 1952
- The Inland Water Transport Authority Ordinance, 1958
- The Culturable Waste Land (Utilization) Ordinance, 1959
- The Inland Shipping Ordinance, 1976
- The Haor Development Board (Dissolution) Ordinance, 1982
- The Land Reform Board Act, 1989
- The Bangladesh Environment Conservation Act, 1995 (amended 2010)
- The Environment Conservation Rules, 2023
- Mega city, Divisional Town and District Town's municipal areas including country's all the municipal areas' playground, open space, park and natural water reservoir Conservation Act, 2000
- The Local Government (Pourashava) Act, 2009
- The Local Government (City Corporation) Act, 2009
- The Local Government (Union Parishad) Act, 2009
- The Environment Court Act, 2010
- The Disaster Management Act, 2012
- The Wildlife (Preservation and Safety) Act, 2012
- The Bangladesh Water Act, 2013
- The National River Conservation Commission Act, 2013

considered in the decision-making process, ensuring that any development that could impact wetland ecosystems is carried out in a manner that minimizes harm to the environment without altering their ecological balance and biodiversity. Moreover, wetlands play an important role in flood regulation, and their management is often closely tied to irrigation and flood control systems. The Irrigation Act, by governing the construction and operation of irrigation channels and reservoirs, indirectly influences the management of wetlands that serve as natural flood buffers. If irrigation infrastructure is not properly integrated with flood control measures, it could either lead to the over-drying of wetlands (through water diversion) or excessive flooding (through uncontrolled irrigation overflow). The law's provisions for water regulation and infrastructure maintenance help prevent such outcomes by promoting more balanced management that considers the flood-regulating role of wetlands.

The Act's provisions for penalties in cases of water diversion, damage, or pollution are essential tools for holding parties accountable for actions that negatively affect wetland hydrology and quality. These legal protections provide an avenue for addressing conflicts between irrigation and wetland conservation.

Since wetlands rely heavily on water regimes that are influenced by irrigation infrastructure, it is crucial for the Act to be applied in a way that protects these ecosystems from negative impacts. Wetlands are dynamic ecosystems that require a delicate balance of water flow, and any changes in water management practices such as the construction of new canals or reservoirs can have far-reaching effects. Therefore, it is important that wetland considerations are incorporated into the planning and implementation of irrigation projects.

3.2.3 The Forest Act, 1927 (Act No. XVI of 1927)

It primarily aims to regulate the transit of and duties leviable on timber and other forest produce, but it does not comprehensively address wetland management, conservation, or their unique ecological needs. There is no legal definition of "forest" or "conservation" under the Act though. The Act empowers the government to regulate the extraction of forest produce, and prohibit hunting and fishing in reserved forests. While this is critical for forest conservation, these provisions do not extend to wetlands, which can also be severely impacted by deforestation or improper management. For example, activities like logging near wetland areas can cause habitat destruction and alter water flow, potentially leading to the drying up or contamination of wetlands. The Act does not contain any provisions that specifically targets the conservation of wetlands. Wetlands are unique ecosystems that require distinct management strategies, including regulation of water levels, control of invasive species, monitoring of pollution, addressing land reclamation and adapting to the impacts of climate change. The Forest Act fails to recognize these needs, and thus it does not provide for the specific protection or improvement of wetlands within or near forested areas. Wetlands also provide important resources like water, biodiversity, and natural filtration systems. However, the Act does

not establish a framework to regulate the sustainable use of wetland resources. The extraction of resources like peat, reeds, or medicinal plants from wetlands, or the use of wetlands for agriculture, is not addressed in the Act, potentially leading to overuse and degradation of these areas. The Act provides only limited powers for private forests. This may be relevant in the context of wetland areas located within private lands adjacent to forests or on private land that could be impacted by forest management activities. The absence of clear regulation over wetland conservation on private lands, combined with limited government authority over private forests, means wetland conservation may be more vulnerable to unsustainable land-use practices on these lands. Ecosystem-based approaches (like watershed management or integrated river basin management) that address both forest and wetland ecosystems together are not facilitated by the Forest Act, 1927. Moreover, it does not empower the government to address illegal activities that may specifically harm wetlands, such as wetland drainage, pollution, or conversion of wetlands for agricultural use. Without stronger, specific enforcement mechanisms or penalties related to wetland degradation, the Act falls short in ensuring that wetland ecosystems are adequately protected within forested landscapes.

3.2.4 The Tanks Improvement Act, 1939 (Act No. XV of 1939)

It was enacted with the primary objective of improving tanks (or water reservoirs), specifically in the areas of irrigation and pisciculture (fish farming). The Act gives the government or designated authorities the power to improve, repair, and maintain tanks. This improvement could include the excavation of tank beds, strengthening embankments, and ensuring that tanks are more effective for irrigation or fish farming. The focus of these improvements was mainly agricultural, ensuring that water was readily available for irrigation during dry periods and that tanks could be used efficiently for pisciculture to increase local fish production. One of the most significant aspects of the Act is that it allowed government authorities to intervene in private property rights in the interest of agriculture. It permitted the government to take control of privately owned tanks if deemed necessary for the improvement or better management of irrigation or pisciculture. This was often done without compensating the owners for their losses, which infringed on the personal rights of the tank owners, especially if the tanks were used for purposes other than agriculture. This provision was justified on the grounds of ensuring greater public benefit through increased agricultural productivity or fish farming, but it is often criticized for disregarding the rights of individuals who may have used the tanks for other purposes, such as drinking water, recreational use, or preserving biodiversity.

The Act does not provide any provisions for the preservation of ecosystems or the biodiversity of the tanks themselves. While tanks are important water bodies that support aquatic ecosystems, biodiversity, and community resources, the Act overlooks these aspects and focuses solely on maximizing their utility for human agricultural and economic activities.

This has led to concerns that the natural environment and wildlife that depend on these tanks could be harmed due to their over-exploitation or changes in water quality caused by the tank improvements focused on agricultural use.

3.2.5 The Non-Agricultural Tenancy Act, 1949 (Act No. XXIII of 1949)

It was enacted to regulate the rights and obligations of tenants and landlords in the context of non-agricultural lands. This includes properties that are used for commercial, residential, or industrial purposes, rather than for farming or agricultural production. While this Act primarily concerns urban and non-agricultural land, its implications for wetland management are indirect but can still be significant, particularly in terms of land use and regulation of wetlands located outside the agricultural sector. Wetlands, particularly those near urban or industrial areas, can fall under non-agricultural land use. The Act's provisions could allow for the conversion of such wetlands into commercial, industrial, or residential developments, depending on the type of tenancy and the owner's intentions. The absence of ecological considerations in the Non-Agricultural Tenancy Act presents a challenge to the sustainable management of wetlands. As tenancy laws focus on economic use and rights rather than environmental conservation, wetlands may not be protected against land conversion or other damaging activities unless there are explicit restrictions in place through other mechanisms. In urban and industrial contexts, wetlands may be seen more as land assets for development rather than natural resources to be conserved. This can lead to habitat loss, pollution, and reduced biodiversity if these lands are converted for non-agricultural uses.

3.2.6 The Protection and Conservation of Fish Act, 1950 (Act No. XVIII of 1950)

It aims to safeguard fish populations in the inland waters of Bangladesh. Wetlands are dynamic ecosystems that provide crucial services such as water filtration, flood control, breeding grounds, feeding areas for many species of fish and habitats for wildlife. By controlling fishing practices, the Act helps maintain healthy fish stocks and ecosystem stability within these wetland areas. It prohibits the use of harmful chemicals, explosives, and other destructive methods that can damage aquatic habitats. Such practices can lead to long-term ecological damage in wetland areas, including the destruction of water quality, fish habitats, and biodiversity. The leasing of wetlands for fishing purposes is also regulated under the Act. This means that wetlands are leased out to individuals or organizations for fishing in a manner that prioritizes the ecological integrity of the area. The Act mandates the monitoring of fishing activities and the enforcement of regulations in wetland areas. This includes the deployment of fisheries officers or environmental watchdogs who ensure compliance with the rules set forth in the Act. Violations of the Act, such as using destructive fishing practices or engaging in illegal fishing during restricted seasons, can result in fines or other penalties. This strengthens the protection of fish habitats and promotes responsible resource use within wetlands.

The Act also recognizes the importance of educating and involving local communities in wetland and fish conservation. Communities living near wetland areas are often dependent on fishing for their livelihoods, and the Act ensures that they are part of the conservation efforts through sustainable fishing practices and awareness programs. Education initiatives may focus on teaching local fishermen about the long-term benefits of sustainable fishing practices, reducing the reliance on harmful methods, and fostering a sense of responsibility toward wetland conservation.

3.2.7 The State Acquisition and Tenancy Act, 1950 (Act No. XXVIII of 1950)

It is a key piece of legislation in Bangladesh that plays an important role in wetland management, particularly in relation to *Jalmahals* (water bodies such as ponds, lakes, and wetlands). The Act primarily focuses on the transfer of ownership of *Jalmahals* from private landlords to the government. This transfer of ownership is intended to ensure that these water bodies, including wetlands, are managed in a more sustainable and equitable manner. Before the Act, *Jalmahals* were often leased out or exploited for commercial purposes without regard for ecological preservation, leading to over-exploitation and degradation of these vital ecosystems. The Act allows the government to implement wetland conservation programs, regulate fishing, and protect fish habitats by controlling access and use. While the government assumes ownership, it can lease out these areas under regulated terms that ensure sustainable resource use, rather than unrestricted exploitation. The Act aims to improve the livelihoods of local communities by ensuring that the wetland areas are protected and sustainably managed, preventing their degradation and ensuring long-term access to their resources.

3.2.8 The Acquisition of Waste Land Act, 1950 (Act No. XIX of 1950)

This Act plays a role in wetland management by granting the government the authority to acquire unused or underutilized private lands, including marshy tracts and watercourses. This law applies to lands that have not been cultivated for at least five years. The government can then repurpose these areas for various public uses, such as agricultural development, forestry, irrigation, and land reclamation. This allows for the improvement of wetland areas, potentially converting marshes into productive farmland or utilizing wetlands for irrigation projects. Additionally, the law supports large-scale cooperative farming and provides opportunities for land settlement and economic development, which could indirectly promote the management and restoration of wetland ecosystems.

3.2.9 The Embankment and Drainage Act, 1952 (Act No. I of 1952)

This act is relevant to wetland management as it governs the construction, maintenance, and management of embankments and watercourses to improve drainage and protect lands from flood, erosion, or water damage. In the context of wetlands, this Act helps control water levels, mitigate flood risks, and prevent erosion in marshy or waterlogged areas. By regulating drainage systems, it can impact wetland ecosystems

by ensuring that water management practices balance flood control with the need to preserve the natural functions of wetlands, such as water filtration, habitat provision, and biodiversity conservation.

3.2.10 The Inland Water Transport Authority Ordinance, 1958 (Act No. LXXV of 1958)

It establishes an authority responsible for the development, maintenance, and regulation of inland water transport and navigable waterways in Bangladesh. Many of these waterways, which include rivers, canals, and other bodies of water, are part of the country's extensive wetland systems. In wetland management, the Ordinance can influence how these water bodies are maintained and managed for transport purposes while ensuring that their ecological functions are not compromised. Proper regulation and management of inland waterways help in balancing navigation needs with the conservation of wetland ecosystems, preventing over-exploitation, pollution, and habitat destruction. It ensures that wetland areas used for transport are managed sustainably, protecting biodiversity and water quality while facilitating economic development through efficient inland water transport.

3.2.11 The Culturable Waste Land (Utilization) Ordinance, 1959 (Ordinance No. XIII of 1959)

It promotes the reclamation and cultivation of waste land, including areas that may be wetlands or marshes. Under this Ordinance, lands that have not been cultivated for at least two years are considered "waste land" and can be reclaimed by the government. The Collector is authorized to acquire such lands and lease them to individuals or groups for the cultivation of food crops, typically for a period not exceeding one year from the initial acquisition. In the context of wetland management, the ordinance can affect wetlands if they are classified as "culturable waste land." Wetlands, often unproductive for traditional farming due to waterlogged conditions or other ecological features, could be targeted for reclamation and conversion into agricultural land under this law. This might involve draining wetlands or altering water levels to make them suitable for crop cultivation, which can have significant ecological consequences such as the loss of biodiversity, disruption of water filtration services, and changes in hydrological cycles. Therefore, while the Ordinance aims to boost food production, its implementation must carefully consider the environmental impacts on wetland ecosystems to avoid long-term degradation. If reclamation is not done sustainably, it can lead to the degradation of wetland ecosystems, affecting both the environment and the people who depend on wetland resources.

3.2.12 The Inland Shipping Ordinance, 1976 (Ordinance No. LXXII of 1976)

This Ordinance governs the survey, registration, and control of vessels operating on inland waterways, many of which flow through wetland areas. Vessels operating on inland waters, such as rivers, canals, and wetlands, must be surveyed to ensure that they are structurally and mechanically sound and meet specific safety

and environmental standards. This helps prevent vessels from causing harm to fragile wetland ecosystems due to structural failure or pollution. The Ordinance also addresses issues like obstruction of navigable waters. This is important for wetland management, as activities like dredging or unregulated vessel movement can disrupt water flow, sedimentation, and aquatic habitats in wetlands. Provisions related to the carriage of dangerous goods aim to prevent the accidental release of pollutants into wetlands, which could degrade water quality and harm biodiversity. The Ordinance includes penalties for violations, such as operating unsafe vessels or obstructing waterways, thus incentivizing compliance with environmental regulations to protect wetland areas.

3.2.13 The Haor Development Board (Dissolution) Ordinance, 1982 (Ordinance NO. XXXVII OF 1982)

It provides a crucial legal foundation for managing the complex and ecologically sensitive haor wetlands in Bangladesh. Haors are vital ecosystems, providing habitat for numerous species, regulating water flow, supporting agriculture, and offering essential services to local communities. By focusing on flood control, land reclamation, agricultural development, and biodiversity conservation, the Ordinance aims to ensure the sustainable use and preservation of these critical wetland ecosystems. The Haor Development Board, a body created under the Ordinance has been tasked with overseeing and coordinating the management and development of haors. The Ordinance grants the Board the authority to create and implement projects and schemes aimed at improving the development of haors and similar low-lying areas. The Ordinance emphasizes the sustainable development of haors, which involves balancing human activities, such as agriculture and settlement, with the need to conserve the unique ecological functions of wetland areas. This includes ensuring that water levels are managed effectively to support both agriculture and biodiversity, without causing long-term degradation of the ecosystem.

3.2.14 The Land Reform Board Act, 1989 (Act No. XXIII of 1989)

It focuses on the creation of a Land Reform Board, which oversees land reforms aimed at improving land distribution, agricultural productivity, and ensuring fair land tenure systems. The Act aims to ensure equitable land access, which might involve redistributing land from large landowners to landless or marginalized communities. In wetlands, this could mean altering land use patterns, potentially bringing them under cultivation or development. A core aspect of the Act is improving agricultural productivity and land management. The conversion of wetlands into agricultural land or settlement areas under land reform programs can result in the loss of critical wetland services, such as flood regulation, water filtration, and biodiversity habitat. Therefore, it is crucial for the Board to balance land reforms with environmental protection, ensuring that wetland ecosystems are not irreversibly damaged in the process.

3.2.15 The Bangladesh Environment Conservation Act (ECA), 1995

Along with its amendments (notably the 2010 amendment), it plays a pivotal role in protecting the environment and managing natural resources in Bangladesh. The Act aims to conserve the environment, improve environmental standards, and mitigate and control environmental pollution thus protecting all ecosystems, including wetlands. Section 6E of the Amendment Act (2010) specifically addresses the protection of wetlands. It imposes a restriction on the filling up of wetlands, which is a critical provision to prevent the loss of these vital ecosystems. While the law restricts the filling of wetlands, it also provides a mechanism for exceptions, where activities may be permitted if an environmental clearance certificate is granted by the authorities. Section 6E of the Bangladesh Environment Conservation Act, 1995 prohibits filling up wetlands and changing the nature of wetlands without prior approval of the Department of Environment which can only be granted in unavoidable national interest. Pursuant to section 15 of the Bangladesh Environment Conservation Act, 1995 any person who acts in contravention of the provisions of section 6E shall be liable to imprisonment not exceeding 10 years or a fine not exceeding taka 10 lakh or both. This introduces flexibility in land use but requires that the potential environmental impacts be carefully assessed.

An important element of the Act is the requirement for an Environmental Impact Assessment (EIA) for certain projects. This is particularly relevant for large-scale developments that might affect wetlands or other sensitive ecosystems, as it ensures that environmental consequences are considered before the commencement of such projects. The Act recognizes the Polluter Pays Principle, ensuring that those who cause environmental damage are responsible for compensating for the harm. This includes measures such as imposing penalties or requiring the polluter to restore or compensate for the affected environmental areas. Despite these provisions, the Act does not offer comprehensive preventive measures against environmental degradation. For example, while there are restrictions on wetland filling, there is no overarching framework to prevent broader ecosystem destruction or ensure proactive conservation of wetlands before development pressures occur its focus is more on mitigating harm and regulating post-damage activities rather than preventing environmental degradation in the first place.

3.2.16 The Environmental Conservation Rules (ECR), 2023

A new set of rules that has been framed in 2023, which replaced the Environment Conservation Rules 1997, complement the Environment Conservation Act as mentioned above by providing detailed guidelines and procedures for implementing its provisions. These Rules require industries, construction projects, and other activities to assess and minimize their environmental impact. The 2023 Rules have partially addressed the public participation process in EIA approval but have left the processes and consequences of public hearings unaddressed. Wetland areas are often subject to the ECR's environmental

clearance process, especially when proposed projects threaten their ecological integrity. The Rules also address issues related to water quality, waste disposal, and pollution control, all of which are pertinent to wetland ecosystems.

3.2.17 Playground, Open Space, Park, and Natural Wetlands Conservation Act, 2000 (Act No. 36 of 2000)

It is a legislative framework established to preserve and protect open spaces, including playgrounds, parks, open spaces, and natural water reservoirs like wetlands, within megacities, divisional towns, district towns, and all municipal areas of the country. Section 5 of the Act is central to wetland management. It mandates that no person or entity is permitted to alter, develop, or change the nature of these areas, including wetlands, without the prior permission of the concerned authorities. The provision serves as a protective measure to prevent degradation of natural wetlands, which could include activities like reclamation, draining, or construction that could harm these ecosystems. This regulation ensures that any development or human activity within or near wetlands is carefully controlled, requiring regulatory oversight and approval to safeguard the environment. The Act indicates that permission to alter these areas must be sought from relevant authorities. Section 8 of the Act sets out punitive measures for violations of the provisions. Anyone found guilty of altering the nature of protected areas, including wetlands, without obtaining the required permission, can face legal penalties which serves as a deterrent against illegal land use changes that threaten natural wetlands and other protected spaces. Pursuant to section 8 of the Act 2000, any person who acts in contravention of the Act is liable to imprisonment not exceeding 5 years or a fine not exceeding taka 50,000 or both. The Act encourages sustainable urban planning by safeguarding natural areas in rapidly developing regions. This is particularly crucial in megacities where urbanization often leads to the loss of open spaces and wetlands due to pressure for development. By legally recognizing the importance of these areas, the Act emphasizes the need for cities to integrate ecological considerations into their planning processes, ensuring that environmental conservation remains a key factor even in densely populated urban settings.

3.2.18 The Local Government Acts

The Local Government (Pourashava) Act, 2009 (Act No. 58 of 2009); the Local Government (City Corporation) Act, 2009 (Act No., 60 of 2009); and the Local Government (Union Parishad) Act, 2009 (Act No., 61 of 2009) amended in 2024, empower local administrative bodies to take responsibility for managing and protecting natural resources, including wetlands, within their jurisdiction. One of the significant challenges for wetlands is encroachment, often driven by unregulated land development, agriculture, or urban expansion. These Acts mandate that local government authorities take steps to address encroachments on wetland areas. The focus on encroachment prevention is critical because unchecked encroachment leads to wetland degradation, loss of biodiversity, and disruptions to ecosystem services such as water filtration and flood control.

3.2.19 The Environment Court Act, 2010 (Act No. 56 of 2010)

This act empowers the judiciary to deal with environmental offenses. This Act empowers the judiciary to address environmental offenses. While the Supreme Court has played a significant role in shaping environmental justice through numerous interventions, this legislation further strengthens the system by authorizing subordinate courts to adjudicate environmental offenses. There are at least 3 different tiers of the magistrate's courts and other subordinate courts to deal with various offenses that have been made punishable under section 15 of the Bangladesh Environment Conservation Act (BECA), 1995. The Mobile Courts, under the Mobile Court Act of 2009, handle offenses punishable by up to two years in prison. For more serious environmental crimes with punishments up to five years or fines of up to 500,000 BDT, the Special Magistrate Courts (SMC) are responsible. These courts are led by metropolitan or first-class judicial magistrates. If the punishment exceeds five years or a fine of 500,000 BDT, the case is sent to the Environmental Courts (EC), which are headed by a Joint District Judge. These courts also handle cases related to compensation under BECA. SMCs and ECs can impose penalties, seize equipment or vehicles used in offenses, order compensation, and require action to prevent future violations. The fines collected can be used to cover prosecution costs or compensate victims. Cases in SMCs and ECs follow the Code of Criminal Procedure (1898) for criminal cases and the Code of Civil Procedure (1908) for compensation cases. Access to these courts is limited; the SMC cannot hear a case without a written report from the Department of Environment (DoE). If a member of the public files a complaint, the SMC may only consider it if the DoE has not taken action within 60 days or if there is a clear case. The same rule applies to ECs regarding compensation claims. Appeals can be made against decisions from the SMC or EC, but the only Environment Appellate Court is in Dhaka. However, these courts only address offenses under BECA, leaving many other environmental issues outside their jurisdiction. As a result, weaker communities, especially those affected by powerful companies, may be discouraged from pursuing legal action due to the complex and adversarial legal process and the limited scope of the courts' authority.

3.2.20 The Disaster Management Act, 2012 (Act No. 34 of 2012)

Wetlands, particularly in flood-prone areas, play a key role in disaster mitigation by acting as natural buffers against floods, cyclones, and storm surges. While the Disaster Management Act does not directly target wetland management, it does contain provisions that indirectly relate to wetland protection and the management of associated risks due to the importance of wetlands in disaster resilience. The Act suggests integrating sustainable land-use practices to reduce disaster risks, which aligns with the need to conserve wetlands that are often affected by unsustainable practices like drainage, land reclamation, and urbanization. It encourages incorporating ecosystem-based approaches into disaster management, which includes

maintaining wetlands and other natural habitats as integral components of disaster risk reduction. The involvement of local communities in disaster preparedness and management is a key feature of the Act. Communities living around wetlands are encouraged to be part of the management and conservation efforts to ensure wetlands continue to provide ecosystem services that protect them from natural disasters.

3.2.21 The Wildlife (Preservation and Safety) Act, 2012 (Act No. 30 of 2012)

It primarily focuses on the conservation, preservation, and protection of wildlife in the country. While the Act does not specifically target wetland management in isolation, it incorporates provisions that help in the protection of wetlands as critical ecosystems for wildlife. Wetland areas can be safeguarded through the designation of protected areas and special biodiversity conservation areas, the prohibition of harmful activities, and the conservation of critical habitats.

3.2.22 The Bangladesh Water Act, 2013 (Act No. 14 of 2013)

The Bangladesh Water Act, of 2013 has mentioned as its objectives the integrated development, management, abstraction, distribution, use, protection and conservation of water resources. The Act has brought under its scope surface water, groundwater, seawater, rainwater and water in the atmosphere. There is a provision in the Act to declare water stressed area and arrange for special management of such area. Under the Act, the government may declare industrial water zone, agricultural water zone, brackish water aquaculture zone, hatchery water zone and flood control zone. The requirement of public consultation in such declaration is not mandatory. The government is required to fix the lowest safe yield level of the aquifer and restrict abstraction of ground water. It is also responsible for conservation and management of sources of potable water supply and sanctuaries of seasonal birds. The Water Act, 2013 has declared the rights to potable water and water for hygiene and sanitation as the highest priority rights.

3.2.23 The National River Conservation Commission (NRCC) Act, 2013 (Act No. 29 of 2013)

The government has enacted the National River Conservation Commission (NRCC) Act, 2013 and formed a National River Conservation Commission. The powers of NRCC are largely recommendatory in nature. It is mandated to advise the government on prevention of unlawful encroachments and pollution of wetlands, and ensure navigability and normal flow of rivers and multifarious uses of river in socio-economic development. The NRCC is required to submit a yearly report to the government on the state of rivers which is to be placed in the Parliament.

3.3 Other Countries

Wetland management laws differ across countries, reflecting their unique environmental challenges, legal systems, and priorities.

3.3.1 India

In India, wetlands are protected through constitutional provisions and state-specific laws. The Ministry of Environment, Forest and Climate Change (MoEF&CC) has notified the Wetlands (Conservation and Management) Rules, 2017 under the provisions of the Environment (Protection) Act, 1986 as a regulatory framework for conservation and management of wetlands in India. Various states like Guwahati, Kolkata, Andhra Pradesh, and Kerala have passed bills to safeguard water bodies. In Kolkata, the definition of "land" includes wetlands, and "water bodies" encompass any land holding water (The East Kolkata Wetlands (Conservation and Management) Act, 2006). Legal provisions impose fines and imprisonment for encroachment, and empower state agencies to enforce protection.

3.3.2 Canada

In Canada, wetlands are indirectly protected through a series of federal acts, including the Canada Wildlife Act, Fisheries Act, Migratory Birds Convention Act, Species at Risk Act, and the Canadian Environmental Assessment Act. These laws help safeguard water bodies, although they do not focus exclusively on wetlands.

3.3.3 United Kingdom

In the United Kingdom, there is no specific act for wetland management. Regulations regarding water bodies are more general, covering all forms of water, including lakes and wetlands. However, the European Union's Water Framework Directive (2000) mandates member states to establish river basin management plans for water bodies, aiming to protect and conserve water systems.

3.3.4 United States

In the United States, wetlands are primarily protected under the Clean Water Act (Section 404 regulates the discharge of dredged or fill material into waters of the United States), which seeks to maintain the chemical, physical, and biological integrity of water bodies, including wetlands. Legal consequences, such as fines and imprisonment, can result from failing to comply with the protection regulations.

3.3.5 China

In China, wetland management is governed by three key laws - the Law on Water and Soil Conservation, the Law on Prevention and Control of Water Pollution, and the Water Law (*for more details, see Law of the People's Republic of China on Water and Soil Conservation, the Law of the People's Republic of China on Prevention and Control of Water Pollution, and the Water Law of the People's Republic of China, 2004. Beijing: Law Press China*). These laws, although distinct, collectively promote sustainable management of water resources. Enforcement involves administrative and criminal sanctions against non-compliance, targeting both government agencies and individuals.

While each country has distinct legal frameworks for wetland management, common themes include the use of fines and imprisonment for non-compliance and the involvement of various agencies to enforce protection and sustainability.

4. Key Constraints and Way Forward

Bangladesh has made significant strides in aligning its environmental policies with international commitments. The country's legal framework demonstrates an evident commitment to sustainable development, balancing economic growth with environmental preservation. However, despite the positive direction in policy formulation, the gap between legal provisions and their actual implementation remains a major challenge. The analysis of wetland management laws reveals key weaknesses that need urgent attention to ensure effective governance.

A primary issue lies in the fragmented and disjointed approach to governance, where multiple ministries and sectors share overlapping responsibilities for wetland management. This lack of coordination often results in inefficiency, miscommunication, and, at times, inter-sectoral conflicts. The division of authority among different bodies complicates resource management and obstructs the creation of a unified, streamlined management system. This situation is exacerbated by the personal interests of officials, which further hampers collaborative efforts, and makes resolution challenging.

Institutional capacity also remains a key concern. Many of the regulatory bodies responsible for wetland management suffer from a lack of adequate training and manpower. This deficiency undermines the effective implementation of policies and laws. Strengthening institutional capacity should therefore be a priority, with a focus on developing a comprehensive program to address both present and future requirements. Given that many of the laws in place were established decades ago, they are outdated and no longer reflect contemporary environmental challenges, including those posed by climate change. Existing laws lack provisions to address emerging issues, and their outdated, top-down approach to governance further limits their effectiveness. A more inclusive, bottom-up approach is needed, one that ensures the active participation of local communities and other stakeholders in policy development and execution.

The current laws also suffer from insufficient punitive measures, which fail to deter illegal activities or effectively change behavior. Enhancing the deterrent effect of legal frameworks through stricter penalties would help instill greater compliance. Additionally, the enforcement of these laws is often weak, and public awareness is lacking. For laws to be effectively enforced, there needs to be widespread education about the importance of wetlands and the consequences of their degradation. Public participation is critical to the success of these initiatives, as the government cannot preserve wetlands alone.

Moving forward, Bangladesh can adopt a more strategic and integrated approach to wetland management. Several key recommendations include:

Strengthening Legislation for Wetland Protection: Bangladesh currently lacks a unified and robust legal framework focused specifically on wetland conservation. While certain aspects of wetland protection are covered by existing laws, these regulations are fragmented and often lack effective enforcement. To address these gaps, there is an urgent need for a consolidated, comprehensive wetland

protection law. This new legislation should not only safeguard wetland habitats but also recognize their broader ecosystem services, including climate regulation, water filtration, biodiversity, and socio-economic contributions. Moreover, a clear legal distinction should be made between various wetland types - coastal wetlands, freshwater wetlands, and peatlands to ensure targeted protection measures are put in place.

Strengthening Enforcement and Implementation Mechanisms: Despite the presence of laws designed to protect wetlands, the lack of enforcement has led to significant degradation due to unregulated activities such as land reclamation, overfishing, and industrial pollution. To counter this, Bangladesh needs to establish a dedicated authority/agency that focuses solely on monitoring and enforcing wetland conservation laws. This body would be empowered to impose stringent penalties for violations, such as fines, imprisonment, and the revocation of licenses for industries causing harm to wetland areas. Additionally, advanced monitoring systems, such as satellite imagery and GIS technology should be employed to track the health of wetlands and detect illegal encroachments, pollution, and deforestation.

Enhancing Public Participation and Awareness: Effective wetland management depends heavily on the active involvement of local communities and stakeholders. To foster a sense of ownership and responsibility, local communities that directly rely on wetland resources should be included in conservation decision-making processes. This can be achieved through community-based wetland management programs that provide education, training, and tools for sustainable resource use. National awareness campaigns should also be launched to highlight the ecological, economic, and cultural importance of wetlands. Additionally, traditional ecological knowledge from local communities should be incorporated into management strategies, ensuring that conservation efforts are both culturally sensitive and scientifically sound.

Integrating Wetland Protection into Development Planning: Wetlands in Bangladesh are often viewed as unproductive lands and are encroached upon for development purposes. To protect these vital ecosystems, wetland conservation must be integrated into the country's broader development plans. This can be accomplished by mandating environmental impact assessments (EIAs) for any proposed development near or within wetland areas, ensuring that the potential environmental consequences are carefully considered. Moreover, sustainable land-use planning should be implemented to ensure that wetlands are protected from encroachment in urban planning, agricultural zoning, and infrastructure development. Establishing buffer zones around wetland areas will further restrict industrial and agricultural expansion, preserving these critical habitats.

Enhancing Financing for Wetland Conservation: Wetland protection and restoration efforts require substantial financial resources, yet Bangladesh currently lacks dedicated funding for these activities. To address this, the government should create a Wetland Conservation Fund, supported by both domestic and

international financial contributions, including private-sector investments. Additionally, financial incentives should be provided to businesses that engage in environmentally sustainable practices, such as eco-tourism and sustainable agriculture, which promote wetland conservation. Partnerships with international organizations should be pursued to secure funding for large-scale wetland conservation projects.

Improving Data Collection and Research on Wetlands: Effective wetland management necessitates access to reliable data regarding their distribution, health, and usage patterns. However, Bangladesh currently lacks comprehensive and up-to-date data on its wetlands. A national wetland inventory should be developed to track the size, condition, and status of wetlands across the country, using a combination of field research and remote-sensing technologies. Regular scientific surveys should also be conducted to assess the biodiversity, water quality, and overall ecological integrity of wetlands. In addition, research into wetland ecosystem services, restoration techniques, and climate resilience should be promoted to inform future conservation strategies.

Incorporating Climate Change Adaptation in Wetland Management: Wetlands play a vital role in climate change adaptation, acting as natural buffers against flooding, storms, and coastal erosion. However, they are also highly vulnerable to the impacts of climate change. To strengthen their resilience, wetland conservation should be integrated into national climate change adaptation plans and strategies. Special focus should be placed on the restoration of degraded wetlands and the protection of coastal and floodplain wetlands, which are crucial for mitigating climate risks. Scientific research into the resilience of different wetland types to climate change should be supported, and restoration efforts should be guided by these findings.

International Collaboration and Compliance: Wetlands often span national borders, particularly coastal wetlands, and regional cooperation is essential for their effective conservation. Bangladesh should actively engage in regional and international wetland conservation initiatives, such as the Ramsar Convention on Wetlands, and collaborate with neighboring countries to manage shared wetland ecosystems. By implementing international agreements related to wetland protection, Bangladesh can ensure coordinated conservation efforts and benefit from regional expertise and resources.

Restoration of Degraded Wetlands: Many of Bangladesh's wetlands have been severely degraded due to human activities, leading to a loss of biodiversity and ecosystem services. Restoration programs are critical to restoring ecological balance and functionality in these areas. Priority should be given to critically degraded wetlands for restoration efforts, focusing on ecosystem-based restoration approaches that enhance biodiversity, improve water quality, and increase resilience to climate change. Public-private partnerships should be fostered to fund and implement large-scale wetland restoration projects, ensuring that the necessary resources are mobilized for successful outcomes.

Through these multifaceted actions, Bangladesh can move toward a more sustainable and effective approach to wetland conservation, ensuring that these vital ecosystems continue to provide essential services for generations to come.

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Chapter 11

High Court in Protecting Wetlands

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1. Introduction

Wetlands and water bodies in Bangladesh are integral components of the country's ecological integrity, biodiversity, and the sustenance of local communities. These ecosystems not only provide essential resources such as water and food, but also serve as critical habitats for diverse species. Despite the existence of constitutional and statutory provisions intended to safeguard these vital resources, wetlands and water bodies in the country continue to face substantial threats, primarily due to pollution, encroachment, and unsustainable development practices. Inadequate government enforcement of environmental regulations has necessitated judicial intervention, resulting in a series of landmark rulings aimed at preserving these ecosystems. These judicial actions underscore an increasing recognition of the importance of wetlands and water bodies for maintaining ecological balance and securing the well-being of future generations. This study explores key court decisions that have significantly influenced the evolution of environmental protection law, specifically with regard to wetlands and water bodies, while also addressing the persistent challenges in implementing and enforcing these judicial rulings.

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The judiciary in Bangladesh has assumed a crucial role in advancing environmental protection through proactive measures and the development of environmental jurisprudence. The Supreme Court has consistently intervened to safeguard wetlands, rivers, and lakes, employing a range of judicial remedies. These have included directives for the demarcation of rivers according to their original and present courses, measures to prevent encroachment, mandates for afforestation along riverbanks, and the invalidation of housing projects that lack proper environmental clearance. The courts have also issued orders for the restoration of wetlands, the demolition of illegal structures, and the designation of wetlands as 'ecologically critical areas,' necessitating specific protective actions.

Environmental rights, as interpreted through judicial enforcement, can be categorized into substantive and procedural rights. Substantive environmental rights pertain to the entitlement to a clean and healthy environment, while procedural rights encompass the ability to access information, participate in decision-making processes, and seek justice in environmental matters. Although the Constitution of Bangladesh does not explicitly enshrine these two types of environmental rights, it incorporates a provision (Article 18A) introduced in 2011, which mandates the State to protect and improve the environment. In the absence of a specific constitutional right to a safe environment, Bangladesh has adopted the approach of "greening" existing human rights, particularly the right to life. This approach entails interpreting the right to a safe environment as part of broader human rights, including the right to life. The landmark ruling in Dr. *Mohiuddin Farooque vs. Bangladesh and Others (1996)* expanded the constitutional right to life, affirming that it includes the right to a safe and healthy environment. This decision, grounded in Articles 31 and 32 of the Constitution, acknowledges that the right to life encompasses the protection of the environment, the maintenance of ecological balance, and the preservation of air and water quality. It emphasizes that life cannot be fully realized without a healthy environment, and therefore, any actions that damage the environment infringe upon the fundamental right to life.

2. Objective

The primary objective of this paper is to analyze the role of judicial intervention in the protection of wetlands and water bodies in Bangladesh, with a focus on the environmental challenges and the effectiveness of court directives. The research aims to:

- Examine the role of the judiciary in addressing administrative inaction and environmental degradation and
- Provide recommendations for improving the enforcement of environmental laws and regulations to enhance the overall management and protection of Bangladesh's wetland ecosystems for sustainable development

3. Selected Landmark Judgements on Wetlands

3.1 Restoration Effort to Reclaim Wetland Encroached for Township Development [65 DLR (AD) 181]

The verdict given by the Supreme Court of Bangladesh in this case (Civil Appeal No.256 of 2009 with Civil Appeal Nos. 253-255 of 2009 and Civil Petition for Leave to Appeal No. 1689 of 2006 (from the judgment and order dated 27.07.2005 passed by the High Court Division in Writ Petition No. 4604 of 2004 with Writ Petition No.5103 of 2003)) stands as a critical turning point in the relationship between urban development, environmental protection, and human rights. At its core, the judgment confronts the delicate balance between private development interests and the public good, emphasizing environmental sustainability as an inextricable component of human well-being.

Metro Makers and Developers Limited (MMDL), a private real estate developer, embarked on a project in a large wetland area in Savar Upazila, branding it as the Modhumati Model Town (MMT). These wetlands played a vital ecological role, functioning as seasonal water reservoirs and natural drainage systems, essential for managing floodwaters from the surrounding region. As a result, the wetlands were classified as a sub-flood flow zone in the Master Plan of Dhaka City, adopted under the Town Improvement Act of 1953. Despite the ecological significance of these wetlands, MMDL proceeded to fill the land with earth to create residential plots, which it then offered for sale to potential buyers. This action occurred despite Rajdhani Unnayan Kartripakkha (RAJUK), the government authority responsible for overseeing urban planning and development in the area, rejecting the company's application for development. Furthermore, MMDL continued advertising and selling these plots in defiance of a stay order issued by the High Court Division of the Bangladesh Supreme Court in Writ Petition No. 5103 of 2003, which had been filed by MMDL itself. This flagrant disregard for legal orders and environmental regulations triggered significant legal and ecological concerns.

The Supreme Court of Bangladesh directed the company to halt the development. The Court's recognition of the right to a healthy environment as an extension of the right to life is a pivotal development in Bangladesh's legal landscape. By framing environmental protection as fundamental to the constitutional right to life, the Court made a profound statement on the interconnectedness of environmental quality and human health. This expands the scope of human rights law, recognizing that the degradation of environmental resources such as wetlands directly impinges on the health, safety, and overall quality of life of individuals. This decision builds on an evolving trend in international jurisprudence, where environmental protection is increasingly viewed not merely as a matter of ecological or aesthetic concern but as essential to the realization of basic human rights. The Court's logic is clear: the destruction of wetlands and flood-flow zones not only disrupts natural systems but also jeopardizes public health and safety, especially in a flood-prone region like Dhaka.

The judgment robustly defends urban planning regulations, particularly the Master Plan of Dhaka. The plan identified certain areas as flood-flow zones, which are critical to managing the seasonal floods that plague the region. By ruling that the filling of wetlands within these zones violates the Master Plan, the Court reinforced the principle that urban development must not come at the expense of public infrastructure, particularly the systems that protect against flooding. The Court's ruling is both a rejection of haphazard urbanization and a call for rigorous adherence to scientifically -informed urban planning. Wetlands, especially in cities like Dhaka, serve as vital drainage systems, absorbing and directing rain and floodwater. If these ecosystems are destroyed for urban expansion, the natural flood-control mechanisms are impaired, exacerbating the city's vulnerability to flooding. In this context, the decision not only prevents irreversible ecological harm but also prioritizes flood mitigation a critical issue for Dhaka, which regularly faces devastating monsoon flooding. By emphasizing the need to preserve sub-flood flow zones and natural drainage systems, the Court reaffirmed that environmental preservation must be prioritized over commercial interests, particularly in ecologically sensitive areas.

The Court's directive to restore the wetland to its original state highlights a key principle of environmental jurisprudence: ecological restoration. The decision to remove the earth that MMDL had dumped into the wetland underscores the importance of reversing environmental damage where possible. This is not just a punitive measure against MMDL for its illegal development; it is also an effort to rebuild the natural habitat and ensure that the wetlands can continue their ecological functions, such as floodwater absorption and providing habitat for wildlife. The Court's insistence on restoration rather than mere compensation for damage aligns with a growing recognition in environmental law that rehabilitation of ecosystems is necessary to address long-term ecological losses. This underscores a progressive approach where the restoration of ecosystems takes precedence over compensatory damages alone, signaling a shift from punitive measures to proactive environmental stewardship.

By holding MMDL accountable for its illegal development in the wetland area, the Court reinforced the importance of regulatory compliance. The development, in violation of the Jaladhar Sangrakhan Ain, 2000 (Wetland Protection Act), demonstrated a clear disregard for the legal framework designed to protect critical ecosystems. The ruling emphasizes that the state's regulatory authority over land use, particularly in ecologically vulnerable zones like wetlands, is paramount and cannot be overridden by private developers. Moreover, the Court's order to dismantle any illegal construction serves as a powerful deterrent to future violations. This is an important step in reinforcing the rule of law, particularly in areas where economic interests may seek to circumvent regulations for short-term gain. The judgment suggests that enforcement of environmental laws must be both stringent and timely, without allowing for delays or exceptions based on economic or commercial arguments.

One of the most critical and complex aspects of this case involves the third-party purchasers who bought land from MMDL in

the development project. The Court directly addressed their legal status, ruling that the principle of bona fide purchasers could not be applied in this case. Even though many of the purchasers were unaware of the illegal nature of the development, the Court held that their rights were secondary to the statutory restrictions protecting flood-flow zones. The Court's decision here is notable for its emphasis on legal compliance over private ownership rights. It acknowledged the economic harm to these individuals but stressed that their claims could not supersede the public interest in preserving natural flood management systems. The Court's ruling requires MMDL to compensate these purchasers, which presents a complicated balancing act between individual property rights and the public good. This decision reaffirms that illegal land use cannot confer legal property rights, regardless of the purchaser's intent or knowledge at the time of purchase.

The Court's ruling extends beyond the specific case of MMDL. It includes sweeping recommendations for improving environmental governance and public awareness:

- Creation of district-level expert committees to monitor environmental degradation, including the destruction of wetlands, deforestation, and land degradation.
- Environmental education in schools and colleges, which is crucial for instilling long-term public awareness of the importance of conservation.
- Stringent enforcement of environmental laws, particularly in flood-prone and ecologically sensitive areas.

These recommendations aim to institutionalize environmental protection at the grassroots level, enhancing both public engagement and governmental accountability in environmental matters. By emphasizing local enforcement and education, the Court addressed the systemic issues that have hindered Bangladesh's environmental protection efforts, such as lack of public awareness and inadequate implementation of existing laws.

This landmark ruling by the Supreme Court of Bangladesh marks a major turning point in the intersection of urban development, environmental law, and human rights. It represents a decisive stand on the primacy of environmental preservation over private development, highlighting the critical role that wetlands play in safeguarding urban populations from flooding. The judgment is notable not only for its environmental significance but also for its broader implications for human rights law and regulatory governance. The Court's emphasis on environmental protection as an integral part of the right to life establishes a robust legal framework for addressing future conflicts between development and conservation, setting a precedent that could inspire similar rulings in other jurisdictions grappling with the same tension.

3.2 BGMEA building - A Destructive Presence Endangering Natural Canal [9 SCOB [2017] AD 70]

The legal battle against the Bangladesh Garment Exporters and Manufacturers Association (BGMEA) building is a remarkable case that underscores the broader issue of legal impunity and the

abuse of power by influential entities in Bangladesh. The High Court's Suo Motu Rule initiated on April 3, 2010, following a newspaper report, reflects the judiciary's intervention in holding accountable a powerful institution that had misused public resources and disregarded environmental laws (*The State Vs. Government of Bangladesh and Others*, 2010).

The case revolves around BGMEA's illegal acquisition of land originally designated for a public purpose - specifically, land that had been acquired by the Railways Department but later transferred to the Export Promotion Bureau for a World Trade Centre. The land, however, was handed over to BGMEA without proper registration and was used to build a private office complex. This violated fundamental principles of land use laws, which dictate that land acquired for one public purpose cannot be repurposed for another without following due legal procedures. The case highlighted a profound abuse of power, where BGMEA's influence led to the manipulation of the legal process, showing the entrenched culture of impunity among powerful organizations.

The BGMEA building was constructed on a wetland, a crucial drainage zone for central Dhaka, contributing to the city's flood management system. The earth filling required for the construction disrupted natural drainage channels, cutting off connectivity between important canals. Despite concerns raised about the environmental impact, authorities appeared to ignore the negative consequences. This demonstrated a significant failure in environmental governance, where development projects, driven by powerful entities like BGMEA, were prioritized over the preservation of the environment.

The construction was conducted in clear violation of the Master Plan for the city, which regulates land use, open spaces, and wetlands. The High Court judgment of April 3, 2011, specifically found the construction to be contrary to the Wetland Protection Act of 2000 and the Open Space Act, rendering the building unlawful. The court ordered the demolition of the building within 90 days, marking a landmark decision in favor of urban planning and environmental conservation. This decision also called for BGMEA to refund the buyers of flats in the building, emphasizing that the transactions were invalid due to the illegal nature of the project.

Despite BGMEA's efforts to appeal the judgment, the Appellate Division of the Supreme Court rejected both the leave to appeal and the civil review petition, reinforcing the legality of the High Court's decision. The final demolition of the building affirmed the legal system's ability to challenge powerful entities and enforce the rule of law, no matter how influential the defendant. This outcome significantly enhanced public trust in the formal legal system, especially in cases where the elite have historically been beyond the reach of justice.

From an environmental governance perspective, this case is a pivotal example of holding the powerful accountable for their actions and enforcing laws designed to protect the environment. By challenging the legality of the BGMEA building, the case brought attention to critical issues such as:

- Urban wetland conservation: The destruction of the wetland was a serious violation of laws protecting natural

water management systems. The demolition of the building supports the argument that urban planning and development should never come at the cost of environmental sustainability.

- Right to Environmental Information and Justice: This case also emphasized the importance of public access to environmental information and the right to justice, particularly for marginalized communities. The High Court's intervention highlighted how the formal legal system can serve as a mechanism for environmental accountability, providing a platform for environmental organizations like the Bangladesh Environmental Lawyers Association (BELA) and others to assist the court in navigating complex legal and environmental issues.
- Challenging Impunity: The judgment stands as a testament to the growing ability of the legal system to tackle cases of legal impunity, particularly where powerful corporate or institutional interests are involved. By addressing BGMEA's abuse of power and ultimately forcing the demolition of the building, the judgment sent a strong message that lawlessness by influential entities would no longer be tolerated, particularly when it infringes upon the public good or the environment.

The BGMEA case serves as a landmark judgment that strengthened both environmental law enforcement and accountability within the urban development sector. By requiring the demolition of an illegal building constructed on a wetland, the Court not only upheld the sanctity of urban planning regulations but also reinforced the right to a healthy environment as an integral part of public rights. The case has had a lasting impact on environmental jurisprudence in Bangladesh and set a significant legal precedent for challenging the abuse of power in the face of corporate impunity. Ultimately, the case has elevated public confidence in the legal system, ensuring that environmental laws are applied consistently, and that even the most influential entities can be held accountable for their actions.

3.3 High Court Cracks Down on Illegal Water Body Grabbing, Calls for Wetlands Authority

The High Court's verdict in the case concerning the illegal land grabbing and filling up of water bodies by Unique Property Development Ltd. (UPDL) and Sonargaon Economic Zone (SEZ) near the Meghna River offers a comprehensive judicial approach to address environmental violations and uphold the sanctity of wetlands in Bangladesh. This case, arising from a writ petition filed by the BELA (Writ Petition No. 1683 of 2014), sheds light on key issues related to land use regulation, environmental protection, and the accountability of private corporations in the context of environmental governance.

The case centers on the unlawful activities of two private companies that had grabbed land and filled up water bodies near the Meghna River, a vital water source and ecosystem. These activities bypassed both the relevant laws and directives from the High Court and the Supreme Court, underscoring

a profound disregard for environmental law by powerful corporate entities. The High Court's findings are significant in that they directly confront the corporate tendency to prioritize short-term economic gains over long-term environmental sustainability, a practice that often remains unchecked due to the economic influence and political connections of such firms. The Court declared the actions of both companies as illegal, thus affirming the principle that no private enterprise has the right to destroy vital ecosystems for private profit. This decision reflects the Court's strong stance on the protection of public resources and natural habitats that have broader implications for sustainable development and environmental justice.

In an effort to remedy the damage caused, the Court ordered that the Department of Environment (DoE) and the local administration take immediate steps to restore the wetlands and farmlands to their original state within six months. The companies responsible for the illegal land grabbing were instructed to cover the cost of this restoration by removing the sandfill they had deposited. This decision emphasizes the concept of corporate responsibility, where firms that harm the environment are financially liable for the damage they cause. It also marks a significant shift in environmental law enforcement, where private sector accountability is becoming more prominent in judicial discourse.

The directive also highlights a critical aspect of environmental governance: that damage to natural resources should not be treated as a mere regulatory violation, but as an actionable public harm that requires comprehensive remediation. By making the companies financially accountable for the cost of restoring the wetlands, the Court introduced a proactive approach to environmental justice, not merely penalizing the wrongdoers but also actively engaging in the repair of the ecological damage caused.

In a notable extension of the judgment, the Court called for educational reforms to address the lack of awareness regarding the importance of wetlands and the environment. It ordered the government to organize regular educational sessions for students across the country, teaching them about the management and development of wetlands and their role in ecological balance. This move seeks to instill in younger generations an appreciation for environmental conservation and a sense of responsibility toward maintaining the country's natural resources.

The Court's call for using satellite technology to geographically map all the wetlands of the country and make them visible to the public via displays in unions, upazilas, and districts represents a novel way of ensuring public engagement in the process of wetland protection. This move not only enhances public knowledge about wetland locations but also empowers local communities to become more vigilant and involved in the protection of their natural surroundings.

Furthermore, the Court's suggestion to organize rallies, seminars, and other awareness programs highlights the need for grassroots mobilization to elevate the significance of wetlands in the national discourse. Such initiatives encourage community participation in environmental conservation, promoting a collective approach to addressing environmental degradation.

One of the most impactful elements of the judgment was the Court's directive for the government to establish a dedicated authority to protect and preserve wetlands across the country. The proposed authority would be responsible for policy formulation, monitoring, and the enforcement of laws related to wetland conservation. This would represent a formal mechanism to centralize efforts to safeguard these critical ecosystems. The formation of such an authority would also provide a more coherent and structured framework for tackling illegal land grabbing and the degradation of wetlands, ensuring that there is a specialized body focused exclusively on the conservation of these environmentally crucial areas. Additionally, it would bolster the capacity of local authorities and communities to address threats to wetlands in a more organized manner. The inclusion of the Sundarbans (a world heritage site and a wetland of immense global importance) in the proposed authority's mandate further underscores the significance of this ruling in promoting a holistic approach to environmental conservation, one that integrates national, local, and global environmental priorities.

Despite the Court's progressive stance, the legal process is not yet concluded. Following the High Court's verdict, a stay order was granted, and the case is now pending for hearing before the Appellate Division. The pending appeal brings uncertainty to the immediate outcome of the judgment, yet it signals the need for further legal examination and the potential for the judgment to be either upheld or modified. However, the very fact that the case has proceeded to this point in the legal system signifies a substantial achievement in terms of environmental legal advocacy. The legal outcome of this case may set a precedent for future legal battles involving private sector abuse of public resources, as well as influence the ongoing debate over the protection of Bangladesh's wetlands, which are increasingly under threat due to urbanization and industrialization.

This case serves as a landmark example of how the judicial system can act as a critical check on illegal environmental practices, even when they involve powerful private entities. By declaring the activities of UPDL and SEZ illegal, ordering environmental restoration, and advocating for a nationwide awareness campaign, the High Court has laid down a blueprint for future environmental governance. Additionally, the directive to create a dedicated authority for wetland protection is an essential step toward ensuring that Bangladesh's vital natural resources are not sacrificed for unchecked economic growth. While the case remains unresolved at the appellate level, its judicial impact has already been significant, highlighting the capacity of the legal system to hold both private corporations and public authorities accountable for environmental degradation.

3.4 Court Orders Protection for City's Green Spaces, Lakes, and Parks [18 BLD (AD) (1998): 18BLD(HCD) (1998)]

The verdict in this case presents a significant legal decision with implications for environmental law, locus standi (the right to bring a legal action), and the protection of public interest, particularly regarding

the preservation of natural resources in urban areas (*Mrs. Parvin Akhter Vs. The Chairman, Rajdhani Unnayan Kartipakkha and others*, 1996).

The case reiterated and applied the principles outlined in previous judgments regarding locus standi which clarified that an individual or group acting in the public interest can be considered a "person aggrieved," even if they do not have a direct personal injury. The Court underscored the environmental concerns, especially those affecting the public at large, give citizens (or organizations) sufficient standing to challenge governmental or local authority actions that may harm the environment. The Court cited *Dr. Mohiuddin Farooque Vs. Bangladesh* (1997) (17 BLD (1997) (AD)1), emphasizing the expansion of the traditional concept of locus standi, which allows persons with sufficient interest, like environmental groups or residents of a locality, to approach the Court for redress even if they are not directly affected by the action in question. This decision aligns with the evolution of public interest litigation (PIL) in many jurisdictions, where Courts recognize that those who represent a larger public cause, such as environmental preservation, have standing to bring actions for the public good. The judgment therefore broadens the access to justice for cases with significant societal or environmental impact.

The core issue in this case is the destruction of greenery, parks, and lakes by RAJUK (the City Development Authority) to make space for roads and residential plots. The Court emphasizes the importance of environmental protection, highlighting that the greenery and the Gulshan Lake are crucial for the environmental well-being of the residents of Gulshan Model Town. The preservation of these spaces is framed not only as an aesthetic issue but also as one that provides tangible environmental benefits, such as better air quality, reduced urban heat, and community well-being.

The ruling places the burden of responsibility on the authorities (RAJUK and others) to balance urban development with environmental preservation. The Court implicitly invokes the principles of sustainable development, noting that public health and environmental benefits outweigh the need for rapid urbanization when it comes to the destruction of irreplaceable natural resources like lakes and green spaces. It is a clear recognition of the constitutional duty to protect natural resources under the broader goal of social justice.

The judgment also connects the duty of the Courts to interpret the Constitution in a manner that advances social, economic, and political justice. In this context, the Court highlights that the destruction of environmental assets can harm the welfare of both present and future generations. This is consistent with modern interpretations of constitutional obligations, where environmental rights are seen as part of the right to life and the broader notion of social justice.

By focusing on the lessees of Gulshan Model Town, the Court affirms that these individuals, as stakeholders in the local environment, are directly impacted by the degradation of natural spaces. The Court notes that the petitioner, as a resident and a lessee of the area, has the standing to bring the suit because the destruction of the lake would negatively affect the community's

quality of life, including environmental, aesthetic, and health-related benefits.

This aspect of the case underscores the Court's commitment to safeguarding not only individual rights but also the collective rights of communities that depend on shared natural resources. The judgment reflects a holistic understanding of environmental law, where local communities are seen as primary custodians of their surrounding environments.

The Court directed RAJUK and other authorities not to destroy the greenery and Gulshan Lake in the future. This directive shows the Court's proactive role in ensuring that urban development does not override environmental conservation efforts. The judgment acts as a preventive measure, aiming to stop future harm to the environment rather than merely offering redress for past actions.

By issuing an injunction against RAJUK, the Court enforces a precautionary principle in environmental governance, which is essential in cases involving potentially irreversible environmental damage. The Court's forward-looking decision aims to create a deterrent effect, ensuring that authorities consider environmental sustainability before engaging in development activities that could harm natural ecosystems.

This judgment reflects a significant shift toward recognizing the rights of individuals and communities to protect their local environments, even in the face of urban development. The case builds on the principles of public interest litigation and environmental law, ensuring that the state and local authorities remain accountable for protecting green spaces, lakes, and other natural resources that provide essential benefits to urban populations. The Court's emphasis on the duty to interpret the Constitution in a way that promotes social, economic, and environmental justice represents an evolving judicial approach to balancing development with environmental stewardship.

3.5 Saving Dhaka's Lifeline: Court Orders Bold Action to Protect Gulshan-Banani-Mohakhali Lake and Declare the same as Environmentally Critical Area

In a landmark ruling, the High Court issued a series of seven transformative directives aimed at protecting the increasingly threatened Gulshan-Banani-Mohakhali lake in Dhaka. This public interest litigation, brought forward by a Supreme Court lawyer, highlighted the lake's crucial role in maintaining the city's ecological balance despite decades of encroachment and urbanization (*Omar Sadat and another Vs. Bangladesh represented by the Secretary, Ministry of Housing and Public Works, Government of the People's Republic of Bangladesh, Bangladesh Secretariat, P.S. Ramna, Dhaka, and others*, 2006).

Once a natural drainage system, the lake now faces relentless encroachment and pollution, jeopardizing its environmental functions. As a vital water retention basin, groundwater recharge source, and temperature regulator, its preservation is essential to Dhaka's sustainability. The Court's ruling directs the government to take swift, comprehensive action to safeguard the lake, including declaring it an "Environmentally Critical Area," halting further encroachments, and improving waste management. The

Court also mandates the formation of a dedicated committee to oversee these efforts and enforce compliance.

With a firm deadline of three months to begin the restoration process and ongoing oversight, this ruling provides a glimmer of hope for the future of the lake and the environment in Dhaka, urging both immediate action and long-term vigilance to preserve this urban oasis.

3.6 Rivers as Legal Entities: A Historic Ruling to Protect Bangladesh's Waterways

In a groundbreaking move, the High Court declared rivers as legal entities, marking a historic shift in how natural resources are viewed and protected (W.P. No. 13989/2016, Judgment dated 30.01.2019 and 03.02.2019). The ruling follows a public interest petition filed by Human Rights and Peace for Bangladesh, which highlighted severe pollution, encroachment, and landfilling of the rivers surrounding Dhaka, particularly the Buriganga, Turag, Balu, and Shitalakkha rivers (litigation *Human Rights and Peace for Bangladesh and Others vs. Bangladesh and Others*, 2009). In a sweeping judgment delivered on March 21, 2010, the Court empowered the rivers with legal standing, making them entitled to protection and restoration through comprehensive legal measures.

The High Court assigned them the same rights and protections as any legal person. This unprecedented recognition provides the legal framework for the rivers to be defended from encroachments and environmental degradation, effectively making them guardians of their own well-being.

The Court mandated the creation of a National River Protection Commission, tasked with overseeing the protection, management, and restoration of rivers, including tackling illegal encroachments and pollution, and ensuring navigability. The Commission is given the authority to act as the legal guardian of rivers, ensuring that any damage to these water bodies is prevented and corrected.

The Court directed the government to adopt short-term and long-term plans based on the Commission's recommendations to restore the country's rivers. These plans focus on removing pollution, encroachments, and structures that obstruct the natural flow of rivers, with a particular emphasis on the four rivers around Dhaka.

Specific directions were given to restore rivers to their original condition, including the demarcation of river boundaries through surveys, re-excavation of canals, and the removal of illegal constructions along riverbanks. The Court also declared these rivers as ecologically critical areas, recognizing their vital role in maintaining ecological balance and ensuring sustainable development.

In a bold move, the Court laid out a clear framework for accountability, ordering the government to take action against land grabbers by publishing their names, restricting them from accessing loans or holding public office, and treating river encroachment as a crime. The Court also directed legislative amendments to ensure severe punishment for those responsible for harming rivers.

This judgment goes beyond recognizing rivers as legal entities by providing a practical and detailed roadmap for their

protection. The establishment of a National River Protection Commission and a comprehensive action plan will enable a coordinated, multi-agency effort to protect Bangladesh's rivers. The ruling also sets a powerful legal precedent for the protection of other natural resources and ecosystems across the country.

In essence, this judgment marks a monumental step toward recognizing the intrinsic value of rivers and the necessity of safeguarding them for future generations. By affording rivers legal rights, the Court has ensured that these vital natural entities are no longer at the mercy of unregulated urbanization, pollution, and encroachment. This ruling is not only a victory for environmental conservation but also a bold assertion of the importance of sustainable development in Bangladesh.

3.7 Balancing Development with Sustainability: Court Prioritizes Environmental Protection Over Economic Gains in Sylhet [2010 BLD (HCD) 30]

In a significant legal development, the High Court ruled in favor of protecting the Piain, Dawki, and Dhala rivers in Sylhet from the harmful effects of mechanized stone extraction. This landmark judgment stems from a writ petition filed by BELA and addresses the environmental degradation caused by unregulated stone extraction activities, which were once conducted manually but were later mechanized in 1998 without environmental clearance (*Bangladesh Environmental Lawyers Association (BELA) Vs. Government of Bangladesh and Others*, 2009).

The ruling emphasized the principle that environmental protection must take precedence over economic interests, particularly when the extraction process threatens the sustainability of vital ecosystems. The Court's decision outlined both the environmental damages and the risks to the local population posed by the mechanized method of stone collection, which is considered more efficient commercially but devastating ecologically.

The Court recognized the severe consequences of mechanized extraction on both the environment and the livelihoods of the surrounding communities. The introduction of hydraulic excavators, which operate with high noise, air pollution, and dust, has had devastating effects on the local ecosystems and endangered the populations who rely on the rivers for their resources. The Court also highlighted the significant risks posed to the region due to its proximity to the Dawki fault, making the area vulnerable to earthquakes.

A core principle reinforced by this judgment is the primacy of environmental protection over economic interests. While acknowledging the importance of economic development, the Court emphasized that sustainable development must not come at the cost of irreversible environmental damage. This ruling affirms that, when faced with potential harm to the environment, economic considerations should not override ecological concerns.

The Court referred to international case law, including the *Rural Litigation and Entitlement Kendra* case in India, where the Supreme Court ruled to shut down harmful mining operations despite their economic importance, recognizing the long-term

ecological costs. This reference highlights a broader global trend towards valuing environmental sustainability over short-term economic benefits.

The Court was particularly critical of the lack of regulatory oversight and environmental clearance for the operations of over 50 excavators in the Jaflong stone quarry. The absence of an Environmental Impact Assessment (EIA) for these operations was noted as a severe oversight that contributed to the destruction of local ecosystems. The Court ordered that no mechanized extraction would be allowed until the Ministry of Environment and the Department of Environment developed specific guidelines to ensure such activities are carried out without harming the environment.

To ensure that any future stone extraction activities are environmentally safe, the Court imposed a temporary ban on mechanized extraction until proper guidelines are framed. These guidelines would govern the extraction process and set strict standards to ensure that any stone collection, whether manual or mechanized, does not damage the ecological integrity of the rivers and surrounding areas.

This ruling sets a strong precedent in Bangladesh, affirming that economic development should not come at the expense of the environment. By prioritizing environmental protection, the Court has emphasized the importance of long-term planning and sustainable resource extraction. This decision also calls for stricter regulatory oversight, urging the government to take proactive measures to ensure that economic activities are aligned with environmental safeguards.

The judgment is a powerful reminder that the exploitation of natural resources must always be balanced with ecological preservation to protect the country's rich biodiversity and ensure the well-being of local communities. As such, it represents a critical step towards fostering a more environmentally conscious approach to development in Bangladesh.

3.8 Protecting Jaflong's Jewel: Court Recognizes Dawki River as Ecologically Critical

In a landmark judgment, the High Court declared the Jaflong-Dawki river in Sylhet an Ecologically Critical Area (ECA), providing robust legal protection for one of the region's most vital environmental assets. The ruling follows two writ petitions filed by BELA and Abdul Hafiz, challenging illegal constructions and ecological damage to the river caused by unregulated stone extraction activities (*Bangladesh Environmental Lawyers Association (BELA) Vs. Bangladesh and others; AND Abdul Hafiz Vs. Bangladesh and others*, 2011).

The Dawki river, located in the picturesque hills of northeastern Bangladesh, is a critical part of the local ecosystem, supporting biodiversity, tourism, and the livelihoods of surrounding communities. However, its ecological integrity has been severely threatened by illegal activities, including the construction of a bailey bridge for the transportation of stones extracted from the river, and the use of hydraulic excavators in stone quarries, which have disrupted the river's natural flow and harmed its environment (BELA earlier filed Writ Petition No. 4958 of 2009 as mentioned above to stop

the mechanized extraction of stones and also to remove mechanized excavators from the Jaflong and Bholagonj stone quarries of the Pian, Dawki, and Dhala rivers and to protect the natural eco-system of the rivers and the lives, property and livelihoods of the people living in the said areas).

The Court directed that the Jaflong-Dawki river and its surrounding areas be officially recognized as an ECA under Section 5 of the Bangladesh Environment Conservation Act, 1995. This designation offers enhanced protection to the river, requiring the government to ensure that no further destructive activities, such as unregulated construction or illegal extraction, are allowed in the area. By granting the river such status, the Court emphasizes the urgent need to protect the river's biodiversity and natural resources.

The Court also ordered the immediate removal of the illegally constructed bailey bridge over the Dawki river, along with its associated approach roads and dams. This structure, built without an Environmental Impact Assessment (EIA) or public consultation, was deemed a serious violation of environmental law and a threat to the river's delicate ecosystem. The removal of such structures is vital to restoring the river's natural flow and minimizing further environmental harm.

The Court called for the formulation of environmental guidelines under Section 13 of the Environment Conservation Act, to regulate activities in ecologically critical areas like the Jaflong-Dawki river. Consequently, a guideline has been framed and notified in an official gazette dated 18 February, 2015 serving as a legal framework to ensure that future development and economic activities in the region are conducted in a manner that protects the river and its surrounding environment.

The Court highlighted the environmental degradation caused by the unregulated use of hydraulic excavators in the stone quarries of Jaflong. These activities have led to the destruction of riverbeds, harming aquatic life and contributing to soil erosion and water pollution. The Court's ruling effectively supports the need for sustainable stone extraction practices and the cessation of mechanized extraction until the proper environmental safeguards are in place.

The ruling not only aims to protect the environment but also addresses the welfare of the local communities. By curbing destructive practices such as illegal construction and unsustainable stone mining, the Court has taken steps to safeguard the livelihoods, property, and health of the people who depend on the river. The ruling underlines the importance of striking a balance between economic activity, particularly stone extraction, and environmental protection.

This ruling sets a significant precedent for the protection of natural resources in Bangladesh, reinforcing the idea that environmental conservation should take precedence when development activities risk irreparable harm to ecosystems. By declaring the river an Ecologically Critical Area, the Court has highlighted the importance of upholding international environmental standards, such as those found in the Rio Declaration on Environment and Development, which asserts that economic development should not come at the expense of environmental sustainability.

Furthermore, the Court's directive for the removal of the bailey bridge, the cessation

of unregulated stone extraction, and the formulation of specific environmental guidelines signifies a progressive approach toward environmental justice. It sends a clear message to both government authorities and private enterprises that environmental degradation in ecologically sensitive areas will no longer be tolerated. This judgment is a powerful affirmation that protecting the environment and ensuring sustainable development are not mutually exclusive but can go hand in hand with thoughtful legal frameworks and proper regulatory oversight. The recognition of Jaflong-Dawki river as an Ecologically Critical Area marks a significant step toward protecting Bangladesh's natural heritage for future generations.

3.9 Preserving Public Heritage: Court Protects Lal Dighi from Unlawful Alteration

In a significant legal victory for public heritage and environmental protection, the High Court delivered a ruling that blocks the Chittagong City Corporation's plans to fill up the historical Lal Dighi with earth to convert it into a swimming pool. BELA filed a writ petition, citing concerns about the illegal encroachment and potential destruction of this culturally and historically significant water body, situated at Andorkilla, Chittagong (*Bangladesh Environmental Lawyers Association (BELA) Vs. The Chittagong City Corporation, represented by its Mayor, Andorkilla, Chittagong and others*, 2010).

Lal Dighi is not just an ordinary water body but an icon of public history. The Court recognized its importance as a symbol of the city's anti-British movement, the language movement, and Bangladesh's liberation war, emphasizing that such cultural landmarks must be preserved for future generations. The Court reasoned that converting the Dighi into a swimming pool would destroy its historical legacy and restrict public access to it, fundamentally altering its nature. The judgment highlights the irreplaceable role of such sites in the collective memory and identity of a community.

The Court affirmed that the plan to fill Lal Dighi and turn it into a swimming pool directly violated the Chittagong Metropolitan Master Plan and the Detailed Area Plan for the city. According to the plan, Lal Dighi was designated as a public water body, integral to the community and meant to be preserved for public use. The Court ruled that such arbitrary alterations of public property without legal authority or public consultation are unlawful and should be blocked.

The Court underscored the alarming rate of environmental degradation in Chittagong, particularly due to the filling up of water bodies for commercial and residential purposes. The petition highlighted the risks of this unchecked destruction, which includes disrupting the hydrological cycle, reducing open spaces necessary for urban planning, and depriving citizens of vital recreational and ecological spaces. The judgment calls attention to the importance of water bodies in maintaining the environmental health of a city and stresses the responsibility of government bodies to ensure the protection of these spaces.

The Court reinforced the notion that public water bodies and open spaces are vital civic amenities. The decision places emphasis on the public's right to access

these spaces and participate in communal activities. Lal Dighi, specifically, has been a center of local gatherings, political events, and cultural practices such as the annual Boli Khela wrestling competition. By proposing a swimming pool catering only to a select group of affluent individuals, the city authorities would be denying the general population access to a precious shared resource.

In its ruling, the Court expressed concern about the broader implications of such urban encroachments, which are not isolated to Chittagong but are a widespread issue across the country. The Court's language reflected its alarm at the continuous shrinkage of open spaces, parks, forests, and water bodies in urban areas, all of which are vital for maintaining urban ecology and public health.

The judgment establishes a key precedent for the protection of public properties and historical landmarks from unlawful exploitation and misuse by state authorities or private entities. By upholding the Chittagong Metropolitan Master Plan, the Court reinforces the necessity of accountable urban planning that aligns with environmental and public interest laws.

This verdict sends a strong message about the importance of protecting public spaces from unlawful alterations driven by economic motives. It reinforces the legal principle that public interest and environmental sustainability must take precedence over private or commercial desires when it comes to the management of natural and cultural resources. The Court's clear stance against encroachment serves as a reminder of the need for a holistic approach to urban development, one that respects historical, cultural, and environmental values.

Additionally, the judgment affirms that public property, such as water bodies, is a collective asset that should not be privatized or appropriated for narrow interests. It serves as an important example of how the judiciary can act as a guardian of both historical preservation and public welfare, ensuring that future generations can enjoy these communal resources in their original, unaltered form.

This landmark ruling is a triumph for environmental and cultural conservation, safeguarding Lal Dighi as a public resource and preserving its historic value for future generations. By preventing its transformation into a private swimming pool, the Court has not only protected a physical space but also reinforced the community's right to access and enjoy public spaces that have deep cultural and historical significance.

3.10 Court Protects Crucial Water Bodies in Dhaka's Industrial Belt from Pollution and Encroachment

In a landmark ruling, the High Court ordered the protection of four significant water bodies - Beel Baghil, Beel Dholai, Beel Pakuria, and Kornapara Khal, from pollution and encroachment caused by industries and influential land grabbers. The petition, filed by BELA (Writ Petition No. 2922 of 2011), highlighted the severe environmental degradation resulting from hazardous industrial waste and illegal encroachments on these water bodies,

which are critical ecological resources for the surrounding community and the greater Dhaka area.

This verdict underscores the fundamental right to a healthy environment, aligning with the constitutional provision that guarantees citizens the right to live in a healthy environment. By intervening in this case, the High Court reinforced the notion that the government and relevant authorities have a duty to protect and preserve natural resources, particularly water bodies, which are central to public health, biodiversity, and the sustainable development of the region.

The judgment directly addresses the industrial pollution from at least 30 industrial units surrounding Dhaka. These industries were identified as the primary contributors to the toxic contamination of the Beels, which are crucial for the local ecosystem and livelihoods. The Court's directive to prevent the discharge of industrial waste reflects a growing judicial awareness of the environmental costs of industrial development without adequate safeguards. By ordering that the authorities compile a list of polluting industries and report the actions taken to mitigate pollution, the Court has held both industry and the Department of Environment accountable for failing to enforce pollution control laws.

One of the core elements of this ruling is the emphasis placed on inadequate enforcement by regulatory authorities, particularly the DoE. The Court observed that authorities had not taken effective measures to curb pollution and protect these water bodies, allowing unchecked environmental degradation. By mandating that the DoE's Director-General and other officials submit bi-annual progress reports, the Court is ensuring regular oversight and placing pressure on government agencies to take proactive actions to combat pollution.

The judgment also addresses the illegal encroachment on the Beels, which have been progressively usurped by influential individuals for personal gain. The Court recognized that such encroachments not only reduce the availability of vital water resources but also disrupt the delicate ecological balance and harm the livelihoods of local communities that depend on these water bodies for fishing, agriculture, and water supply. The Court's directive to evict encroachers affirms the principle that public resources, such as water bodies, must remain accessible to all citizens and be protected from illegal appropriation.

A key part of the judgment involves continuous monitoring to ensure compliance. The Court ordered that authorities maintain regular monitoring of the waste treatment systems in the identified industries to assess their adherence to environmental standards. This directive ensures that short-term interventions will lead to long-term improvements in the management of industrial waste and that compliance will be enforced through regular oversight.

The verdict is significant not only in terms of the immediate protection of these water bodies but also as a wake-up call to both government agencies and industries about the importance of strict environmental governance. It sends a strong message that environmental laws must be enforced consistently to ensure the sustainability of

natural resources for present and future generations. The requirement for regular reporting and accountability mechanisms reflects a shift toward greater transparency and active government oversight.

This ruling provides an important legal precedent for the protection of vital water bodies in urban and industrial settings. It emphasizes the need for comprehensive and integrated environmental management that involves all stakeholders, including industries, government agencies, and local communities. The decision also reinforces the principle that industrial development should never come at the expense of the environmental and public good.

Additionally, this judgment could serve as a model for future cases involving pollution and encroachment on water bodies, particularly in rapidly industrializing regions. It strengthens the argument that public natural resources must be preserved for the collective well-being, ensuring they remain accessible, usable, and intact for future generations.

The Court's decision to protect Beel Baghil, Beel Dholai, Beel Pakuria, and Kornapara Khal from pollution and encroachment is a major victory for environmental justice and public rights in Bangladesh. The ruling holds both industries and government agencies accountable for their failure to protect these critical water bodies, ensuring that they are preserved for the public's benefit. By mandating regular monitoring and compliance measures, the Court has taken a decisive step toward ensuring sustainable management of natural resources in one of Bangladesh's most important industrial regions.

3.11 Judicial Intervention to Preserve Wetland: High Court Deems Local Administration's Actions Illegal in Land Conversion for Private University

The case involves the conversion of a 4.23-acre wetland, recorded as a beel/nama in the C.S. and S.A. records, into "waste land" by the Deputy Commissioner of Brahmanbaria. This move, purportedly to facilitate the long-term settlement of the land for a private university owned by a local member of Parliament, was contested through a writ petition (Writ Petition No. 10417 of 2021). The petitioner sought to protect the land from being filled for construction purposes, emphasizing its importance as a wetland.

Upon preliminary hearing, the High Court issued a rule, questioning the legality and constitutionality of the land conversion and its leasing for the university project. The Court sought to determine whether the local administration's actions were done in good faith and within legal boundaries, and whether they violated environmental and public interest standards.

The judgment, delivered on November 24, 2022, declared the actions of the local administration illegal. The High Court specifically ruled that the conversion of the beel/nama land into "waste land" for the university construction was unlawful. It directed that the land records be reverted to reflect the wetland's original status as a beel, reinforcing its ecological and public importance. Furthermore, the Court emphasized that the land must be protected to serve the broader public interest, which includes the preservation of wetlands crucial

for environmental balance and biodiversity. The ruling also sheds light on the importance of maintaining accurate and truthful land records, as the alteration of land classification such as changing the status from beel to "waste land" should not be manipulated for personal or political gain.

The verdict aligns with judicial efforts to curtail undue exploitation of land resources for private benefits, particularly when public land or environmentally sensitive areas are at risk. It reinforces judicial oversight in ensuring that administrative decisions adhere to constitutional and environmental norms.

3.12 High Court Orders Suspension of SAF Tannery for Non-Compliance with Environmental Laws to Protect Bhairab River

The case concerns the longstanding operation of the SAF Tannery, owned by the Akiz Group, located on the banks of the Bhairab River in Jessore District. This tannery, in operation since 1980, has operated without the necessary Effluent Treatment Plant (ETP) and has failed to obtain an Environment Clearance Certificate (EC), which are legally required to mitigate industrial pollution. The petition (Writ Petition No. 15782 of 2018), filed to protect the river from extensive pollution, emphasizes the environmental and health risks posed to the surrounding neighborhoods by the tannery's unchecked discharge of pollutants into the river.

The High Court's intervention in this matter underscores the critical role of the judiciary in enforcing environmental protection standards and holding industries accountable for their environmental impact. On November 10, 2022, the Court issued a directive to suspend the tannery's operations until it complies with environmental laws, specifically requiring the installation of an ETP and obtaining the necessary EC. This ruling is a significant step in addressing environmental degradation caused by industrial operations that violate pollution control laws.

The High Court's ruling places a strong emphasis on the government's duty to enforce environmental protection laws and uphold public health standards. It sends a clear message to industries operating in ecologically sensitive areas that they must comply with regulations designed to protect natural resources. Furthermore, the order for regular monitoring and enforcement actions highlights the judiciary's role in overseeing the implementation of environmental laws, particularly in cases where local administrations may fail to act on their own.

3.13 Appellate Division Upholds Wetland Protection: Directs Department of Environment to Enforce Compliance in Housing Projects

This case arises from a writ petition filed in 2009 by BELA to protect wetlands from being filled for two housing projects namely, Royal and Sonargaon City in violation of environmental laws. Initially, the High Court had issued a direction against the filling of wetlands but erroneously concluded that the lands in question could not be officially declared wetlands. This decision, prompted BELA to appeal the verdict before the Appellate Division in

2017, seeking a clearer, enforceable directive to preserve the wetlands.

On December 11, 2022, the Appellate Division of the Supreme Court delivered its judgment (Civil Appeal No.288/2017), directing the DoE to protect the five designated beels totaling 112.50 acres from any further encroachment. In addition, the Court ordered that the DoE monitor and enforce compliance with all environmental conditions stipulated in the EC for the housing projects, ensuring that these conditions, including the protection of the wetlands, are fully adhered to.

The Appellate Division's judgment represents a significant victory for environmental protection in Bangladesh, especially in the context of urban development. The Court's directive to the DoE to protect wetlands and enforce compliance with environmental regulations provides an essential check against the environmental harm that can result from large-scale housing projects. By holding developers accountable and ensuring the protection of vital ecosystems, the decision strengthens the role of the judiciary in preserving the country's natural heritage. The ruling serves as an important reminder that environmental preservation must be integrated into the development process, ensuring that progress does not come at the expense of the environment.

Conclusion

The series of landmark verdicts discussed above highlights the growing recognition of the need to balance economic development with environmental sustainability in Bangladesh. These rulings, handed down by the High Court, have addressed a wide array of environmental issues, including the protection of rivers, water bodies, and natural ecosystems, as well as the regulation of industrial activities that threaten these resources.

Each verdict serves as a catalyst for reform, ensuring that both government authorities and industries are held accountable for environmental degradation. These judgments have underscored several key principles:

Environmental Rights as Fundamental: The recognition that environmental protection is not just an aspiration but a fundamental right is crucial for safeguarding natural resources for future generations. The Court's rulings, whether related to the protection of rivers or water bodies, have affirmed that these resources are inextricably linked to public health, livelihoods, and the ecological balance of the country.

Public Interest: The Court highlighted the need for actions in the public domain to align with public benefit, prohibiting activities that encroach on community resources like wetlands, which hold significance for local ecosystems and the broader environmental good.

Government Accountability: The Court has repeatedly emphasized that government agencies must play a proactive role in enforcing existing laws. Whether it is preventing pollution, addressing illegal encroachment, or monitoring industrial activities, the government is now more compelled to act swiftly and effectively. Regular monitoring and reporting, as

required by several judgments, are critical in maintaining government transparency and responsibility.

Environmental and Economic Balance: The verdicts have emphasized the need for a careful balance between development and environmental preservation. Whether dealing with stone extraction in rivers or the transformation of public water bodies, the Court has clearly stated that economic interests must not override environmental considerations, particularly when it comes to irreversible damage to natural resources.

Public Participation and Awareness: These rulings have highlighted the role of public participation in environmental protection. Many cases arose from the efforts of organizations like BELA and concerned citizens who recognized the importance of preserving natural resources. Public advocacy and legal action will continue to play an essential role in holding industries and government bodies accountable for their actions.

Land Record Integrity: These rulings also shed light on the importance of maintaining accurate and truthful land records, as the alteration of land classification such as changing the status from beel to "waste land" should not be manipulated for personal or political gain.

While the verdicts provide crucial legal frameworks for environmental protection, the key challenge lies in the effective implementation of these laws. The government needs to ensure that the monitoring systems are robust and capable of enforcing regulations in real time. Creating a dedicated environmental enforcement task force could ensure timely action against polluters and encroachers.

As highlighted in the verdicts, public awareness is critical. The government, NGOs, and civil society should collaborate to promote environmental education, focusing on the importance of protecting rivers, water bodies, and other ecosystems. Community engagement can help in identifying local environmental issues, and by providing clear information, citizens can become active participants in the conservation efforts.

Moving forward, Bangladesh must prioritize sustainable development strategies, ensuring that industries adopt green technologies and environment-friendly practices. The use of hydraulic excavators for stone extraction, as criticized in the judgments, needs to be replaced with less damaging, more sustainable alternatives. Green audits for industries and environmental impact assessments for large-scale projects should be mandatory.

While the verdicts have highlighted existing laws like the Bangladesh Environment Conservation Act, there is still room for legal reform. To stay ahead of emerging environmental threats, the legal framework should evolve, including stricter penalties for violations and clear directives for industries regarding sustainable operations. Additionally, more eco-centric planning should be incorporated into the urban development process to prevent future encroachments on water bodies.

Finally, achieving long-term environmental protection will require continued collaboration among all stakeholders: government, industries,

environmental organizations, and local communities. Regular consultations, multi-stakeholder forums, and cross-sectoral cooperation will be crucial to ensure the preservation of natural resources while fostering economic growth.

In conclusion, these judicial decisions mark a significant step toward securing environmental justice in Bangladesh. However, their impact will only be fully realized if accompanied by systematic changes in governance, increased environmental awareness, and a sustained effort toward sustainable development. The way forward lies in the consistent and collective efforts of all sectors of society to safeguard the country's invaluable natural resources for generations to come.

Reference

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Section

4

Legal Fights, Civic Voice and Intellectual Discourse

Chapter 12

Disappearing Wetlands and the Political Economy of Media in Bangladesh

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1. Introduction

Ramsar Convention emphasizes the significance of wetlands for biodiversity as well as the environmental services they offer, which are vital to millions of people's quality of life. Wetlands are becoming more widely acknowledged as productive resources that support both ecological stability and economic viability Thompson and Colavito (2007).

Notwithstanding their importance, encroachment, pollution, and unsustainable development practices are seriously degrading Bangladesh's wetlands, especially in urban areas like Dhaka. Most of Bangladesh's wetlands are located in the Ganges-Brahmaputra-Meghna Delta, which is the biggest and most populated delta in the world (Ericson et al., 2005). Many wetlands are being turned into residential or industrial areas as a result of ongoing urbanization, endangering biodiversity and eroding local communities' means of subsistence.

Although the media are vital in bringing environmental issues to public attention, the story of Bangladesh's wetland loss is still remarkably under-reported. Wetland encroachment has been reported on occasion, but these pieces frequently lack the consistent attention required

to emphasize how serious the matter is. Powerful corporate interests have been able to encroach on these resources without consequences due to the media's inaction. In most of the cases, marginalized populations bear the brunt of the loss of these essential ecosystems. Such a trend not only worsens environmental degradation but also causes social injustices.

This research seeks to critically assess the relationship between media coverage and wetland degradation in Bangladesh. The study focuses on changes in media ownership and its impact on urban planning choices and its impact on the environment. This study aims to raise awareness of the pressing need for a more proactive and knowledgeable media discourse to address the ecological and social consequences of wetland degradation. In conclusion it highlights the significance of a more critical and involved media landscape in tackling the pressing issues brought on by environmental degradation and urbanization.

2. Methodology

The study uses a qualitative methodology that combines critical discourse analysis, content analysis, and historical analysis to examine this intricate interaction. The development of media ownership patterns in Bangladesh is contextualized through historical analysis, which charts their progression from the nation's independence in 1971 to the present. This background is essential to comprehending how political and economic forces impact media representations of environmental and urban planning challenges.

3. Theoretical Framework

Antonio Gramsci's Hegemony Theory and the Political Economy of Mass Media are two interconnected theoretical frameworks that serve as the foundation for this investigation.

According to the Hegemony Theory, prevailing ideas are spread by means of social and cultural institutions, such as the media, which are vital in forming societal norms and values. Gramsci's idea of hegemony highlights the nuanced ways that power is upheld through cultural narratives and media portrayals, not just by force but also with the consent of the governed. This study critically analyzes how media discourse is influenced by hegemonic power dynamics, which put urban development ahead of environmental preservation. The study demonstrates how prevailing ideologies about urbanization and economic expansion obscure important conversations about wetland protection and ecological sustainability.

An analytical framework for comprehending the complex interrelationships between media ownership, production, and distribution within larger political and economic contexts is offered by the Political Economy of Mass Media. This viewpoint emphasizes how power dynamics and economic interests shape media content, influencing public opinion and policy debates. The study looks into how portrayals of wetlands and urban planning issues are affected by media conglomerates' ownership patterns—which are frequently associated with the land development and real estate industries. By using this paradigm, the study seeks to understand how media narratives

are distorted by economic incentives, which prioritize profit-driven urban growth over environmental concerns.

These theoretical frameworks provide a thorough method for comprehending the intricate relationships that exist in Bangladesh among media, power, and environmental consequences. they offer a starting point for examining the changes in media ownership and its impact on wetland degradation, exposing the wider ramifications for environmental justice and urban planning.

4. Research Design

In order to investigate the development of media ownership and its effects on environmental outcomes in Bangladesh, this study used a multi-method qualitative research methodology that included historical analysis, content analysis, and critical discourse analysis. ***Historical Analysis:*** This study looks into how media ownership has changed over time and how it has affected environmental problems, namely the loss of wetlands in Dhaka, Bangladesh. The study looks at four different time periods: 1971–1980, 1981–2000, 2001–2015, and 2016–2024. It looks at how news content and narratives about urban development and environmental conservation have changed in tandem with changes in media ownership.

This analysis includes trend of media ownership, governmental policies, and the media environment over time. The analysis sheds light on how changes in media ownership reflect broader societal trends and impact public discourse by placing these changes within Bangladesh's political and economic framework.

A content analysis was conducted to look into how urban development, wetland protection, and related topics were portrayed in the media. This analysis is based on important themes, stories, and viewpoints that were conveyed in a variety of media, including newspapers, television news, and internet platforms. By pointing out the biases or gaps in the coverage of wetland issues, the content analysis demonstrates how policy discussions and public discourses are framed and the degree to which environmental concerns are handled.

Critical Discourse Analysis: The underlying ideologies and power relations incorporated into media portrayals were examined using critical discourse analysis in order to gain a fuller understanding of the power dynamics at work. This examined the terminology, framing, and rhetorical devices used by media organizations. The study investigated how prevailing discourses and ideologies impact policy agendas and public perceptions. It also shows how media rhetoric, particularly in relation to urban planning and environmental governance, might either support or undermine current power systems.

5. Research Perspective

The media initially covered nation-building initiatives in the years after independence. However, the Newspaper Declaration's cancellation stunted the growth of independent journalism, resulting in a media environment where the ruling party's narratives predominate. Important environmental concerns, such as the preservation of wetlands, thus got less attention.

As Bangladesh went through a new stage of globalization in the 1990s, the media started to focus more on foreign crises, particularly the war between Iran and Iraq. Significant industrialization in the nation also started at this time. As steel, jute mills, and chemical industries grew, the media's emphasis shifted, emphasizing economic expansion and rising living standards more and more. The ready-made clothing industry became a major economic force after this industrial boom. The growth of industries, frequently at the expense of wetlands, was framed by the media as being associated with the advancement of the country. Wetlands were routinely filled in for industrial and urban growth since they were often seen as barriers to development. As a result, the media frequently ignored the environmental damage brought about by these actions, supporting the myth of development.

This paper examines how media ownership affects public opinion and governmental actions, which leads to the continued disregard for wetland conservation, using Gramsci's hegemony theory. The intricate connection between political power, media narratives, and environmental policy is highlighted by RAJUK's involvement in the Detail Area Plan (DAP) implementation and its control over media gatekeepers. Additionally, the internal disputes amongst land mafias show how the risks to urban wetlands have been made worse by vested interests.

This study intends to identify the fundamental factors that have contributed to the loss of wetlands by critically examining the historical background and contemporary dynamics of media ownership and content in Bangladesh, highlighting the pressing need for a more ecologically conscious media discourse.

6. Historical Background of Media in Bangladesh

The media landscape has seen substantial changes since Bangladesh gained its independence in 1971. There were only 10 daily newspapers in the nation on December 16, 1971, (Ahmed et al., 2003). After gaining independence, the government took control of thirty daily publications, three semi-weeklies, and 151 weeklies by 1974. However, independent journalism was suppressed when the Special Powers Act was passed in 1974, giving the government broad control over the media environment (Haq, 2007)

The Daily Ittefaq, Sangbad, Azad, Purbadesh, Dainik Bangla, Bangladesh Observer, and Morning News were important newspapers at this time (Press Reference). Although few publications were published from cities outside Dhaka, media activity was largely centered in the city. The Daily Ittefaq and the Sangbad, created during the Pakistan era, have remained as major representatives of the time. Following independence, a number of weekly publications also became popular, drawing readers in with titles like Robbar, Sachitra Sandhani, and Bichitra (Ahmed et al., Banglapedia).

When the government closed all newspapers on June 16, 1975, with the exception of four state-run publications—Dainik Ittefaq, Dainik Bangla, The Bangladesh Observer, and The Bangladesh Times—the political landscape drastically changed. All reporters and employees of the shut-down media were still paid by the state treasury throughout this period (Mustafiz, 2010).

Many of the old newspapers started to reappear gradually after the change of political regime. But the trend of controlling media continued and about fifty daily and weekly newspapers were shut down for critical reporting between 1982 and 1989 (Ahmed et al., Banglapedia).

The decision to abolish all but four state-controlled periodicals in 1974 is the reason why Bangladesh's media has not been able to grow on its own. This oppressive atmosphere lasted until the first Caretaker Government removed some of the Special Powers Act's limitations on December 6, 1990, which made it easier for new newspapers to register (Haq, 2007). Newspapers like Dainik Khobar and Banglar Bani are prime examples of how media ownership remained concentrated among business people and industrial institutions even after these restrictions were lifted (Ullah, 2002).

After 1990, there was a significant shift in the political environment, which led to the rise of private electronic media, first television and then radio, and a boom in print media. Bangladesh had over 300 daily newspapers by the end of the 20th century. But and the country's electronic media was mostly under government control as there was only one radio and one television channel. However, corporate entities controlled the print media industry, which was fully privately held (BCDJC, 2003.

The media environment continued to expand under the Awami administration, which took power in 2009. By 2007, there were two FM radio stations that mostly aired music and eight private satellite TV channels that were devoted to news and entertainment (Haq, 2007). Governments granted licenses for television station since 1996; however, after 2008, the number of licenses issued increased significantly, indicating a tendency toward unaccountable governance (Riaz & Rahman, 2021).

The ownership structure of Bangladesh's media has changed dramatically over the last ten years. The traditional function of newspapers in social evolution and political discourse is becoming less prominent, and media are increasingly seen as a business rather than a moral vocation. These days, political party affiliates, corporate entities, or conglomerates frequently own radio stations, television networks, and newspapers (Ferdous, 2009). Concerns are raised by this combination of economic interests and media ownership, especially when many media owners are also real estate investors who use their media platforms to promote their commercial objectives.

7. Disappearing Wetlands, Political Economy of Media in Bangladesh

Wetlands in Dhaka are declining, and in many cases, have completely vanished, due in large part to the political economics of the media in Bangladesh. Through the Rajdhani Unnayan Kartripakkha (RAJUK), the government has filled in wetlands under the pretense of development. (*Prothom Alo*, 2019) Plots are then distributed to members of the ruling party, usually based on political ties. This has made it possible for big private companies and commercial associations to convert wetlands into factories and residential areas, greatly increasing the wealth of powerful people who buy and sell these important ecosystems (*Prothom Alo*, 2019).

RAJUK's implementation of the Dhaka Detailed Area Plan (DAP) has come under fire for failing to sufficiently address the city's water bodies. This oversight runs counter to international agreements like the Ramsar Convention and current environmental laws like the Bangladesh Environment Conservation Act of 1995 and the Water Body Conservation Act of 2000. Concerns over increased flooding and environmental degradation are raised by the DAP's land use classifications, which frequently clash with defined flood flow zones.

In order to manage the city's water resources, the Japan International Cooperation Agency (JICA) established primary and secondary flood flow zones in its Flood Action Plan (FAP). In order to prevent impeding flood flow, which can result in negative hydraulic impacts including increased floodwater levels and changed flow directions, the DMDP Structure Plan Policy RS/3 highlights the necessity of regulating land development within these designated floodplain zones (Hossain, 2018).

The media have rarely highlighted these pressing issues. This silence is caused by a number of circumstances, including the government's distribution of plots to media directors and editors, the construction of housing complexes for journalists, and the ownership of media by land grabbers and real estate entrepreneurs. Reporters who cover pollution and encroachment run the risk of being counter-propagandized, and many journalists hold the view that *"filling up water bodies is development."* The invasion of wetlands has therefore been economically advantageous to the media, and this has created a culture of silence over these environmental violations

Numerous wetlands and water bodies have been destroyed as a result of the rapid expansion of Dhaka's Baridhara, Uttara, and Diabari neighborhoods. These sites, which were once teeming with aquatic ecosystems, have been filled in to make way for commercial and residential construction (Hashim, 2019) (Shafique, 2023) (Alam, 2024). Significant losses of natural water bodies have resulted from the filling in or pollution of even tiny lakes and ponds that were constructed for recreational purposes. Banshree Lake, for instance, has completely disappeared, and similar outcomes have befallen water features in areas like Eastern Housing, Pallabi Extension, and the Journalists' Residential Area (Kabir, 2021).

In the end, this problem has been successfully suppressed by giving plots in different areas of the capital to the media gatekeepers and journalist' leaders. The future of Dhaka's wetlands and the function of the media in environmental campaigning are among the pressing issues brought up by the ongoing threat to the city's ecological balance posed by the entwining of politics, commercial interests, and the media.

7.1 Allocation of plots to gatekeepers and Journalist Leaders

With a primary focus on urban areas like Dhaka, as well as cities like Chattogram and Rajshahi, the Bangladeshi government has granted journalists and their associations significant land allocations. In order to improve the living conditions and career chances for journalists, these allotments cover both residential and commercial land.

In Dhaka, for example, the National Housing Authority has given several journalist associations large parcels of land for the construction of affordable housing. The government has also made industrial sites available in Dhaka's Tejgaon Industrial Area, which encourages journalists to start their own businesses and support the local economy(The Daily Star, 2023).

Important government organizations have been instrumental in overseeing these land distributions, including the Rajshahi Development Authority, Chattogram Development Authority, and Rajdhani Unnayan Kartripakkha (RAJUK). By identifying appropriate sites and managing the distribution process, these institutions show that the government understands the critical role that the media plays in society.

Leading media executives and journalists accumulated significant wealth in the 1980s, mostly from government land distributions. The majority of these plots were found in regions that were formerly wetlands, such as Baridhara and Uttara (Alam, 2024).

On June 10, 2012, Advocate Abdul Mannan Khan, the then-Minister of Housing and Public Works, made significant land allocation announcements for journalists in Bangladesh at a Q&A session of the 9th National Assembly. Notably, the head of the Dhaka Journalists' Housing Cooperative Society Limited was given 0.42 bigha of land in Mirpur Sector 11 by the National Housing Authority (Bangla news, 2012). The president and secretary of the Dhaka Journalists' Cooperative Society Limited were given seven acres of land in Mirpur/ Uttara Sector 8, while the Bangladesh Journalists' Association was given 400 plots in Mirpur Sector 2.

In the Tejgaon Industrial Area, 16 industrial plots were also set aside for journalists. In addition, plots were given by RAJUK to 166 journalists in Uttara and 193 journalists in the Purbachal New Town project (Banglanews, 2012).

The government also provided land for journalists in other cities. Two journalists were given plots by the Rajshahi Development Authority, whereas fifty journalists were given plots by the Chattogram Development Authority (Jewel, 2012).

7.2 Ownership of the media by real estate businessmen

A significant portion of the media in Bangladesh is owned by entities involved in the real estate business. These real estate businesses themselves are involved in grabbing wetlands to develop large residential areas, properties, and industrial complexes. Consequently, the media under their control remains silent on these matters. In some cases, these media organizations have emerged as protectors of the real estate businesses of their owners. As a result, news about the encroachment of wetlands in and around the capital is not being reported in the media.

The period from 1971 to 1980 marks the early years of Bangladesh's independence. The media landscape was dominated by state-owned outlets and a limited number of private publications. There is no evidence of significant involvement of real estate businesses in media ownership during this time.

From 1981 to 2024, approximately 30-38 media outlets have ties to real estate businesses. These include newspapers, television channels, radio stations, and online platforms.

From 1981 to 2000, media diversification began as private ownership gained momentum. Businesses from various industries, including real estate, began acquiring or establishing media outlets as part of their broader business strategies.

The link between real estate and media ownership emerged during this period, but it was still in its nascent stage. Media entities started serving as tools to promote favorable narratives for their owners' interests.

A small number of newspapers, television channels, and radio stations began operations under private ownership. Around 5-6 media outlets (including newspapers and television) owned by business groups that are also involved in real estate businesses entered to the media businesses.

From 2001 to 2016, a significant shift occurred during this period, with real estate businesses heavily investing in media. This trend was driven by the need to protect their vested interests, such as controversial land development projects and urban expansions.

Media entities established during this period included newspapers, television channels, radio stations, and online platforms. Many of these were directly tied to large conglomerates with substantial real estate portfolios.

Media often avoided reporting on issues such as wetland encroachment and environmental degradation, ensuring favorable public and governmental perceptions of real estate projects. Approximately 10-12 new media outlets were established during this period by entities involved in real estate.

From 2017 to 2024, this period saw the consolidation of media ownership under conglomerates with diverse business interests, particularly real estate. New media ventures, including digital platforms and specialized television channels, emerged. Real estate-linked conglomerates strategically used these platforms to amplify their influence and manage public perception.

Many of these entities established significant media portfolios, combining print, broadcast, and online platforms to create extensive reach. Media often functioned as a shield for real estate-related activities, continuing to sideline critical reporting on environmental or urban planning issues. Roughly 15-20 new media outlets, including television channels, newspapers, and online platforms, emerged during this period.

7.3 The risk of facing counter-propaganda

Media outlets that expose institutions involved in encroachment of water bodies and helping their owners make money often face propaganda campaigns. These campaigns are typically orchestrated by media outlets owned by the same real estate companies (Riaz & Rahman, 2021).

For instance, a covert conflict emerged between two largest conglomerates in Bangladesh - the Jamuna Group and the Basundhara Group centring a dispute over their two establishments -- Jamuna Future Park and Basundhara Residential Area. In this battle, Kaler Kantho and Bangladesh Pratidin, owned by the Basundhara Group, were pitted against Jugantar, owned by the Jamuna Group (bdnews24.com, 2014; *Prothom Alo*, 2014).

After the back-and-forth publication of conflicting news, one party halts negative

coverage of the other to protect its own interest/existence. As a result, reports of land grabbing and pollution come to a standstill. Consequently, incidents of land grabbing and wetland pollution in and around the capital are largely overlooked.

For example, in 2006, a legal battle arose between the Bashundhara and Jamuna Groups. The Bashundhara Group accused the Jamuna Group of kidnapping one of their security guards. However, a court later dismissed the case, indicating that the accusation was unfounded and that the real reason for the lawsuit stemmed from a business dispute between the two companies over land and property. (bdnews24, 2011).

In October 2023, the Daily Jugantor, owned by the Jamuna Group, published two reports criticizing East-West Properties Development Ltd., a subsidiary of the Bashundhara Group. The Bashundhara Group in its counter alleged that these reports were "false, baseless, and confusing" which tarnished the image of the company and its chairman, Ahmed Akbar Sobhan.

In response to the alleged defamation, the Bashundhara Group filed a Tk 1,100-crore compensation lawsuit against seven individuals and entities linked to the Jamuna Group. The defendants included Jamuna Group chairman Nurul Islam Babul, his wife Salma Islam, their son Shamim Islam, the publisher and acting editor of the Daily Jugantor, and the newspaper itself (*Prothom Alo*, 2014).

Notably, this was not the first legal action taken by the Bashundhara Group against the Jamuna Group. In February 2023, M Belayet Hossain, the senior deputy managing director of the Bashundhara Group, filed a separate defamation case against five individuals, including Nurul Islam Babul and Salma Islam, based on similar allegations of false reporting. (*Prothom Alo*, 2014).

A case study examines a significant defamation lawsuit filed in Bangladesh in 2014. The dispute centered on allegations of false and defamatory reporting by the Daily Jugantor, a newspaper owned by the Jamuna Group, against the Bashundhara Group, one of Bangladesh's largest conglomerates (BanglaNews24.com, 2014).

The core of the lawsuit revolved around allegations that the Daily Jugantor published two articles containing false and defamatory statements about the Bashundhara Group and its chairman, Ahmed Akbar Sobhan. The articles accused the group of engaging in corrupt practices, including bribery and asset grabbing (Tribune, 2014).

Sobhan filed a lawsuit seeking 1.1 billion taka in damages, arguing that the false and defamatory statements had significantly harmed both his reputation and that of the Bashundhara Group. The lawsuit initiated a legal battle between the two business conglomerates. (bdnews24, 2014)

Amidst these developments, Banglanews24.com, owned by the Bashundhara Group, has consistently published news critical of the Jamuna Group. For instance, on March 25, 2014, it published a report titled "Jamunar Babuler dokhole shotokoti takar jomi" (banglanews, 2014). Additionally, on February 20, 2014, it published another report titled "Ondher bosotvitay Jamunar Hunter karkhana" (banglanews, 2014). Furthermore, Kaler Kantho, also owned by Bashundhara (repetition), featured an article on February 27, 2014, titled "Jamunar Babuler Kache Prodhanmntrio tuccho" (Kaler Kantho, 2014).

In a similar vein, banglanews24.com published numerous news articles critical of the US-Bangla Group. For instance, they published an article on January 29, 2021, alleging that "12 US-Bangla Group companies are involved in massive VAT evasion!" (Banglanews, 2021)

On February 8, 2016, Bangladesh Pratidin, another newspaper owned by the Basundhara Group, ran a story titled "Asian City's New Fraud Trap," alleging fraudulent practices by the company (Bangladesh Pratidin, 2016).

On December 8, 2011, banglanews24.com reported that "Asian is Not Giving Plots to Customers After Taking Billions of Taka," accusing the company of defrauding customers by accepting payments without delivering the promised plots (Banglanews, 2011).

The owners have exploited the media to undermine their business competitors. However, the accusation of filling wetlands for housing projects is a longstanding issue that affects all business groups in the real estate sector.

7.4 Widespread belief among journalists

In Bangladesh, filling wetlands is often confused with development. Raising low-lying land is seen by many as a sign of advancement. Therefore, when marshes are filled, elevated, and offered for sale as industrial plots, a large segment of the populace views this change as a development. Many journalists share this viewpoint, and as a result, they frequently fail to consider the ecological consequences of such acts, which leads to a dearth of coverage on the subject.

Because of the nation's history of flooding and other natural disasters, there is a strong desire to raise low-lying areas and regulate water bodies in order to reduce the risk of flooding. A common perception that such actions are necessary for growth and advancement has been influenced by this historical background.

Furthermore, it's possible that a large number of Bangladeshi journalists are not exposed to environmental education, which limits their comprehension of the ecological significance of wetlands. This lack of understanding supports the idea that filling wetlands is a harmless—even advantageous—practice.

Wetlands are being turned into valuable real estate as a result of Bangladesh's rapid urbanization, which has increased demand for land. Because they might see wetland development as a driver of economic progress and prosperity, journalists' opinions may be influenced by this financial motivation.

The idea that filling wetlands is essential for advancement is further supported by government policies that prioritize infrastructure projects and urban expansion. Journalists may be more likely to accept the government's narrative without question when it presents such measures as beneficial.

All things considered, Bangladeshi journalists' belief that filling wetlands is a sign of progress is a complicated matter with roots in historical, economic, and cultural elements. This idea has a big impact on how the media covers wetland destruction, frequently leading to selective reporting, little critical analysis, and the normalization of the practice.

8. Conclusion

The complex connection between the political economy of the media and the disappearing wetlands of Dhaka, Bangladesh, has been carefully investigated in this study article. It draws attention to the ways that media outlets' ownership structures and their impact on public opinion have greatly accelerated the deterioration of these vital ecosystems.

The study finds that a number of interrelated factors contribute to the media's silence on wetland destruction. First, there are conflicts of interest that prevent critical reporting on wetland encroachment because many media owners have direct financial ties to real estate development. Second, media owners and journalists are given plots in wetland regions by the government, which encourages gratitude and dependency and may influence their editorial choices. Third, media are reluctant to look into wetland concerns because they fear reprisals from influential land grabbers and their political ties. Finally, the biological significance of wetlands is further obscured by the common misperception among some journalists that filling them signifies development.

The study also charts the development of media ownership in Bangladesh over time, showing a move toward greater concentration in the hands of political and business elites. Because of this concentration, the media now plays a bigger role in influencing public opinion and governmental decisions, frequently giving urban expansion precedence over environmental preservation.

In summary, this study highlights how urgently Bangladesh's media ecosystem needs to become more independent and critical. The media may play a significant role in promoting sustainable urban development and the preservation of the nation's natural heritage by exposing the environmental damage associated with the loss of wetlands and holding influential parties responsible.

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Annexure

Group Name	Real Estate Projects	Media
Asian Group	Asian Housing Limited, Rupayan Housing Estate Ltd., Ratul Properties, Rupayan City Uttara, RAK Ceramics, Palli Properties Pvt. Ltd, Ashaloy Housing and Developer Ltd, Marina Property (BD) Limited	The Daily Asian Age, Asian Television etc.
Rupayan Group	Rupayan Land Development Ltd., Rupayan Hotels and Resorts, Rakeen Development Company (BD) Ltd	The Daily Desh Rupantor, Desh Radio
Bashundhara Group	Bashundhara City Shopping Complex, East West Property Development (Pvt.) Ltd, Basundhara Housing, Riverview Housing Project.	The Daily Bangladesh Pratidin, Daily Kaler Kantho, The Daily Sun, News24 TV, T Sports TV, Banglanews24.com
Bengal Group	Bengal Concept and Holdings Ltd., NTV Roza Properties, Roza Industrial Park Ltd	RTV
Mohammadi Group	MG Properties Limited	Nagorik TV, The Daily Observer
Karnaphuli Group	Karnaphuli Garden City, HR Bhaban	Bhorer Kagoj, Diner Sheshey
Jamuna Group	Jamuna Future Park	The Daily Jugantor, Jamuna TV
DBC Group	AG Green Property Developments Limited, AG Property Development Limited	DBC 24/7 TV
Unique Group	Borak Real Estate Pvt Ltd., Unique Hotel and Resorts Ltd, Unique Property Development Ltd	The Daily Amader Somoy
Gemcon Group	Gemcon City Ltd	The Daily Dhaka Tribune, Banglatribune.com
HRC Group	HRC Properties Limited, Bangladesh Land Limited, Hamid Properties Limited	The New Age, Jai Jai Din
Ashiyan Group	Ashiyan Lands Dev. Ltd., Ashiyan Homes Ltd.	Daily Manobkantha
Beximco Group	Shinepukur Holdings Ltd.	Independent TV, The daily Independent
S. Alam Group	S. Alam Properties Limited 1. Commercial Building 2.Commercial cum residential building 3. Residential Building 4. Hotels & Resorts.	Ekushey Television, Nexus Television
US Bangla Group	US-Bangla Assets Ltd. (Purbachal American City), U. S. Bangla Developers Limited	Daily Ajker Patrika, Dhaka Post, Shomoyer Alo, ShareBiz

Chapter 13

Evolving Role of Civic Society Organizations in Protecting Urban Wetlands

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1. Introduction

The protection of urban wetlands is a critical global issue that requires attention due to the challenges posed by urban expansion and the resulting destruction of wetlands (Davidson, 2014; Flute-Chouinard et al., 2023). Wetlands play an indispensable role in landscape nutrient processing and provide a wide range of ecosystem services, from provisioning to flood regulation to cultural services in cities (McInnes, 2013; Mitsch et al., 2015; Cheng & Basu, 2017; Janse et al., 2019; Alikhani et al., 2021). Urbanization and industrialization have led to pollution of surface waters and wetlands, raising crucial questions about land use regulation and waste management within urban watersheds (Hettiarachchi et al., 2014). Bangladesh, sheltered within an active Bengal Delta, is experiencing rapid economic growth through urbanization, foreign investment and remittances, and manufacturing industries (Sawada et al., 2018). It is clear that the cost of Bangladesh's development has been borne by its urban wetlands, such as in Dhaka (Sultana et al., 2009). Wetland protection and restoration planning in Bangladesh is still in its nascent stage, and in Bangladesh's urban areas, there are no rigorous initiatives to restore wetlands. There is also a lack of systematic

theoretical research and long-term practical experiences in exploring the multifaceted dimensions of wetland restoration in the country. In this context, civic society organizations (CSO) are a valuable arena for research and intervention as CSOs can draw popular support and build momentum for wetland restoration and sustainable policy changes in Bangladesh. Adoption of national-level wetland policy is positively associated with the expansion of the democratic public sphere, an activity in which CSOs are primary actors (Peimer et al., 2016). However, research on Bangladeshi CSO activities to protect urban wetlands is absent in the prevailing literature. This chapter addresses this gap by investigating the role of civic society organizations in protecting Bangladesh's urban wetlands.

The chapter reviews civil society activism around water and wetlands between 1990 and 2023. The following sections shed light on CSO's impact, strengths, and limitations vis-a-vis water and wetland management in Bangladesh's urbanizing regions. Much of the existing research on Bangladesh's water bodies has studied the physical degradation of Bangladesh's urban wetlands and highlighted regulatory deficiencies and bureaucratic non-transparency (Islam et al., 2010; Mahmud et al., 2011). But, citizen initiatives have been less studied, primarily because such initiatives at all scales (national, regional, local, neighborhood) are hard to identify without local embeddedness and even harder to document and analyze with limited resources. This chapter identifies the evolving roles of citizen groups, highlighting the contribution of their actions from a historical perspective. By drawing on citizen group histories, this chapter emphasizes the institutional and political opportunities and constraints for civil society actions. The chapter discusses the evolving frontiers of movements from the neo-traditionalist 'environmentalism of the poor' approach to more collaborative civil society environmentalism. It also offers reflections on how water and wetland activists have responded to the rise of social media, particularly by harnessing social media's communication powers for their activism.

2. Materials and Methods

The findings shared in the chapter are derived from a triangulation of three activities: interviews, group discussions, and analysis of secondary sources. 12 in-person interviews with activists, CSO leaders, water professionals, environmental journalists, academics, development professionals, community leaders, donors, and students were conducted. These individual interviews focused on developing a historical perspective on urban wetlands. Participants were asked to share stories of wetland loss as well as their own stories of resistance and activism for protecting wetlands. Two group discussions with CSO leaders and activists and two group discussions with wetland communities along the Buriganga and Turag rivers in Dhaka were conducted. In these group discussions, participants exchanged their experiences and views on the impacts of wetland loss on their lives and livelihoods, their sense of exclusion from environmental policies and conservation efforts, and their perception of constraints on their activism. In addition, newspaper articles, news reports, books, organizations' websites, and social media were analyzed to develop an understanding of the CSOs.

3. Mapping Contentious Collective Actions

This section compiles water and wetland-related CSO activities between 1990 and 2023. The CSO activities are categorized by their start dates, and many have continued for more than a decade. The list below (Table 13.1) is not an exhaustive list of water and wetland movements. The examples of the movements mentioned in this chapter are found noteworthy during the interviews and discussion sessions.

খিলগাঁও থানার বিস্তীর্ণ এলাকার নদীর পানি মারাত্মকভাবে দূষিত হয়ে পড়েছে। এর প্রতিকারের দাবিতে বারো গ্রাম উন্নয়ন সংস্থা এলাকায় সমাবেশ করে -দিনকাল

Figure 13.1: Dinkal Newspaper Clipping of Baro Gram Andolon, 2001

Source: Suroj Mia, Personal Archives, 2001

In the past decades, citizen groups have drawn attention to interruptions of river flows, widespread pollution, destruction of biodiversity and habitats, and intensifying impacts of climate change. Bangladesh's civil society organizations, water and wetland movements, and citizen groups have been playing a crucial role by promoting community-led natural resource management practices, offering a future-oriented governance approach, and engaging millions of delta dwellers in envisioning a just water management system in opposition to the environmentally destructive development plans of authorities and elites. Bangladeshi civil society groups, deploying a wide range of practices, are engaged in "contentious politics" to protect Bangladesh's rivers and wetlands (Tilly & Tarrow, 2015). Contentious politics here refers to collective actions that confront elites and authorities around shared claims to water, rivers, and wetlands.

4. From Environmentalism of the Poor to Civil Society Environmentalism

Driven by Bangladesh's ongoing wetland loss and related ecological devastation, water and wetland movement of Bangladesh has evolved from neo-traditional "environmentalism of the poor" (Martinez-Alier, 2003) approaches to a more wide-ranging set of approaches that includes collaboration between local associations, state, non-governmental organizations (NGOs), and the Bangladeshi diaspora. Particularly, with the expansion of the development aid sector since the 2000s, more collaborative and hybrid approaches appeared in the environmental organizing scene. For example, since 2010, the rights of the Boral River movement has taken shape through support from organizations like BAPA and Action Aid. They took support from groups like Riverine People in conducting studies that informed the movement. The Boral River movement, armed with an ecological knowledge base, created a 100 km human chain along the Boral River in 2010 to draw attention to the river's degradation.

5. The rise of social media in protecting rivers and wetlands

Bangladesh is particularly vulnerable to environmental change (including climate change) and its devastating impacts. The evolution of information technology and their fast adoption in this country has shaped innovations within water and wetland organizing for change. With an increasing number of cellphone users and social media users, environmental organizers have leveraged social media platforms and the internet to build awareness and disseminate information about environmental threats, sustainable practices, and calls to action. Environmental conversations about rivers and wetlands have been popularized since 2010 through social media. In 2010, students from Dhaka University started organizing and celebrating World River Day. Their organizing evolved into Riverine People, an organization that actively used social media to communicate and spread a love for rivers through sharing images of rivers. Such social media organizing connected urban communities and rivers in a novel way. Media and larger environmental organizations that until then had not focused on rivers and wetlands were inspired by social media.

Table 13.1: List of CSO Activities to Protect Bangladesh's Urban Wetlands

Timeline	Collective Action	Actor(s)	Description	Impact
1992-present	Bangladesh Environmental Lawyers Association	Lawyers, environmentalists	BELA promotes environmental justice and advocates for environmental jurisprudence in Bangladesh. Their legal and advocacy work extensively covers wetlands and river issues.	Successfully fought against housing projects such as Modhumoti Model Town on Turag River's wetlands. Contested the land use change of river and wetlands under factory occupation. Successfully fought for rights of nature legislation in Bangladesh.
1998-present	Buriganga Bachao Andolon	Environmentalists, political organizations (CPB)	Buriganga river in Dhaka faced encroachment and environmentalists Mihir Biswas and Professor Mozaffar organized against encroachment.	The largest movement to protect Buriganga from encroachment and pollution.
2001-present	Rights of Kapatakkho	Environmentalist	Environmentalist Kamrul Islam organized to protect Kapatakkho.	Islam used Bhashani's concept of 'hoq' to create a narrative for river conservation.
2000-present	Movement against wetland grabbing in Dhaka	Farmers, small landowners, NGOs (BELA, Ain O Salish Kendro, POBA)	In the late 2000s, Ashiyan Lands Development Company, a private housing company, started filling up north-eastern floodplains of Dhaka to create a township called Ashiyan City. The project displaced small landowners and affected wetland agricultural communities in the region.	Local communities, along with several civil society organizations including Bangladesh Environmental Lawyers Association, Ain O Salish Kendra, Bangladesh Environment Movement, Poribesh Bachao Andolon and others, mobilized to stop the project.

Timeline	Collective Action	Actor(s)	Description	Impact
2008-present	Bangladesh Poribesh Andolon	Environmentalists	Bangladesh Poribesh Andolon responds broadly to environmental degradation in Bangladesh.	Although Bangladesh Poribesh Andolon's organizing is not focused on rivers and wetlands, they organized a conference on haor in 2004 and works in collaboration with local groups on river and wetland issues. They started celebrating World River Day in 2010. They initiated a river and wetland committee (currently inactive).
2001-2005	Baro Gram Andolon	Residents, NGOs (the Hunger Project, Baro Gram Unnoyon Shongstha)	Organized by Suruj Mia, the Baro Gram Unnoyon Shongstha and the Hunger Project mobilized 36 villages against Balu River polluters.	Successfully mobilized communities and fought against the pollution of Balu River.
2010	Rights of Boral River	Locals, NGOs (BAPA, Riverine People)	State development projects placed sluice gates and roads on Boral River. The Boral River dried up, causing widespread water scarcity for drinking and farming.	Local and national level organizing in collaboration with NGOs led to the removal of roads, but the sluice gates remain.
2010	Organizing against BGMEA wetland grabbing	Environmentalists, NGOs (BELA)	The BGMEA constructed their headquarters in a wetland area, which led to protests by environmentalists.	The building is under demolition after about a decade of organizing.
2010	Riverine People	Youth, environmentalists	Riverine People organized to create awareness about rivers among general people.	Critical youth engagement for river restoration.
2014-present	Bangladesh River Travelers Network	Environmentalists, activists	A tourism-based civil society movement.	They have a national-level organizational structure with committees in every district. They conducted several successful activities, including sensitization for Gazipur rivers, encroachment on Gazipur wetlands, and youth activities.
2016	Brahmaputra Surokkha Andolon	Environmentalists	Organized by Abul Kalam Azad, locals organized human chains, social media campaigns, and gatherings to make Brahmaputra waterways navigable. Mymenshing city.	The organizing resonated locally but did not reach a national audience.
2010	Organizing against Bangladesh Army grabbing wetlands in Narayanganj	Local landowners, environmentalists	Bangladesh Army occupied wetlands (*naal, beel, boro land*) that were home to fishermen and farming communities. The locals, including landowners and environmentalists, protested the construction of the residential housing project, Jolshiri Abashon.	The movement was unsuccessful against the overwhelming forces of the state.

Timeline	Collective Action	Actor(s)	Description	Impact
2019-present	River and Delta Research Center	Researchers, Environmentalist	Led by environmental researcher and activist Mohammad Azaz, River and Delta Research Center is challenging the state's conventional development agenda by generating knowledge about canals, rivers, and wetlands across Bangladesh.	River and Delta Research Center has been unique in adopting a feminist political ecology lens in their work and in advancing environmental research agenda rooted in social justice concerns.
2017-2019	Right of Turag River	NGOs (Nong-gor; Human Rights and Peace for Bangladesh)	Inspired by the Rights of Nature legislation in New Zealand in 2017, Bangladeshi NGOs, lawyers, and environmentalists organized to get Turag River's personhood recognized through a high court petition.	Established rights of nature legislation in Bangladesh and grants 'living entities' status to all rivers in Bangladesh.

Figure 13.2: BD Clean youth volunteers cleaning canal

Source: The Business Standard, 2019

From appreciating rivers and wetlands, the social media posts have now turned to protecting rivers and wetlands. A lot of defensive organizing is currently based on social media. Citizens are posting about river and wetland pollution in their areas in social media, which is then picked up by the mainstream media. #DhakaRiver is an example of a Twitter hashtag that made visible the degradation of urban rivers in Bangladesh. Once the posts are picked up by the media, at times the media attention leads to government action. For example, Mohammad Azaz posted about a road cutting through the Dholesshori River, and the subsequent media attention led to the road's removal within a week. In another incident, real estate billboards were put up in Belai Beel, a conserved wetland in Gazipur. Monir Hossain's social media post regarding the incident led to a court case against the company. Social media environmentalism has allowed organizers to engage a wider audience, transcending geographical limitations within and outside Bangladesh.

6. Citizens and Researchers Rise Up

Action research and citizen science projects have grown in the last decades. For example, the River and Delta Research Centre took initiative in leading research on Dhaka's rivers, canal encroachment, demarcation pillar, river baseline survey, and canals of Chittagong city. Such citizen-led science projects are contesting the state's conventional rhetoric. Citizen volunteer action has also expanded. BD Clean, a youth organization, participated in cleaning many canals of city corporations (Figure 13.2). River Bangla, a river-related online news portal,

has successfully brought together activists, academicians, environmental leaders, and rights advocates from India and Bangladesh to share and exchange news and views.

7. Growing Environmental Arts-Based Awareness Building

Increasingly, arts and culture-based river and wetland organizing is shaping public consciousness about water and wetlands in Bangladesh. Kakoli Prodhan, a photographer, launched a 'Nodi Nebe' exhibit which was showcased near rivers. Through this 2020 exhibit, Prodhan drew viewers' attention to the loss and degradation of rivers and wetlands as well as the human losses tied to these. Sharmin Sultana Sumi, a singer, songwriter, and composer, created a music project, 'Nodi Rocks,' to draw youth attention to rivers. Prodhan and Sumi's artistic interventions convey complex riverine issues in ways that are accessible to the public. They are also aimed to inspire communities and youth to participate actively in safeguarding rivers and wetlands.

8. Indigenous River and Wetland Management Practices

The environmental movement witnessed the convergence of traditional wisdom and modern strategies. Indigenous knowledge about sustainable agricultural practices, water management, and natural resource conservation has been blended with scientific advancements to devise contextually relevant solutions. This amalgamation not only honors Bangladesh's rich heritage but also enhances the efficacy of movement and civil society organizing. In Koyra, Khulna, and other places, TRM (Tidal River Management) has been recognized as an indigenous approach to the management of tidal wetlands, and this is being combined with scientific approaches. A scientific knowledge base has also proven important in these collaborations. For example, the Farakka movement weakened as it did not have a sound scientific basis. On the other hand, the Tipamukh movement advanced because of solid scientific knowledge about the issues concerned. While drawing up traditional knowledge and practices is crucial for developing solutions that resonate with local communities, scientific knowledge is crucial for sustaining a larger movement for environmental justice. There is a lack of indigenous-focused organizing in urban areas. More recently, the River and Delta Research Centre (RDRC) has been working with indigenous fishing communities of Dhaka to highlight how urbanization has marginalized their local river stewardship practices.

9. Green Agenda in Print and News Media

Print media has played a pivotal role in river and wetland protection in Bangladesh, serving as a reliable and influential platform to raise awareness, mobilize communities, and advocate for sustainable practices. Despite the rise of digital communication, the enduring presence of print media has proven essential for reaching diverse audiences and fostering lasting change. Prior to 2010, the media did not cover water and ecology in a serious way. After 2010, Daily Star and Channel-I started to report on the

environment, particularly around rivers and wetlands, and their reporting created a vocal and vibrant public sphere around environmental issues. More journalists become interested on environmental issues. Notably, Channel-I, Prothom Alo, and the Daily Star were some of the forerunners in fostering dedicated environmental journalism. The media houses took up river and wetland issues professionally and appointed well-qualified and committed people to report environmental cases. Iftekhar Mahmud (at Prothom Alo), Pinaki Roy (the Daily Star), Morshed Khan (Daily Star), Abdul Mannan (Jugantor), Abdur Rahman Khan (the Independent), Shopon Bashar (the Independent), M Idris Ali (journalist based in Chittagong) and Jahiduzzaman (Channel-i) were important figures who published hundreds of stories on rivers and wetlands that inspired new journalists during this time. Along with that, the Bangladesh Delta Bulletin, edited by Katherine Terwisschavan, highlighted activities and news related to delta management.

In other print media, *Mizanur Rahman's Potrika* was a quarterly newspaper that focused on rivers. M Enamul Haque published several books that were crucial for river and wetland activists and organizers. The Water Development Board published a reference book in six parts, which provided baseline information for organizers. River and Delta Research Center initiated *Obobahika*, an academic Bangla journal that brings together local intellectuals for developing an analysis of rivers, wetlands, and delta environments. Several NGOs have also developed project-based reports on rivers. For example, *Uttoron's* report on North Bengal's rivers was a significant publication for river organizers.

Print media outlets, including newspapers, magazines, and newsletters, have been instrumental in disseminating information about environmental issues, policy developments, and success stories. Environmental organizations like BAPA utilized print media to highlight the urgency of the degradation and pollution of rivers. Hard-hitting investigative reports, editorials, and visually impactful photo essays have compelled the public, and in some cases, the judiciary during court cases, to confront the reality of environmental destruction and the need for collective action. Columns in newspapers such as Daily Star, Jugantor, Somokal, The Business Standard, and Prothom Alo, written by experts, have been crucial for organizing. Speeches from experts and leaders from seminars and conferences spread among activists and environmentalists through print and news media.

10. Wetland Environmentalism's Ambiguous Relations to State and Capitalism

Bangladesh, as a developing nation, grapples with the challenges of balancing economic growth driven by capitalist principles and the imperative to address pressing environmental concerns. The state's role in this equation is pivotal, as it formulates policies that influence location decisions of industries, resource allocation, and environmental regulations. While economic growth can lead to improved living standards, unchecked capitalism contributes to environmental degradation through practices like deforestation, pollution, and overexploitation of natural resources.

Environmental organizing for river and wetland conservation has a loose structural or ideological connection to the dominant political economy. Environmentalists have primarily reacted to degradation without offering sustainable and popular alternatives to extractive capitalist economy of Bangladesh. In some ideological narratives, particularly predominant leftist environmentalist narratives, the state is seen as a reflection of Bangladesh's upper elite class interests. However, in action and organizing, environmentalists predominantly engage the state as a mediating space for natural resource conflicts. Most prominently, environmentalist organizations reacted to the degradation brought about by extractive developmentalism. Environmental organizing has shied away from engaging corporations directly, instead operating on a blame-and-shame approach where corporates and factory owners are framed as polluters within environmental narratives. The hesitation to engage is reflected on the corporate side as well. Pro-development narratives have framed environmentalists as failing to understand development. Since the state is not transparent or accountable, any mediation between environmentalists and the direct industrial polluters has been fraught with tension, ambiguity, and mistrust. Civil society has been unable to host mediated conversations with industrialists. River and wetland advocacy, in many cases, remains limited precisely for this reason. Although the state's reliance on capitalist-driven growth can provide resources for environmental initiatives, this potential remains untapped. For instance, funding for conservation projects or renewable energy infrastructure may come from private investments under the capitalist system.

River and wetland organizing in Bangladesh functions by pressuring the state to adopt more ecologically sensitive policies. Grassroots movements, NGOs, and advocacy groups often emerge to address the adverse impacts of capitalist-driven development. They highlight the dire consequences of unchecked industrialization, advocate for sustainable practices, and call for stricter environmental regulations. Until 2015, environmental organizing took an island approach, meaning they critiqued the state but did not engage the state in negotiations. For example, in the case of Modhumoti Model Town, the environmentalists spoke up against the state but did not negotiate with the state directly. During that time, the media picked up the environmentalist narratives and spread the critique of the state. The media pressure led to the desired results for environmental organizing. The collaboration between environmentalists and media without direct engagement with the state was successful because the earlier state regime was a more open and tolerant regime which enabled media freedom to air criticism of the state. After 2015, the state shifted into a more closed and intolerant regime. Since then, environmental organizations have had to engage the state directly, though in a less confrontational way. Organizers invited state officials as chief guests to events and appealed to their beneficence. Instead of directly blaming the government, environmental organizers highlighted specific sub-actors within the state machine as detrimental to the environment. River and wetland advocates developed and deployed broader categories like "grabber" and "polluter" to circumvent the potential threats of direct finger-pointing

when dealing with an intolerant surveillance regime. Despite these defensive maneuvers, reporters faced more violence than environmental activists. In fact, reporters had to leave the country and lose jobs.

11. Practices of Contention

The water and wetlands movements in Bangladesh developed a diverse and impactful repertoire of contention, encompassing a range of strategies and tactics to address pressing ecological challenges. These approaches reflect the movement's adaptability, resourcefulness, and determination in the face of wetland loss and river degradation. These modular forms of action range from legal advocacy to awareness campaigns to protests and direct action.

Legal action in the form of petitioning and lawsuits has emerged as a powerful tool within the movement's repertoire. Environmental organizations, such as BELA, have leveraged the legal system to challenge harmful projects and advocate for the enforcement of environmental regulations vis-a-vis urban wetlands. Landmark court cases have resulted in halting destructive ventures, highlighting the role of the judiciary as a potential ally in the fight for ecological conservation.

A wide range of public awareness-building strategies can be seen in the river and wetland organizing. Particularly, organizers used local cultural and artistic expressions to evoke emotional responses and foster a deeper connection to wetland and river issues. For example, Jewel A Rab, based in Charukola, organized performing arts projects centering on Buriganga. Several organizations consistently celebrate festivals such as Buriganga River Fest, Turag River Fest, and River Carnival. From theater and meme shows to football tournaments on River Day, boating competitions, art competitions, and debate competitions, organizers used diverse mediums to educate, engage, and inspire youth and general people to take action to protect urban wetlands and rivers. Storytelling events (Esho Nodir Golpo Shuni), river camps with college studies, and talk shows have also become consistent avenues for engaging the public. Performative protests such as Gonogosul (mass bathing) at Buriganga drew large crowds to rally for rivers and urban wetlands.

One prominent element of the movement's repertoire is mass mobilization and protest. From large-scale rallies to sit-ins, human chains, and blockades, activists have used public demonstrations to draw attention to critical issues such as water pollution, wetland grabbing, and river degradation. These events not only raise awareness but also exert pressure on the government and industries to adopt more environmentally friendly policies and practices.

Knowledge-sharing events such as conferences, roundtables, seminars, and workshops have also been marked characteristics of civil society organizing for rivers and wetlands. To a lesser extent, organizations have engaged in volunteering activities like cleaning up rivers and planting trees along rivers. Unique mutual aid efforts to address the immediate harms of environmental and climate injustice have been piloted. RDRC, for example, started a Water Justice Project, which provided clean water to urban fishing communities facing industrial pollution.

12. Networks and Organizations

At the grassroots level, community-based organizing forms a cornerstone of the movement's approach. Local environmental groups, often composed of directly affected residents by ecological issues, play a pivotal role. These groups leverage their intimate knowledge of local ecosystems and challenges to design contextually relevant solutions. They organize workshops, awareness campaigns, and skill-building sessions, fostering a sense of ownership and empowerment within communities. Non-Governmental Organizations like BELA have extensively collaborated with diverse grassroots initiatives and advocacy campaigns. These collaborations mobilize communities, conduct research, and engage in legal actions to protect the environment. BELA, for instance, has been instrumental in advocating for environmental justice through public interest litigation against polluters and projects detrimental to the ecosystem.

Civic Society Organizations (CSOs) also play a crucial role in orchestrating environmental campaigns and initiatives. These organizations possess the resources and expertise to drive larger-scale projects, engage with policymakers, and raise public awareness. They collaborate with local communities, share knowledge, and provide platforms for collective action, amplifying the impact of the movement. Bangladesh's environmental movement has embraced a dynamic mode of organizing and networking, driven by the nation's urgent need to address environmental challenges. This mode of operation underscores the movement's adaptability and effectiveness in mobilizing communities and advocating for change. Networking involves forging connections among various stakeholders, including CSOs, community groups, academia, and international organizations.

River and wetland movements in Bangladesh have ambiguous relations with international institutions and INGOs. Despite the state's environmentally disruptive processes, in many cases, international institutions like the Asian Development Bank, World Bank, and United Nations Development Programme continued to support the state's development agenda. In other cases, environmental movements have benefited and leveraged their relationships to international entities and used resources, funding, expertise, and global networks for advancing environmental justice.

13. Frames: Climate, Rights of Nature, Nationalism, Justice, Urbanization

Bangladesh's environmental movement mobilizes multiple frames of contention and identities, reflecting the complex nature of the nation's environmental challenges and the diverse range of actors involved in the movement.

13.1 Climate Frame

Several CSOs have mobilized within the frame of sustainability and climate resilience. With Bangladesh being highly vulnerable to climate change and rising sea levels, this frame emphasizes the urgency of adopting sustainable practices and advocating for policies that prioritize long-term ecological health over short-term economic gains. It also calls for increased resilience-building efforts to withstand the impacts of a changing climate. For instance, Youth Net for Climate

Justice is a youth group that organizes passionate young climate activists all over Bangladesh. The climate frame situates Bangladesh within global environmentalism conversations. Bangladesh's vulnerability to climate change has led to the country being seen as a "climate hotspot," which has propelled activists to engage with international frameworks and forge alliances with global environmental movements. Although so common, river and wetland issues have not been adequately weaved into the climate frame.

13.2 Rights of Nature Frame

Activists and legal advocates have mobilized the Rights of Nature frame to constitutionally recognize the rights of Bangladesh's rivers. This was made possible through long-term grassroots organizing such as floating seminars and human chains. *Nongor* played a key role in these activities. On the legal front, Human Rights and Peace for Bangladesh (HRPB) and others led the effort in the High Court. Turag, an urban river, was the centerpiece of this advocacy struggle. The media sensation around grassroots organizing influenced the court's decision to recognize the rights of rivers. The emergence of the rights of nature frame - particularly within the river and wetland environmental laws and regulations - opens up a new arena and basis for further advocacy and legal action against extractive and harmful practices.

13.3 Nationalist Frame

Nationalist frames - secular and religious - have been mobilized in different river and wetland struggles. For instance, in both Tipaimukh Badh Andolon and Farakka Andolon, the movements deployed a nationalist framing to make a case against the dams in India. The Indian dams were seen as an affront to Bangladesh's sovereignty. However, the success of nationalist frames of contention relied on their knowledge basis. Farakka Andolon weakened over time because it lacked a knowledge base. On the other hand, the Tipaimukh Badh Andolon was informed by research and knowledge generated by NGOs like Action Aid. Armed with research, the movement was partially more successful in continuing over a longer time period. The political parties and religious groups used that research knowledge and mixed in anti-India sentiment to create a nationalist environmental frame of contention. The nationalist frame is less visible in the case of urban wetlands and rivers, though the River and Delta Research Centre's ongoing work around rivers' role in Bangladesh's war of liberation is a notable initiative that mobilizes the nationalist frame for protecting urban rivers and wetlands.

13.4 Justice Frame

Environmental Justice has been a prevalent frame of contention within the movement for rivers and wetlands. By localizing the environmental justice frame, activists and organizations highlight the disproportionate impact of environmental degradation on marginalized communities, often low-income, low-caste and rural populations. This frame underscores the need to address both ecological and social injustices, emphasizing that the burdens of pollution, climate change, and resource depletion are not evenly distributed. Notably, the BELA

has mobilized the environmental justice frame of contention since its inception. RDRC also uses justice framing in their advocacy and research work.

13.5 Urban Frame

Urbanization framing has been harnessed to highlight the unique experiences and vulnerabilities of rivers, wetlands, and related biodiversity and human issues in the context of accelerating urbanization. For instance, Buriganga Bachao Andolon, initiated by Mihir Biswas, started with a recognition of Dhaka's urbanizing impacts on the Buriganga River and its communities. Biswas has been a crucial figure in almost every river and wetland related movement in Bangladesh. Subsequently, Biswas and Mozaffar advanced an anti-encroachment movement along the Buriganga River which was in direct response to expansionary urbanization. In another example, the RDRC used an urbanization frame in its #DhakaRivers and ongoing water justice projects with urban fishing communities.

14. Organizational Accountability and Sustainable Leadership

In some cases, river and wetland movements emerging from civil society lack formal organizational structure. The movement might, in these cases, build around the charismatic and eloquent leader with great mobilizing skills but lacking management skills. In other cases, movements might present themselves as anti-authoritarian and, therefore, without a formal leader. But such arrangements hide hierarchies and create movements run by informal power relations around a central leader figure. No leader alone can lead and solve the destruction of rivers and wetlands as witnessed in Bangladesh. A 'savior' leader may be very effective on the local scale in organizing people but that leader alone cannot bring about structural change in society. For example, in the case of Boral River, the struggle to free Boral from sluice gates and roads received much attention nationally. The movement was also partially successful as the roads were removed. But, the organization did not move further due to overreliance on a single person's leadership without a transparent and accountable structure to move it forward.

In another instance, the Brahmaputra Surakkha Andolon, Abul Kalam Azad organized a powerful local movement with human chains and social media campaigning to keep the river navigable. Within Mymensingh, the movement spread, but it did not offer a concrete policy or generate actionable ecological knowledge, and it remained disconnected from national-level conversations. Therefore, the movement did not create a mass base across the country.

Future urban river and wetland movement leadership needs to be transparent, accountable, experienced, and geared towards movement-wide progress as opposed to the project success of individual organizations. Organizations and movements can have many leaders on multiple scales. The differing roles and responsibilities of many leaders need to be clear, transparent, and accountable to reasonable decision-making and hierarchies. The rules of leadership for each organization and movement needs to be discussed and made public so that people

in the movement or organization also can see themselves in that structure and take up opportunities for advancement.

15. Sustainability, Aid, and Funding

River and wetland organizations often struggle with inadequate funding, limiting their capacity to run effective campaigns, conduct research, and mobilize communities. On the other hand, big organizations and movements become unsustainable because they lack conceptual rigor in their explanation of problems. Particularly, the lack of knowledge and evidence base leads to an organizing agenda that is not action-oriented and, therefore, not sustainable. In the case of well-funded organizations, the organization's project agenda may differ from the needs, cultural understanding, and interests of the people in the project area. When people do not relate to the project's agenda, they do not take ownership, and the projects remain short-term. Furthermore, with the widespread professionalization of CSOs, volunteerism and philanthropy have drastically reduced in Bangladesh. In the successful cases of organizing in the past decades, volunteerism, amateur passion, and philanthropy played a vital role.

16. Concluding Remarks: Recommendations for Policymakers

The review of past decades of CSO activities to protect urban wetlands makes clear that citizens, researchers, and local communities are increasingly more active in knowledge-making processes. Alongside, arts-based awareness-building strategies have expanded in the country. A growing green agenda is clearly visible in news and print media. In case after case, water and wetland environmentalists have taken a conflictual and collaborative stance towards polluters, whether state or industrialists. Several meaningful and successful forms of organizing and networking have emerged in the past decade, and they have formed the basis of sustainable activism around water and wetlands. The movements and organizations deployed frames of nationalism, climate, rights of nature, justice, and urbanization in making their claims. Based on CSO activities, several policy recommendations can be made to protect Bangladesh's urban wetlands:

- Bangladesh's governmental institutions should disincentivize economic activities that negatively affect the ecological conditions of urban wetlands, particularly ecological processes that are vital for the maintenance of livelihoods, biodiversity, and urban ecosystem services.
- From the national to local level, civil society actors need to be included in making decisions and conducting research on urban wetlands.
- Urban-level policies need to be crafted and implemented for capturing timely information and for making integrative wetland protection plans at the watershed level.
- CSOs, research institutions, and policymakers require a dedicated channel for effective communication of research results to support wetland conservation management.

- Urban wetlands' economic value in terms of the myriad ecosystem services they provide needs to be estimated.
- Both national and local governments should emphasize community-based monitoring, assessment, and enforcement of wetland protection laws and policies.
- Moving beyond laws, governance mechanisms need to be created. Special regulations, long-term mechanisms, incentives, and technical support for wetland protection should be established to mitigate wetland degradation.
- Urban wetland policies need to be developed based on the unique context-specific challenges and opportunities of different urban centers in Bangladesh.
- Existing laws and policies need to be empirically investigated and evaluated as case studies.
- Existing wetland protection laws and plans need to be implemented, and local communities need to be centered in their monitoring and assessment.
- Executive bodies related to river and wetland management in urban regions need to be transparent and open to public scrutiny.
- Wetland governance needs to recognize that urban wetland-level protection and restoration requires a multidisciplinary approach, integrating ecological, cultural, and societal aspects to ensure the sustainable protection and management of urban wetlands.

Water and wetland movements of Bangladesh in their contentious practices show that directly affected people in Bangladesh lack access to representative institutions. The lives and livelihoods of the vulnerable are intricately tied to the water, river, and wetland ecologies in the Bengal Delta. Collectively, the movements show that development has endangered people as well as the ecosystems in the delta, and therefore, the movements are a direct response to Bangladesh's pro-growth development agenda. There's been a wide range of organizing efforts in the past decades. Paradoxically, wetland loss and river degradation have increased during this time. Environmental organizing, for the most part, was not sustainable. However, through these movements, many new conservation initiatives were generated. Local voices increased in the arena of river and wetland governance. Print and news media have taken up rivers and wetlands as one of their main issues. River and wetland movements sensitized the local Bangladeshi communities and reached national and international levels. Through contentious and collaborative organizing, wetland and river movements are altering conventional notions and practices of development. They are positioning themselves as a key actor in local and regional security as they are critical for public engagement in natural resource management. It is understandable that not all movements and activism will achieve success in concrete terms. But generating movements and sustaining dissenting activism in itself matters. Bangladesh's water and wetland civil society organizing can potentially shape the geopolitics of natural resources management in the region.

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Chapter 14

Let the Water Flow: Way Forward

Dr. Ishrat Islam, Dr. Mohammad Shakil Akther and Sumaiya Tabassum

Considering the tangible and intangible values of wetland, the global community came forward with a commitment to ensure the sustainable conservation of wetland. This vow is reflected in many global documents like the *Ramsar Convention's Strategic Plan 1997-2002* (UNESCO, 1996), *Brundtland Commission Report* (Brundtland Commission ,1987), *Agenda 21* (United Nations, 1992) and recently in SDG (2016-30) (United Nations, 2015). Considering the importance of wetland in the constitution of Bangladesh, it is stated that "*The state shall endeavor to protect and improve the environment and to preserve and safeguard the natural resources, biodiversity, wetlands, forests and wildlife for the present and future citizens.*" (Government of Bangladesh, 1972, as amended in 2011). Bangladesh has made remarkable efforts in recognizing the significance of wetlands and addressing the rules and regulations to protect them through various policies, acts, laws, plans and strategies. Among them, the National Water Policy 1999, the Environment Policy 2018, the Playground, Open Space, Park, and Natural Water Reservoir Conservation Act of 2000, the National Water Management Plan 2004 and the National Sustainable Development Strategy (NSDS) are some of the notable documents. The vast wetlands of Bangladesh are always considered a divine gift of nature. Along with other wetlands of the country,

wetlands located within the urban areas are disappearing at a very fast pace, and it is considered a major threat from environmental and socio-economic perspectives. The coexistence of nature and development is always a challenge, and keeping the balance is critical. The Environmental Law Centre of IUCN rightly identified the complex relationship among different actors and the socio-economic and political factors that shape the arena of wetland conservation and its wise use. A series of complex and dynamic relationships is evident in the battle to conserve the urban wetlands of Bangladesh.

Saving Urban Wetlands: Workshop

A stakeholder workshop was held on September 26, 2024, at BUET. The workshop was attended by 25 participants from 13 organizations, including academia, different government organizations, city corporations, NGOs, civil society organizations and media (see Figures 14.1, 14.2 and 14.3). The findings from the 12 research works conducted by 28 researchers which are included in this book on urban wetlands of Bangladesh were shared in the workshop. Based on the overall discussion in the workshop the participants suggested a guideline to safeguard the urban wetlands.

Figure 14.1: Participants attending the stakeholder workshop

Figure 14.2: Participants conducting the group discussion session

Figure 14.3: Authors shared their research findings and recommendations with the stakeholders in the workshop

The primary objectives of the workshop were the following:

- Identifying and ranking the relevant stakeholders for wetland management
- associated with the process of urban wetland management
- Pinpoint a maximum of 10 issues that are required to be addressed to ensure the protection and conservation of urban wetlands
- Identifying and ranking the relevant stakeholders for wetland management
- Analyzing the Strengths, Weaknesses, Opportunities and Threats (SWOT) of the conservation process of the urban wetlands.

Stakeholders in wetland management

The participants identified a list of stakeholders associated with wetland management. The power matrix of the stakeholders is shown in Figure 14.4.

The participants ranked the Ministry of Land and the District Commissioner (DC) and Assistant Commissioner (Land) Office as the most powerful institutions for the conservation process of the urban wetlands, as they have authoritative power to manage the wetland, particularly in the case of *khas* wetlands (such as canals, ponds, river banks, etc). The Development Authorities (such as RAJUK, KDA, CDA, etc) and the Local Government Institutions (LGIs) are the second most powerful stakeholders because they are responsible for preparing the Structure Plan and Detailed Area Plan under their jurisdiction area. Conservation of wetlands is one of their crucial responsibilities for them.

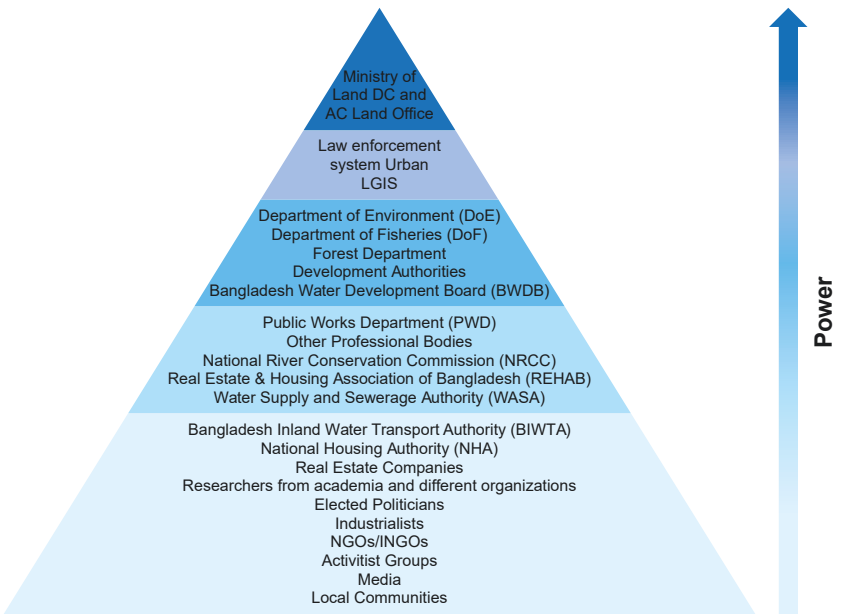

Figure 14.4: Power matrix of different stakeholders

The participants believe that officials of the Urban Development Authorities and LGIs hold the authoritative power to restrict any illegal encroachment within their jurisdiction. The law enforcement system consists of the entire judiciary system, including the law enforcement officers required to play a significant role in ensuring the strict implementation of the existing laws and regulations to protect wetlands and jointly hold the second position in the power matrix with LGIs. The fourth tier comprises the Public Works Department (PWD), professional bodies, the National River Conservation Commission (NRCC), the Housing Association of Bangladesh (REHAB)

and the Water Supply and Sewerage Authority (WASA). All of these stakeholders, except the professional bodies, hold the authoritative power of controlling wetland encroachment and ensuring proper drainage.

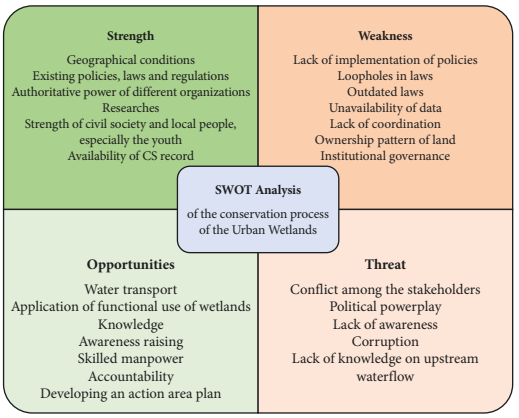

Figure 14.5: SWOT Analysis of the conservation process of the urban wetlands as prepared by participants in the workshop

The last tier, which holds the least power, contains the Bangladesh Inland Water Transport Authority (BIWTA), the National Housing Authority (NHA), real estate companies, researchers from academia and different organizations, elected politicians, industrialists, NGOs/INGOs, activist groups, media and local communities (see Figure 14.4). Although BIWTA and NHA have authoritative power, according to the participants, their power is not as strong as the other authoritative organizations identified.

Real estate companies and industrialists are responsible for most of the illegal encroachments on the urban wetlands since they have sufficient financial resources and a strong political background/power. Hence, these stakeholders have been identified by the participants as the negative force in the effort to save wetlands.

SWOT analysis of the conservationprocess of the urban wetlands

The participants of the workshop believe the geographical characteristics of our country may act as a positive stimulus in protecting wetlands (see Figure 14.5). The numerous policies, laws and acts that are already in practice for the conservation of urban wetlands are our greatest strengths and can be properly implemented through the authoritative power of the different government organizations, such as RAJUK, CDA, RDA, DoE, WASA, NRCC, etc. Additionally, research on diversified issues of conserving wetlands is being conducted, which is also one of the strengths. The availability of Cadastral Survey (CS) records can be helpful in this case as well. The power of the civil society and local people, especially the youth, has always been one of the dominant forces in safeguarding wetlands.

However, some weaknesses in the conservation process have also been mentioned by the participants (see Figure 14.5). Despite multiple policy documents for saving the wetlands, the lack of implementation of these policies makes the wetland conservation efforts vulnerable. Moreover, outdated laws are also hampering the conservation process. Despite having a huge collection of data on wetlands, they cannot be used most of the time due to limited availability of data. The ownership pattern of the land influences the encroachment of the wetlands. Furthermore, the institutional governance system failed in saving the wetlands. However, according to the participants, the most prominent weakness in the process of managing

wetlands is the lack of coordination among the stakeholders.

For managing the urban wetlands, the participants highlighted a few opportunities as well (see Figure 14.5). Considering the abundance of water bodies in Bangladesh, there is a significant prospect to popularize water transport again through integrated transport planning. Wetlands are always associated with recreational and aesthetic value. The professionals, researchers and different stakeholders required to work together in developing an action plan to conserve wetlands for retrieving its multi-faceted values. Besides these, raising awareness among the general population, recruiting more skilled manpower in the management process and ensuring their accountability are some of the other opportunities identified by the participants.

The participants have opined on multiple threats that might be present in the conservation process as well (See Figure 14.5). Conflict among the stakeholders is a major constraint, which is often backed up by political power play. Moreover, a lack of awareness among the general population regarding the environmental degradation caused by the loss of wetlands is a barrier towards the conservation approach. One of the strongest obstacles to conservation of wetlands is identified as extreme corruption prevailing among some of the major stakeholders.

Actions for saving urban wetland

Under the scope of this project, 12 research studies and one workshop was conducted. These research works presented the scenario of wetland loss from a spatio-temporal perspective. A number of research works focused on socio-economic and environmental issues associated with wetland loss. Finally, an in-depth discussion was presented in five research works on the legal framework and the role of media and civic society. Moreover, an anthological paper discussed the previous researches on wetland in Bangladesh. Finally, a workshop was arranged to share the research findings. The participants of the workshop suggested a set of measures required to be adopted for protection of urban wetlands. The following set of actions compiled under four categories are derived from the research papers and views of workshop participants.

- Planning Measures
- Legal and Regulatory Measures
- Governance and Management
- Awareness Raising
- Participatory Approach

Planning Measures

The research works conducted for this book as well as the workshop emphasize the role of physical planning in conservation and protection of urban wetlands. Bangladesh is also one of the signatories of Kunming-Montreal Bio-diversity Framework which targeted participatory, integrated, and biodiversity inclusive spatial planning. A number of goals of SDG also put emphasis on conservation of wetland and bio-diversity. Considering these the following planning measures are suggested:

- Developing an action plan to protect the wetlands of urban areas of Bangladesh.

- All urban area masterplans are required to address wetland as a critical component of planning.
- The detail area plan of the urban areas should clearly demarcate the wetland and propose necessary tools and strategies to ensure conservation of wetland.
- Incentive mechanisms such as Transfer of Development Right (TDR), tax rebates and similar other measures needed to be adapted to compensate the private wetland owners. These measures are required to be supported with necessary legal documents and institutional policies.
- Regular excavation, are dredging of wetland
- Disposal of liquid waste to wetland should be strictly prohibited. In this case separation of sewerage line from storm water drainage is necessary.

Regulatory Measures

Bangladesh as a signatory of the Ramsar Convention – the international treaty to conserve wetland systems has developed many policies and promulgated many laws for management of the wetlands. However, as the papers in this book suggested there is a problem in implementation. The researchers and the participants of the workshop suggested the following regulatory measures for wetlands of Bangladesh-

- The confusion of wetland related terminologies prevailing in the existing policy, planning and legal documents required to be standardized
- The existing laws and regulations needed to be updated.
- The strict enforcement of the laws and rules to protect wetland from encroachment, degradation and pollution.
- The eviction of illegal encroachments on wetlands should be a continuous process by the regulatory authorities.

Governance and Management

The research identified that the government is the most powerful stakeholder for protection of wetlands and there is a lack of co-ordination among the different stakeholder. Considering these aspects, the following are suggested-

- There should be a committee in every district to protect wetlands, headed by the DC. All the stakeholders including members of civic society, and NGOs who are working for protection and conservation of wetlands should be member of this committee. The committee should ensure coordination among the stakeholders, to monitor and evaluate the condition of the wetlands.
- To protect wetland from degradation and pollution, waste management is a pre-requisite.
- All the decisions should be evidence based and supported by necessary research
- Decision making should follow a participatory approach

Awareness Raising

This study identified that lack of awareness is one of the major weaknesses and threats for wetland management in Bangladesh. The followings are suggested to overcome these-

- There should be awareness raising program highlighting the environmental, social and economic importance of wetland in every community residing around wetlands regularly.
- It is essential to strengthen the local community by increasing their access to information, government policy for Transfer of Development Right, social networks, and legal and institutional support.
- The electronic and print media should regularly publish articles highlighting the importance of wetland and act as a vanguard against encroachment and degradation of wetlands.
- The advertisement of unauthorized housing on wetland in electronic and print media should be strictly prohibited.
- The officials of development agencies should be trained on conservation of wetland and how to integrate wetland in development activities.

Conclusion

Being a crucial part of the ecosystem and urban livelihood, the protection of wetlands has become a dire need. This conservation process of the wetland is a collective responsibility that demands proper inclusion and coordination of all the related stakeholders. Strict enforcement of laws and transparency in performing responsibilities are necessary as well. Hence, to stop the fading of our precious urban crisscrossed beauties, it is high time we become aware and take necessary action for them collectively.

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Being a crucial part of the ecosystem and urban livelihood, the protection of wetlands has become a dire need. This conservation process of the wetland is a collective responsibility that demands proper inclusion and coordination of all the related stakeholders. Strict enforcement of laws and transparency in performing responsibilities are necessary as well. Hence, to stop the fading of our precious urban crisscrossed beauties, it is high time we become aware and take necessary action for them collectively.

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